

ELEVATOR

FIELD

Embodiments described herein relate generally to a hybrid-drive elevator which is driven using a battery power.

BACKGROUND

In general, an elevator ascends and descends in a pulley system in which a rope is wound around a rotation shaft of a traction machine and an elevator car and a counterweight are hung at respective ends of the rope, and the car moves in an opposite direction to the counterweight by the rotation of the traction machine via the rope.

Let us suppose that an elevator car, for example, moves down in a hoistway. Here, if the weight of the car is heavier than the counterweight, the traction machine can function as a power generator to produce electrical power. Similarly, when the car moves up and the weight of the car is lighter than the counterweight, electrical power can be produced. This power is called "regenerative power" and the driving operated is carried "regenerative drive". On the other hand, the drive which requires power is called "power drive".

Recently, a hybrid-drive elevator which charges the power produced during the regenerative drive in a battery, and power from the battery is used as an assist during the power drive has been proposed.

However, general hybrid-drive elevators are manufactured to use commercial power by standard, and they do not use the battery power effectively. Further, when a power failure occurs, the source is switched from the commercial power to the battery. But the switching takes some time, and the operation temporarily stops during the power cut, disabling to continue the operation smoothly.

SUMMARY

In general, according to one embodiment, an elevator includes a drive device configured to drive a traction machine on power supplied from a commercial power source, a battery device configured to store power generated during a regenerative drive and supply the stored power to the drive device during a power drive and a control device connected to the commercial power device and the battery device, the control device configured to be disconnected from the commercial power source during a regular drive and control operation of the elevator using power supplied from the battery device.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram showing a structure of a hybrid-drive elevator according to an embodiment;

FIG. 2 is a flowchart illustrating a power supply operation during a regular operation of the elevator in the embodiment;

FIG. 3 is a diagram illustrating the states of SW1 to SW4 and the flow of power during the regular operation of the elevator in the embodiment;

FIG. 4 is a flowchart illustrating a power supply operation during parking of the elevator in the embodiment; and

FIG. 5 is a diagram illustrating the states of SW1 to SW4 and the flow of power during the parking of the elevator in the embodiment.

DETAILED DESCRIPTION

Embodiments will now be described with reference to drawings.

FIG. 1 is a diagram showing a structure of a hybrid-drive elevator according to an embodiment.

This elevator comprises a drive device 10, a battery device 20 and an elevator control device 30. The drive device 10 comprises a converter 11, a smoothing capacitor 12 and an inverter 13, and is

configured to supply power necessary to drive a traction machine 2 according to a drive instruction from the elevator control device 30.

5 The converter 11 converts an alternating-current (AC) voltage supplied from a commercial power 1 into a direct-current (DC) voltage. The commercial power 1 is a three-phase AC power source. The smoothing capacitor 12 is configured to smooth ripples of a DC voltage converted by the converter 11. The inverter 13 is
10 configured to convert a DC voltage applied from the converter 11 via the smoothing capacitor 12 by a pulse-width modulation (PWM) control into an AC voltage of any frequency and voltage value. The AC voltage inverted by the inverter 13 is supplied as drive power
15 to the traction machine 2.

 The traction machine 2 is a synchronous motor and rotated by power supplied from the drive device 10. A rope 3 is wound around the traction machine 2 via a sheave (not shown). One end of the rope 3 is coupled
20 with an elevator car 4 and the other end is coupled with a counterweight 5. With this structure, the car 4 and the counterweight 5 ascend or descend via the rope 3 in a pulley system according to the rotation of the traction machine 2.

25 The battery device 20 comprises an AC/DC converter 21, a DC/DC converter 22, a DC/DC converter 23 and a battery 24. The battery device 20 is configured to store the power of the commercial power 1 and also the power generated by the regenerative drive from the
30 drive device 10 to charge the battery 24, and supply the power charged on the battery 24 to the drive device 10 during the power drive. Further, the battery device 20 is configured to supply a necessary electrical power to the elevator control device 30.

35 The AC/DC converter 21 comprises an AC side connected to a primary side of a control power transformer 31 provided in the elevator control device

30, and a DC side connected to a DC bus line of the battery device 20. The AC/DC converter 21 comprises a function of converting AC to DC, and a function of converting DC to AC.

