

TITLE OF THE INVENTION

CONTROL DEVICE OF ELEVATOR

BACKGROUND OF THE INVENTION

5 The present invention relates generally to a
control device of an elevator, and more particularly to
a control device of an elevator which controls the
driving of an inverter device by using a current-
feedback control method.

10 In normal cases, in an elevator, electric currents
of respective phases, which are supplied from an
inverter device to an electric motor, are detected by a
current detector, and the detected current is fed back
to a control device, thereby executing speed control.
This method is called "current-feedback control". A
15 magnetic-type current sensor, which is composed of a
core and a Hall element, is generally used as the
current detector.

20 In this magnetic-type current sensor, a magnetic
field, which is generated in the core by a current to
be measured, is converted to a voltage signal by the
Hall element. At this time, a minute magnetic flux
remains in the core and there is a problem that such a
residual magnetic flux adversely affects subsequent
current detection.

25 There is known a prior-art technique of
eliminating a detection error due to such a residual
magnetic flux, as disclosed in, for instance, Jpn. Pat.

Appln. KOKAI Publication No. 10-164885. This patent document discloses that an offset amount of the current detector is memorized each time the elevator is stopped, and a mean value of the offset amounts is calculated as a correction amount of a current detection value.

The technique of the above-described patent document, however, aims at correcting the offset amount by calculations, and does not intend to eliminate the residual magnetic flux itself in the current sensor.

The residual magnetic flux is not fixed and is an uncertain factor that varies from with time. Thus, the correction method using calculations cannot necessarily solve the above-described problem, and the speed control may be affected.

BRIEF SUMMARY OF THE INVENTION

Embodiments of the present invention eliminate a detection error due to a residual magnetic flux of a current sensor and always execute high-precision speed control by exact current detection.

One aspect of the present invention provides a control device of an elevator which detects a current, which is supplied from an inverter device to a motor, by a magnetic-type current sensor, and controls driving of the inverter device on the basis of a detection value of the detected current, comprising: a demagnetization control unit which supplies, in a short time period at a timing associated with an operation of the elevator, a

current for demagnetizing a residual magnetic flux of the current sensor, thereby restoring the current sensor to a reset state.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

FIG. 1 shows the structure of a control device of an elevator according to a first embodiment of the present invention;

5 FIG. 2 is a schematic view for describing the structure of a magnetic-proportion-type current sensor which is used as a current sensor in the first embodiment;

10 FIG. 3 is a diagram for explaining a sweep current which is used as a current for demagnetization in the first embodiment;

FIG. 4 is a flowchart illustrating a process operation of the control device of the elevator according to the first embodiment;

15 FIG. 5 is a flowchart illustrating a process operation of a control device of an elevator according to a second embodiment of the invention;

20 FIG. 6 shows the structure of a control device of an elevator according to a third embodiment of the invention;

FIG. 7 is a schematic view for describing the structure of a magnetic-balance-type current sensor which is used as a current sensor in the third

embodiment;

FIG. 8 is a flowchart illustrating a process operation of a control device of an elevator according to the third embodiment;

5 FIG. 9 shows the structure of a control device of an elevator according to a fourth embodiment of the invention;

FIG. 10 is a flowchart illustrating a process operation of a control device of an elevator according to the fourth embodiment;

FIG. 11 is a flowchart illustrating a process operation of a control device of an elevator according to a fifth embodiment of the invention;

15 FIG. 12 is a flowchart illustrating a process operation of a control device of an elevator according to a sixth embodiment of the invention;

FIG. 13 is a flowchart illustrating a process operation of a control device of an elevator according to a seventh embodiment of the invention;

20 FIG. 14 is a flowchart illustrating a process operation of a control device of an elevator according to an eighth embodiment of the invention; and

FIG. 15 is a flowchart illustrating a process operation of a control device of an elevator according to a ninth embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the present invention will now be

described with reference to the accompanying drawings.
(First Embodiment)

FIG. 1 shows the structure of a control device of
an elevator according to a first embodiment of the
5 present invention. A driving system of the elevator
includes a three-phase AC power supply 101, a converter
device 102, a smoothing capacitor 103, an inverter
device 104, current sensors (CS) 105A and 105B, a motor
106, a regenerative resistor 107, and a switching
10 element 108.

The three-phase AC power supply 101 supplies an AC
voltage of a predetermined power as a commercial power
supply. The converter device 102 converts the AC
voltage, which is supplied from the three-phase AC
15 power supply 101, to a DC voltage. The smoothing
capacitor 103 smoothes an output voltage from the
converter device 102. The inverter device 104 converts
the DC voltage, which is delivered from the converter
device 102 via the smoothing capacitor 103, to an AC
20 voltage of an arbitrary frequency and voltage value by
pulse-width modulation (PWM) control. The AC voltage,
which is obtained by the conversion, is supplied to the
motor 106 as a driving power.

A windup sheave 11 is attached to a rotational
25 shaft of the motor 106. A car 13 and a counterweight
14 are vertically moved in a well-bucket fashion within
an elevation passage via a rope 12 that is passed over

the sheave 11.

The regenerative resistor 107 is a resistor for converting regenerative power to thermal energy. The switching element 108 is turned on at a time of
5 regenerative driving, and causes regenerative power, which reversely flows from the inverter device 104, to flow to the regenerative resistor 107.

For example, in the case where the car 13 moves downward along the elevation path, if the load of the
10 car 13 is heavier than the counterweight 14, no driving power is needed. Thus, the motor 106 functions as a power generator and generates regenerative power. On the other hand, in the case where the car 13 moves upward along the elevation path, if the load of the car
15 13 is lighter than the counterweight 14, no driving power is needed, and regenerative power is produced. In this way, the driving of the car, which requires no driving power, is called "regenerative driving". Conversely, the driving that requires driving power is
20 called "power driving". The power that is produced at the time of regenerative driving is converted to thermal energy by the regenerative resistor 107 via the switching element 108, and is thus consumed.

The current sensors 105A and 105B are provided
25 between the inverter device 104 and the motor 106, and detect currents of respective phases that are supplied from the inverter device 104. The structure of the

current sensor 105A, 105B will be described later with reference to FIG. 2.

The current that is detected by the current sensor 105A, 105B is converted to a voltage signal and
5 supplied to a voltage detection circuit 109. The voltage detection circuit 109 detects the voltage signal as a current value of the current that is being supplied to the motor 106, and delivers the detected current value to a control device 110.

10 The control device 110 is composed of a computer in which a CPU, a ROM and a RAM, for instance, are mounted. The control device 110 controls the driving of the inverter device 104 on the basis of the current values which are detected by the current sensors 105A
15 and 105B. In addition, the control device 110 switch-controls the switching element 108 in accordance with the present driving state (regenerative/power).

The control device 110 includes a demagnetization control unit 110a as a function relating to the present
20 invention. The demagnetization control unit 110a supplies a current for demagnetization to the current sensors 105A and 105B at a predetermined timing, and demagnetizes a residual magnetic flux.

A gate driving circuit 111 delivers each control
25 signal, which is output from the control device 110, to the inverter device 104 and the switching element 108.

FIG. 2 is a schematic view for describing the

structure of the current sensor 105A, 105B which is used in the present device.

In normal cases, a magnetic-proportion-type current sensor 20, as shown in FIG. 2, is used as the
5 current sensor 105A, 105B. The magnetic-proportion-type current sensor 20 comprises a magnetic core 21 having a gap, a Hall element 22 that is an electromagnetic conversion element, and an amplifier circuit 23 that amplifies an output from the Hall
10 element 22. When a current that is to be measured flows through a conductor wire 24, a magnetic field, which is proportional to the to-be-measured current, is generated in the magnetic core 21. The Hall element 22 converts the magnetic field, which is generated in the
15 magnetic core 21, to a voltage signal. This voltage signal is amplified by the amplifier circuit 23 and is output.

In the meantime, in the current sensor 105A, 105B having the above-described structure, a magnetic flux
20 remains in the magnetic core 21 and adversely affects subsequent current detection.

To solve this problem, in the first embodiment, each time the elevator (car 13) stops at a target floor, a sweep current, as shown in FIG. 3, is supplied
25 to the current sensor 105A, 105B in a short time period. Thereby, the residual magnetic flux in the current sensor 105A, 105B is demagnetized and the

current sensor 105A, 105b is restored to a reset state (non-current-detection state).

5 An initial value I_x of the sweep current (alternating current) is set at a rated current of the current sensor 105A, 105B. The sweep current is controlled and attenuated from the initial value I_x to zero within a predetermined time period t_x with a predetermined frequency T_x . By supplying the sweep current at high frequency, the residual magnetic flux
10 can efficiently be demagnetized in a short time period. Conversely, even in the case of supplying a sweep current, if the frequency of the sweep current is low, a long time is needed for demagnetization and it is difficult to completely demagnetize the residual
15 magnetic flux.

Next, a process operation of the first embodiment is described.

FIG. 4 is a flowchart illustrating the process operation of the control device of the elevator
20 according to the first embodiment.

Upon occurrence of a car call or a hall call, a driving instruction is input to the control device 110. Thereby, the control device 110 controls the driving of the inverter device 104 and starts driving the elevator
25 (car 13) (step A11). When the elevator arrives at a target floor (step A12), the control device 110 executes control to finish driving the elevator

(step A13).