5 According to this embodiment, a required power is supplied from the battery device 20 to the elevator control device 30 in the regular operation. During this period, the power (DC current) of the battery device 20 is converted by the AC/DC converter 21 into
10 an alternating current of a different voltage, and the converted power is given to the primary side of the control power transformer 31 of the elevator control device 30.

15 In consideration of a voltage drop between the drive device 10 and the battery device 20, a voltage V2 of the battery power is set lower than voltage V1 of the commercial power 1. More specifically, V1 is 200V, whereas V2 is 140 to 190 V.

20 During the parking of the elevator, the power of the commercial power 1 is given to the battery device 20 via the control power transformer 31 in the elevator control device 30. During this period, the power (alternating current) of the commercial power 1 is converted by the AC/DC converter 21 into a direct
25 current of a different voltage in the battery device 20.

30 Note that the term "parking" means a state in which the operation of the elevator is stopped, for example, at night. During parking, the power supply to the drive device 10 is shut off, and the elevator car 4 is stopped at a predetermined floor.

35 The DC/DC converter 22 is provided on an upstream side of the battery 24. The DC/DC converter 21 comprises a function of converting DC to DC of a different voltage. According to this embodiment, the power generated during the regenerative drive is obtained from the drive device 10 to charge the battery

24. For charging the battery 24, the power is converted into a voltage standard of the battery 24 by the DC/DC converter 22. On the other hand, for supplying power of the battery 24 during the power drive, the power is converted into a predetermined voltage to be supplied the drive device 10.

The DC/DC converter 23 is provided between an emergency power device 32 and the DC bus line of the battery device 20. The DC/DC converter 23 comprises a function of converting DC to DC of a different voltage. The DC/DC converter 23 is operated when regenerative power obtained by the drive device 10 or power of the battery 24 is utilized as an emergency power source for the elevator control device 30.

The elevator control device 30 is built in a control board (not shown). The elevator control device 30 is configured to control the driving operation of the entire elevator system, including the control of the drive device 10 and the battery device 20. The elevator control device 30 is connected to the commercial power 1 and the battery device 20. Here, in this embodiment, the elevator control device 30 is disconnected from the commercial power 1 when regular driving and controls the driving operation of the elevator using the power supplied from the battery device 20. Further, during the parking, the elevator control device 30 applies power supplied from the commercial power 1 to the battery device 20 for charge.

The elevator control device 30 comprises the control power transformer 31, the emergency power device 32, a control power device 33 and an illumination power device 34.

The control power transformer 31 is configured to input two different types of voltages to the primary side thereof. The control power transformer 31 comprises the primary side, one terminal of which is connected to the commercial power 1, and the other one

of which is connected to the AC/DC converter 21 of the battery device 20, and a secondary side, to which the control power device 33 and the illumination power device 34 are connected. The control power transformer 31 converts the power from the commercial power 1 and that from the AC/DC converter 21, and supplies to the control power device 33 and the illumination power device 34. As described above, voltage V2 of the power supplied from the battery device 20 is set lower than voltage V1 of the power supplied from the commercial power 1 ($V2 < V1$).

The emergency power device 32 is configured to supply necessary power to devices used in emergency situations such as an emergency light and an intercom phone, and it comprises a power supply circuit and the like. The control power device 33 is configured to supply necessary power to control devices including a micro-computer circuit board, and it comprises a power supply circuit and the like. The illumination power device 34 is configured to supply necessary power to illumination and ventilation devices in the car 4, and it comprises a power supply circuit and the like.

Of these, the control power device 33 and the illumination power device 34 are operated by the power transformed by the control power transformer 31. The emergency power device 32 is operated by the power from the battery device 20 via the DC/DC converter 23.

The battery 24 comprises a large-capacitance and high-performance charge/discharge function. An example of the battery 24 is a lithium ion cell.

Further, switches SW1 to SW4 for switching power supply/shut-off are shown in the figure.

SW1 is provided in a three-phase power supply line connected between the commercial power 1 and the control power transformer 31, which is on the power input side of the elevator control device 30. When SW1 is on, power is supplied from the commercial power 1 to

the elevator control device 30.