Assume now that information (e.g., the position of the car, opening/closing of the door, etc.) during the driving of the elevator is successively input to the control device 110. In addition, the current, which is supplied from the inverter device 104 to the motor 106, is detected by the current sensors 105A and 105B, and the detected current is fed back to the control device 110. Based on the detection value, the control device 110 controls the driving of the inverter device 104 and runs the elevator at a target speed.

On finishing driving the elevator, the control device 110 controls demagnetization of the current sensor 105A, 105B (step A14). After the demagnetization control, the control device 110 opens/closes the door of the elevator door and transitions to the preparation for subsequent driving (step A15).

In the above description, the phrase "finishing driving the elevator" refers to the state in which the elevator (car 13) arrives at a target floor and the rotation of the motor 106 is stopped.

The demagnetization control is executed by supplying a current for demagnetization from the inverter device 104 to the current sensor 105A, 105B in a short time period. Specifically, as has been described with reference to FIG. 3, the preset current

I_x is supplied in such a manner as to be gradually attenuated to zero within the predetermined time period t_x with the predetermined frequency T_x.

As described above, when the driving of the elevator stops, the sweep current is supplied to the current sensor 105A, 105B in a short time period. Thereby, the residual magnetic flux remaining in the current sensor 105A, 105B can be demagnetized and the current sensor 105A, 105B can be restored to the reset state. Therefore, a shift amount of the hysteresis voltage of the current sensor 105A, 105B can be suppressed and an exact current value can always be obtained, and high-precision speed control can be executed on the basis of the current value.

(Second Embodiment)

Next, a second embodiment of the present invention is described.

In the first embodiment, the preset sweep current is supplied as the current for demagnetization. On the other hand, the second embodiment is characterized by supplying a reverse-bias current as a current for demagnetization.

The structure of the device is the same as shown in FIG. 1, so a description of the structure is omitted here. The process operation of the second embodiment is described below.

FIG. 5 is a flowchart illustrating the process

operation of the control device of the elevator according to the second embodiment.

Upon occurrence of a car call or a hall call, a driving instruction is input to the control device 110. Thereby, the control device 110 controls the driving of the inverter device 104 and starts driving the elevator (car 13) (step B11). When the elevator arrives at a target floor (step B12), the control device 110 executes control to finish driving the elevator (step B13).

It is assumed that information (e.g., the position of the car, opening/closing of the door, etc.) during the driving of the elevator is successively input to the control device 110. In addition, the current, which is supplied from the inverter device 104 to the motor 106, is detected by the current sensors 105A and 105B, and the detected current is fed back to the control device 110. Based on the detection value, the control device 110 controls the driving of the inverter device 104 and runs the elevator at a target speed.

On finishing driving the elevator, the control device 110 detects the output voltage of the current sensor 105A, 105B via the current detection circuit 109 (step B14), and calculates the value of current corresponding to the residual magnetic flux of the current sensor 105A, 105B, on the basis of the detected voltage value (step B15). The control device 110

supplies, as a reverse-bias current, the current having the value obtained by the calculation to the current sensor 105A, 105b via the inverter device 104 in a short time period, thereby carrying out the demagnetization control (step B16). After the demagnetization control, the control device 110 opens/closes the door of the elevator door and transitions to the preparation for subsequent driving (step B17).

Even with the structure in which the current corresponding to the residual magnetic flux of the current sensor 105A, 105B is supplied as the reverse-bias current in the short time period, it is possible, as in the first embodiment, to demagnetize the residual magnetic flux of the current sensor 105A, 105B and to restore the current sensor 105A, 105B to the reset state. Therefore, a shift amount of the hysteresis voltage of the current sensor 105A, 105B can be suppressed and an exact current value can always be obtained, and high-precision speed control can be executed.

(Third Embodiment)

Next, a third embodiment of the present invention is described.

The third embodiment is configured to execute the demagnetization control after the power supply to the current sensor is turned off.

FIG. 6 shows the structure of a control device of an elevator according to the third embodiment of the invention. The structural parts common to those in the first embodiment are denoted by like reference numbers,
5 and a description thereof is omitted.

Unlike the structure of FIG. 1, the structure shown in FIG. 6 includes a CS power supply 112 for supplying driving currents to the current sensors 105A and 105B, opening/closing switching 114A and 114B which
10 are provided between the CS power supply 112 and the current sensors 105A and 105B, and a switch driving circuit 113 which opens/closes the opening/closing switches 114A and 114B.

When a residual magnetic flux of the current
15 sensor 105A, 105B is to be demagnetized, if the CS power supply 112 is on, it is possible that the residual magnetic flux cannot completely be reduced to zero even if the current for demagnetization is supplied to the current sensors 105A and 105B. In
20 particular, in the case of using a magnetic-balance-type current sensor 30, as shown in FIG. 7, as the current sensor 105A, 105B, this possibility becomes higher. Specifically, this current sensor 30 is a closed-loop-type sensor in which a feedback current is
25 caused to flow in a secondary winding so as to always cancel a magnetic field due to the to-be-measured current.

As shown in FIG. 7, the magnetic-balance-type current sensor 30 comprises a magnetic core 31 having a gap, a secondary winding (coil) 32 that is wound around the magnetic core 31, a Hall element 33 that is an
5 electromagnetic conversion element, and an amplifier circuit 34 that amplifies an output from the Hall element 33.

The secondary winding 32 is wound in such a direction as to cancel the magnetic field that is
10 generated by the to-be-measured current. When the to-be-measured current flows in a conductor wire 35, a magnetic field, which is proportional to the to-be-measured current, is generated in the magnetic core 31. The Hall element 33 converts the magnetic field, which
15 is generated in the magnetic core 31, to a voltage signal. This voltage signal is converted to a current by the amplifier circuit 34 and is fed back to the secondary winding 32. Thereby, the canceling magnetic field, which is generated in the secondary winding 32,
20 cancels the magnetic field that is generated by the to-be-measured current, thus always keeping the magnetic field in the gap at zero. In addition, the canceling current, which flows in the secondary winding 32, is converted to a voltage signal via an output resistor 36
25 and is derived as a sensor output.

In this structure, if the CS power supply 112 is turned on, a magnetic flux tends to easily stay in the

secondary winding 32 and the magnetic flux adversely affects subsequent current detection. Thus, in the third embodiment, the CS power supply 112 is once turned off, and then the demagnetization control is executed. Thereby, the residual magnetic flux is surely demagnetized.

Next, a process operation of the third embodiment is described.

FIG. 8 is a flowchart illustrating the process operation of the control device of the elevator according to the third embodiment.

Upon occurrence of a car call or a hall call, a driving instruction is input to the control device 110. Thereby, the control device 110 controls the driving of the inverter device 104 and starts driving the elevator (car 13) (step C11). When the elevator arrives at a target floor (step C12), the control device 110 executes control to finish driving the elevator (step C13).

Assume now that information (e.g., the position of the car, opening/closing of the door, etc.) during the driving of the elevator is successively input to the control device 110. In addition, the current, which is supplied from the inverter device 104 to the motor 106, is detected by the current sensors 105A and 105B, and the detected current is fed back to the control device 110. Based on the detection value, the control device

110 controls the driving of the inverter device 104 and runs the elevator at a target speed.

On finishing driving the elevator, the control device 110 opens the opening/closing switches 114A and 114B via the switch driving circuit 113, and turns the
5 CS power supply 112 off (step C14). In this state, the control device 110 executes the demagnetization control of the current sensor 105A, 105B (step C15). After the demagnetization control, the control device 110
10 opens/closes the door of the elevator door (step C16), closes the opening/closing switches 114A and 114B to turn the CS power supply 112 back on, and transitions to the preparation for subsequent driving (step C17).

In the above description, the phrase "finishing driving the elevator" refers to the state in which the
15 elevator (car 13) arrives at a target floor and the rotation of the motor 106 is stopped.

The demagnetization control is executed by supplying a current for demagnetization from the inverter device 104 to the current sensor 105A, 105B in
20 a short time period. Specifically, as has been described with reference to FIG. 3, the preset current I_x is supplied in such a manner as to be gradually attenuated to zero within the predetermined time period t_x with the predetermined frequency T_x . In the
25 meantime, as in the second embodiment, the reverse-bias current may be calculated and supplied in a short time

period.

As described above, the CS power supply 112 is once turned off and then the demagnetization control is executed. Thereby, the residual magnetic flux
5 remaining in the current sensor 105A, 105B can be demagnetized more exactly, and the accuracy of current detection can be increased.

(Fourth Embodiment)

Next, a fourth embodiment of the present invention
10 is described.

The feature of the fourth embodiment is that when an abnormality is detected in the output of the current sensor after the demagnetization control, a protection operation is performed and an alarm reporting the
15 abnormality is issued.

FIG. 9 shows the structure of a control device of an elevator according to the fourth embodiment of the invention. The structural parts common to those shown in FIG. 1 of the first embodiment are denoted by like
20 reference numbers, and a description thereof is omitted.

Unlike the structure of FIG. 1, the structure shown in FIG. 9 includes a protection operation unit 115 and an alarm issuance unit 116. The protection
25 operation unit 115 executes a predetermined protection operation for securing safety when an abnormality is detected in the output of the current sensor 105A, 105B

after the demagnetization control. For example, the protection operation unit 115 halts the service driving of the elevator in accordance with an instruction from the control device 110.