SW2 is provided in a three-phase power supply line connected between the commercial power 1 and the converter 11, which is on the power input side of the drive device 10. When SW2 is on, power is supplied from the commercial power 1 to the drive device 10.

SW3 is provided in two power supply lines connected between the DC bus line of the drive device 10 and the DC bus line of the battery device 20. When SW3 is on, power is supplied from the drive device 10 to the battery device 20, and also power is supplied from the battery device 20 to the drive device 10.

SW4 is provided in a three-phase power supply line connected to the AC/DC converter 21, which is on the power output side of the battery device 20, and to the control power transformer 31, which is on the power input side of the elevator control device 30. When SW4 is on, power is supplied from the battery device 20 to the elevator control device 30, and power supplied to the battery device 20 via the elevator control device 30.

With the above-described structure, the battery device 20 is connected to the drive device 10 and the elevator control device 30 such as to be able to exchange power therebetween. Thus, the regenerative power obtained by the drive device during regular operations and the power of the commercial power source are charged to the battery device 20, and the charged power is not only supplied to the drive device 10 during the power drive, but also used for the operation of the elevator by supplying the power to the elevator control device 30. Further, even in the state where the power supply to the drive device 10 is shut off during the parking, the power of the commercial power 1 is given to the battery device 20 via the elevator control device 30 for charging.

The operations of the elevator in the embodiment

will now be described in detail in two parts: (a) power supply operation during regular operation and (b) power supply operation during parking.

5 (a) Power Supply Operation during Regular Operation

FIG. 2 is a flowchart illustrating the power supplying operation during a regular operation of the elevator.

10 The regular operation means operation service in which the car 4 of the elevator is moved at a predetermined speed and also stopped at a requested floor.

15 In order to start a regular operation, from the point where the parking is ended or the inspection is finished, SW1 provided between the commercial power 1 and the elevator control device 30 is on (step S11). Thus, power is supplied from the commercial power 1 to the elevator control device 30 to be started.

20 Once the elevator control device 30 is started, SW1 to SW4 are switched on or off by the elevator control device 30 thereafter. More specifically, first, the elevator control device 30 turns on SW2 provided between the commercial power 1 and the drive device 10 (step S12). Thus, the power is supplied from
25 the commercial power 1 to the drive device 10.

Subsequently, the elevator control device 30 turns on SW3 provided between the drive device 10 and the battery device 20 (step S13), and also turns on SW4 provided between the battery device 20 and the elevator control device 30 (step S14). Thus, the drive device 10 and the elevator control device 30 are connected to
30 the battery device 20.

Here, the elevator control device 30 turns off SW1 (step S15). When SW1 is off, the elevator control
35 device 30 is cut off from the commercial power 1. From this on, the elevator control device 30 operates on the power supplied from the battery device 20.

FIG. 3 is a diagram illustrating the states of SW1 to SW4 and the flow of power during the regular operation of the elevator. In this figure, arrows indicate flows of power.

5 During the regular operation, SW1 is off, whereas SW2 to SW4 are on. With this state, the drive device 10 can be operated with not only the power supplied from the commercial power 1 but also the power from the battery device 20. Further, the power obtained during the regenerative drive can be charged on the battery device 20.

10 On the other hand, the elevator control device 30 operates on the power supplied from the battery device 20. In this case, the power supplied from the battery device 20 to the elevator control device 30 contains the regenerative power obtained by the drive device 10.

15 As described above, the elevator can be operated by effectively utilizing the battery device 20 during the regular operation. Even in the case of a power failure or an open-phase error of the commercial power 1, the elevator can be operated by using the power charged on the battery 24. Here, since the battery device 20 is connected to the elevator control device 30, the operation of the elevator can be continuously performed by using the power of the battery 24 directly, without necessity for switching from the commercial power 1 to the battery device 20. More specifically, the car 4 is moved to the nearest floor with the power of the battery 24, and then the operation of the elevator is continued at a low speed or a rated speed only for a determined time.

20 Further, conventionally, when switching from the commercial power to a battery power, the voltage temporarily drops, which causes a shock to swing the car 4 or flickering of the light, etc. However, in this embodiment, the battery power is used from the beginning, thereby making it possible to prevent such a

shock (shock-free operation), and continuously operate the elevator.