5 The alarm issuance unit 116 cooperates with the protection operation unit 115 to issue an alarm reporting the abnormality at a predetermined location. The predetermined location may be, for instance, a location where the present device is installed (e.g., a
10 machine room or a building management room), or an outside remote-control center that is connected to the control device of the elevator via a communication network. In short, the predetermined location may be a location where a management worker or a maintenance
15 worker can immediately confirm the alarm. In addition, the methods of issuing an alarm may include a method of outputting an alarm sound via a speaker, a method of outputting an alarm message by sound, and a method of displaying an alarm message on a display device.

20 Next, a process operation of the fourth embodiment is described.

FIG. 10 is a flowchart illustrating the process operation of the control device of the elevator according to the fourth embodiment.

25 Upon occurrence of a car call or a hall call, a driving instruction is input to the control device 110. At this time, the control device 110 detects the output

voltages of the current sensors 105A and 105B via the current detection circuit 109 (step D11), and determines whether the output voltage value is within a preset range of normal values (step D12).

5 If the output voltage value of the current sensor 105A, 105B exceeds the preset range (No in step D12), the control device 110 executes the demagnetization control of the current sensor 105A, 105B (step D13).

10 The demagnetization control may be executed by supplying a preset sweep current to the current sensor 105A, 105B in a short time period, as in the above-described first embodiment. Alternatively, as in the second embodiment, the demagnetization control may be executed by calculating the reverse-bias current and
15 supplying it to the current sensor 105A, 105B in a short time period.

 After the demagnetization control, the control device 110 checks once again the output voltages of the current sensors 105A and 105B (step D14). Normally,
20 the output voltage value of the current sensor 105A, 105B is approximately zero, since the residual magnetic flux of the current sensor 105A, 105B is demagnetized by the demagnetization control and the current sensor 105A, 105B is set in the state prior to driving.
25 However, if the output voltage value exceeds the preset range (No in step D15), the control device 110 determines that the current sensor 105A, 105B is

faulty. Immediately thereafter, the control device 110
activates the protection operation unit 115 and halts
the service driving of the elevator (step D16) and
activates the alarm issuance unit 116 to issue an alarm
5 reporting an abnormality (step D17).

On the other hand, in step D12 or step D15, if the
output voltage of the current sensor 105A, 105B is
within the preset range, the control device 110
controls, as in normal cases, the driving of the
10 inverter device 104 and starts driving the elevator
(car 13) (step D18). When the elevator arrives at a
target floor (step D19), the control device 110
executes control to finish driving the elevator (step
D20).

15 It is assumed that information (e.g., the position
of the car, opening/closing of the door, etc.) during
the driving of the elevator is successively input to
the control device 110. In addition, the current,
which is supplied from the inverter device 104 to the
20 motor 106, is detected by the current sensor 105A,
105B, and the detected current is fed back to the
control device 110. Based on the detection value, the
control device 110 controls the driving of the inverter
device 104 and runs the elevator at a target speed.

25 On finishing driving the elevator, the control
device 110 executes the demagnetization control of the
current sensor 105A, 105B (step D21). The phrase

"finishing driving the elevator" refers to the state in which the elevator (car 13) arrives at a target floor and the rotation of the motor 106 is stopped.

After the demagnetization control, the control
5 device 110 checks once again the output voltage of the
current sensor 105A, 105B (step D22). If the output
voltage value of the current sensor 105A, 105B falls
within the preset range (Yes in step D23), the control
device 110 opens/closes the door of the elevator door
10 and transitions to the preparation for subsequent
driving (step D24). On the other hand, if the output
voltage value exceeds the preset range (No in step
D23), the control device 110 determines that the
current sensor 105A, 105B is faulty. Immediately
15 thereafter, the control device 110 activates the
protection operation unit 115 and halts the service
driving of the elevator (step D16) and activates the
alarm issuance unit 116 to issue an alarm reporting an
abnormality (step D17).

20 As has been described above, when an abnormality
is detected in the output of the current sensor 105A,
105B after the demagnetization control, the elevator is
stopped and an alarm reporting the abnormality is
issued. Thereby, the influence of a malfunction of the
25 current sensor 105A, 105B is prevented and the safety
of passengers can be secured. Moreover, a maintenance
worker can quickly cope with the abnormality, for

example, by replacing the current sensor 105A, 105B.
(Fifth Embodiment)

Next, a fifth embodiment of the present invention is described.

5 The first embodiment is configured to execute, without condition, the demagnetization control of the current sensor when the driving of the elevator is stopped. On the other hand, the fifth embodiment is characterized by executing the demagnetization control
10 only in the case where an output variation of the current sensor before and after the driving is a preset value or more when the driving of the elevator is stopped.

Next, referring to the structure of FIG. 9 (the
15 fourth embodiment) by way of example, a process operation of the fifth embodiment is described.

FIG. 11 is a flowchart illustrating the process operation of the control device of the elevator according to the fifth embodiment.

20 Upon occurrence of a car call or a hall call, a driving instruction is input to the control device 110. At this time, the control device 110 detects the output voltage of the current sensor 105A, 105B via the current detection circuit 109 (step E11), and
25 determines whether the output voltage value is within a preset range of normal values (step E12).

If the output voltage value of the current sensor

105A, 105B exceeds the preset range (No in step E12),
the control device 110 determines that the current
sensor 105A, 105B is faulty. Immediately thereafter,
the control device 110 activates the protection
5 operation unit 115 and halts the service driving of the
elevator (step E22) and activates the alarm issuance
unit 116 to issue an alarm reporting an abnormality
(step E23).

On the other hand, if the output voltage of the
10 current sensor 105A, 105B is within the preset range
(Yes in step E12), the control device 110 controls, as
in normal cases, the driving of the inverter device 104
and starts driving the elevator (car 13) (step E13).
When the elevator arrives at a target floor (step E14),
15 the control device 110 executes control to finish
driving the elevator (step E15).

It is assumed that information (e.g., the position
of the car, opening/closing of the door, etc.) during
the driving of the elevator is successively input to
20 the control device 110. In addition, the current,
which is supplied from the inverter device 104 to the
motor 106, is detected by the current sensor 105A,
105B, and the detected current is fed back to the
control device 110. Based on the detection value, the
25 control device 110 controls the driving of the inverter
device 104 and runs the elevator at a target speed.

On finishing driving the elevator, the control

device 110 detects the output voltage of the current sensor 105A, 105B via the voltage detection circuit 109 (step E16). The phrase "finishing driving the elevator" refers to the state in which the elevator (car 13) arrives at a target floor and the rotation of the motor 106 is stopped.

The control device 110 determines whether a difference between the detected output voltage of the current sensor 105A, 105B and the output voltage that was detected in step E11 before the driving is a preset value or more (step E17). If the difference between the output voltages before and after the driving is the preset value or more (Yes in step E17), the control device 110 executes the demagnetization control of the current sensor 105A, 105B (step E18).

On the other hand, if the difference between the output voltages before and after the driving is less than the preset value (No in step E17), the control device 110 does not execute the demagnetization control and determines whether the output voltage value is within the preset range of normal values (step E20). If the output voltage value exceeds the preset range (No in step E20), the control device 110 determines that the current sensor 105A, 105B is faulty. Immediately thereafter, the control device 110 activates the protection operation unit 115 and halts the service driving of the elevator (step E22) and

activates the alarm issuance unit 116 to issue an alarm reporting an abnormality (step E23).

5 If the output voltage value falls within the preset range (Yes in step E20), the control device 110 opens/closes the door of the elevator door and transitions to the preparation for subsequent driving (step E21).

10 The demagnetization control may be executed by supplying a preset sweep current to the current sensor 105A, 105B in a short time period, as in the above-described first embodiment. Alternatively, as in the second embodiment, the demagnetization control may be executed by calculating the reverse-bias current and supplying it to the current sensor 105A, 105B in a
15 short time period.

After the demagnetization control, the control device 110 detects the output voltage of the current sensor 105A, 105B (step E19) and determines whether the output voltage value is within the preset range of
20 normal values (step E20). If the output voltage value exceeds the preset range (No in step E20), the control device 110 determines that the current sensor 105A, 105B is faulty. Immediately thereafter, the control device 110 activates the protection operation unit 115
25 and halts the service driving of the elevator (step E22) and activates the alarm issuance unit 116 to issue an alarm reporting an abnormality (step E23).

If the output voltage value falls within the preset range (Yes in step E20), the control device 110 opens/closes the door of the elevator door and transitions to the preparation for subsequent driving (step E21).

As has been described above, the demagnetization control is executed only in the case where an output variation of the current sensor 105A, 105B before and after the driving is a preset value or more when the driving of the elevator is stopped. This makes it needless to execute the demagnetization control each time the driving of the elevator is stopped. The current sensor 105A, 105B is efficiently demagnetized, as needed, and the current sensing precision can be maintained.

In this description, the structure of FIG. 9, which includes the protection operation unit 115 and alarm issuance unit 116, has been exemplified. The present embodiment, however, is similarly applicable to the structure of FIG. 1 (the first embodiment) or the structure of FIG. 6 (the third embodiment).

(Sixth Embodiment)

Next, a sixth embodiment of the present invention is described.

The first embodiment is configured to execute, without condition, the demagnetization control of the current sensor when driving the elevator is finished.