Moreover, even in such a case where the primary side, that is, the power input side, of the drive device 10 is damaged, disabling to receive the power from the commercial power 1, the elevator can be operated continuously by supplying the power from the battery device 20 to the drive device 10.

(b) Power Supply Operation during Parking

FIG. 4 is a flowchart illustrating the power supplying operation during parking of the elevator.

For example, at night, when the regular operation is finished, the operation of the elevator is stopped, which is called "parking".

When shifted from a regular operation to parking (Yes in step S21), the elevator control device 30 turns off SW2 provided between the commercial power 1 and the drive device 10, and also turns off SW3 provided between the drive device 10 and the battery device 20 (step S22). In this manner, the power supply to the drive device 10 is shut off, thereby making it possible to prevent wasteful power consumption.

Then, the elevator control device 30 turns on SW1 provided between the commercial power 1 and the elevator control device 30 (step S23). At this point, SW4 provided between the battery device 20 and the elevator control device 30 is ON. Therefore, as SW1 is on, the power of the commercial power 1 is supplied to the battery device 20 via the control power transformer 31 of the elevator control device 30. The power supplied from the elevator control device 30 to the battery device 20 is stored in the battery 24 via the AC/DC converter 21 and the DC/DC converter 22.

FIG. 5 is a diagram illustrating the states of SW1 to SW4 and the flow of power during the parking of the elevator. In this figure, arrows indicate flows of power.

During the parking, SW1 is on, SW2 to SW3 are off and SW4 is on. With this arrangement, the battery 24 can be charged by the power from the commercial power 1 via the control power transformer 31 of the elevator control device 30. Thus, the regular operation can be started with the power of the battery 24 fully charged during the parking.

Note that, for example, the drive device 10 breaks down, it is possible to supply power from the battery device 20 to the emergency power device 32.

According to at least one of the embodiments described above, it is possible to provide an elevator which can be operated by effectively utilizing a battery power and can be continuously operated without any problem even in the case of a power failure.

Note that the embodiments provided above are described in connection with the structure in which the power from the commercial power 1 is also charged in the battery 24 during the regular operation, but the embodiments are not limited to this. That is, it is not essentially necessary to utilize the power of the commercial power 1 for charging, but it suffices if only the regenerative power is used for charging the battery 24.

While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

WHAT IS CLAIMED IS:

1. An elevator comprising:

a drive device configured to drive a traction machine on power supplied from a commercial power source;

a battery device configured to store power generated during a regenerative drive and supply the stored power to the drive device during a power drive; and

a control device connected to the commercial power device and the battery device, the control device configured to be disconnected from the commercial power source during a regular drive and control operation of the elevator using power supplied from the battery device.

2. The elevator of Claim 1, wherein

the control device is configured to charge the battery device with the power supplied from the commercial power device during parking.

3. The elevator of Claim 1, further comprising:

a first switch provided in a first power supply line between the commercial power source and the control device;

a second switch provided in a second power supply line between the commercial power source and the drive device;

a third switch provided in a third power supply line between the drive device and the battery device; and

a fourth switch provided in a fourth power supply line between the battery device and the drive device;

wherein the control device is configured to: during the regular drive, turns on the first switch to connect to the commercial power source; turns on, while being connected to the commercial power source, the second switch and the third switch to connect the commercial power source and the battery device to the

drive device; turns on the fourth switch to connect the control device to the battery device; and thereafter, turns off the first switch, to separate the control device from the commercial power source, thereby
5 controlling the operation of the elevator using the power supplied from the battery device.

4. The elevator of Claim 3, wherein
the control device is configured to: during the parking, turns off the second switch and the third
10 switch to disconnect the commercial power source and the battery device from the drive device; thereafter, turns on the first switch to connect to the commercial power source, thereby charging the battery device with the power supplied from the commercial power source.

5. The elevator of Claim 1, wherein
the control device comprises a transformer on a primary side thereof, configured to receive two
different types of voltages, one terminal of the primary side being connected to the commercial power
15 source, and an other being connected to the battery device.

6. The elevator of Claim 5, wherein
a voltage of the battery device input to the transformer is set lower than that of the commercial
20 power source.

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