On the other hand, the sixth embodiment is characterized by executing the demagnetization control only in the case where an elapsed time from starting to finishing driving the elevator equals or exceeds a
5 preset time when driving the elevator is finished.

Next, referring to the structure of FIG. 9 (the fourth embodiment) by way of example, a process operation of the sixth embodiment is described.

FIG. 12 is a flowchart illustrating the process
10 operation of the control device of the elevator according to the sixth embodiment.

Upon occurrence of a car call or a hall call, a driving instruction is input to the control device 110. Thereby, the control device 110 controls the driving of
15 the inverter device 104 and starts driving the elevator (car 13) (step F11). When the elevator arrives at a target floor (step F12), the control device 110 executes control to finish driving the elevator (step F13).

20 It is assumed that information (e.g., the position of the car, opening/closing of the door, etc.) during the driving of the elevator is successively input to the control device 110. In addition, the current, which is supplied from the inverter device 104 to the
25 motor 106, is detected by the current sensor 105A, 105B, and the detected current is fed back to the control device 110. Based on the detection value, the

control device 110 controls the driving of the inverter device 104 and runs the elevator at a target speed.

When the driving of the elevator is stopped, the control device 110 calculates the elapsed time from starting to finishing driving the elevator (step F14).
5 The phrase "finishing driving the elevator" refers to the state in which the elevator (car 13) arrives at a target floor and the rotation of the motor 106 is stopped.

10 The control device 110 determines whether the calculated elapsed time equals or exceeds the preset time (step F15). If the calculated elapsed time equals or exceeds the preset time (Yes in step F15), the control device 110 executes the demagnetization control
15 of the current sensor 105A, 105B (step F16). The reason for this is that the time of excitation of the current sensor 105A, 105B becomes longer as the elapsed time becomes longer, and there is a higher possibility that there remains a greater residual magnetic flux.
20 On the other hand, if the elapsed time is less than the preset time (No in step F15), the control device 110 does not execute the demagnetization control and opens/closes the door of the elevator, thus transitioning to the preparation for subsequent driving
25 (step F19)

The demagnetization control may be executed by supplying a preset sweep current to the current sensor

105A, 105B in a short time period, as in the above-described first embodiment. Alternatively, as in the second embodiment, the demagnetization control may be executed by calculating the reverse bias current and supplying it to the current sensor 105A, 105B in a short time period.

After the demagnetization control, the control device 110 detects the output voltage of the current sensor 105A, 105B (step F17) and determines whether the output voltage value is within the preset range of normal values (step F18). If the output voltage value exceeds the preset range (No in step F18), the control device 110 determines that the current sensor 105A, 105B is faulty. Immediately thereafter, the control device 110 activates the protection operation unit 115 and halts the service driving of the elevator (step F20) and activates the alarm issuance unit 116 to issue an alarm reporting an abnormality (step E21).

If the output voltage value falls within the preset range (Yes in step F18), the control device 110 opens/closes the door of the elevator door and transitions to the preparation for subsequent driving (step F19).

As has been described above, the demagnetization control is executed only in the case where the elapsed time from starting to finishing driving equals or exceeds the preset time when driving the elevator is

finished. This makes it needless to execute the demagnetization control each time the driving of the elevator is stopped. The current sensor 105A, 105B is efficiently demagnetized, as needed, and the current
5 sensing precision can be maintained.

In this description, the structure of FIG. 9, which includes the protection operation unit 115 and alarm issuance unit 116, has been exemplified. The present embodiment, however, is similarly applicable to
10 the structure of FIG. 1 (the first embodiment) or the structure of FIG. 6 (the third embodiment).

(Seventh Embodiment)

Next, a seventh embodiment of the invention is described.

15 The first embodiment is configured to execute, without condition, the demagnetization control of the current sensor when the driving of the elevator is stopped. On the other hand, the seventh embodiment is characterized by executing the demagnetization control
20 only in the case where an output voltage of the current sensor is a preset value or more when the driving of the elevator is stopped.

Next, referring to the structure of FIG. 9 (the fourth embodiment) by way of example, a process
25 operation of the seventh embodiment is described.

FIG. 13 is a flowchart illustrating the process operation of the control device of the elevator

according to the seventh embodiment.

Upon occurrence of a car call or a hall call, a driving instruction is input to the control device 110. Thereby, the control device 110 controls the driving of the inverter device 104 and starts driving the elevator (car 13) (step G11). When the elevator arrives at a target floor (step G12), the control device 110 executes control to finish driving the elevator (step G13).

It is assumed that information (e.g., the position of the car, opening/closing of the door, etc.) during the driving of the elevator is successively input to the control device 110. In addition, the current, which is supplied from the inverter device 104 to the motor 106, is detected by the current sensor 105A, 105B, and the detected current is fed back to the control device 110. Based on the detection value, the control device 110 controls the driving of the inverter device 104 and runs the elevator at a target speed.

At the time of finishing driving the elevator, the control device 110 detects an output voltage of the current sensor 105A, 105B via the voltage detection circuit 109 (step G14) and determines whether the output voltage value is a preset value or more (step G15). The phrase "finishing driving the elevator" refers to the state in which the elevator (car 13) arrives at a target floor and the rotation of the motor

106 is stopped.

5 If the output voltage value is the preset value or more (Yes in step G15), the control device 110 determines that a residual magnetic flux remains in the current sensor 105A, 105B, and executes the demagnetization control of the current sensor 105A, 105B (step G16). On the other hand, if the output voltage value is less than the preset value (No in step G15), the control device 110 does not execute the demagnetization control and opens/closes the door of the elevator, thus transitioning to the preparation for subsequent driving (step G19)

15 The demagnetization control may be executed by supplying a preset sweep current to the current sensor 105A, 105B in a short time period, as in the above-described first embodiment. Alternatively, as in the second embodiment, the demagnetization control may be executed by calculating the reverse bias current and supplying it to the current sensor 105A, 105B in a short time period.

20 After the demagnetization control, the control device 110 detects the output voltage of the current sensor 105A, 105B (step G17) and determines whether the output voltage value is within the preset range of normal values (step G18). If the output voltage value exceeds the preset range (No in step G18), the control device 110 determines that the current sensor 105A,

105B is faulty. Immediately thereafter, the control device 110 activates the protection operation unit 115 and halts the service driving of the elevator (step G20) and activates the alarm issuance unit 116 to issue
5 an alarm reporting an abnormality (step G21).

If the output voltage value falls within the preset range (Yes in step G18), the control device 110 opens/closes the door of the elevator door and transitions to the preparation for subsequent driving
10 (step G19).

As has been described above, the demagnetization control is executed only in the case where the output voltage of the current sensor 105A, 105B is the preset value or more when the driving of the elevator is
15 stopped. This makes it needless to execute the demagnetization control each time the driving of the elevator is stopped. The current sensor 105A, 105B is efficiently demagnetized, as needed, and the current sensing precision can be maintained.

20 In this description, the structure of FIG. 9, which includes the protection operation unit 115 and alarm issuance unit 116, has been exemplified. The present embodiment, however, is similarly applicable to the structure of FIG. 1 (the first embodiment) or the
25 structure of FIG. 6 (the third embodiment).

(Eighth Embodiment)

Next, an eighth embodiment of the invention is

described.

The first embodiment is configured to immediately execute the demagnetization control of the current sensor when the driving of the elevator is stopped. On the other hand, the eighth embodiment is characterized by executing the demagnetization control after the door is opened, when the driving of the elevator is stopped.

Next, referring to the structure of FIG. 9 (the fourth embodiment) by way of example, a process operation of the eighth embodiment is described.

FIG. 14 is a flowchart illustrating the process operation of the control device of the elevator according to the eighth embodiment.

Upon occurrence of a car call or a hall call, a driving instruction is input to the control device 110. Thereby, the control device 110 controls the driving of the inverter device 104 and starts driving the elevator (car 13) (step H11). When the elevator arrives at a target floor (step H12), the control device 110 executes control to finish driving the elevator (step H13).

It is assumed that information (e.g., the position of the car, opening/closing of the door, etc.) during the driving of the elevator is successively input to the control device 110. In addition, the current, which is supplied from the inverter device 104 to the motor 106, is detected by the current sensor 105A,

105B, and the detected current is fed back to the control device 110. Based on the detection value, the control device 110 controls the driving of the inverter device 104 and runs the elevator at a target speed.

5 At the time of finishing the driving the elevator, the control device 110 confirms that the door of the elevator is opened (step H14), and then executes the demagnetization control of the current sensor 105A, 105B (step H15).

10 The demagnetization control may be executed by supplying a preset sweep current to the current sensor 105A, 105B in a short time period, as in the above-described first embodiment. Alternatively, as in the second embodiment, the demagnetization control may be
15 executed by calculating the reverse bias current and supplying it to the current sensor 105A, 105B in a short time period.

 After the demagnetization control, the control device 110 detects the output voltage of the current
20 sensor 105A, 105B (step H16) and determines whether the output voltage value is within the preset range of normal values (step H17). If the output voltage value exceeds the preset range (No in step H17), the control device 110 determines that the current sensor 105A,
25 105B is faulty. Immediately thereafter, the control device 110 activates the protection operation unit 115 and halts the service driving of the elevator (step

H19) and activates the alarm issuance unit 116 to issue an alarm reporting an abnormality (step H20).

5 If the output voltage value falls within the preset range (Yes in step H17), the control device 110 closes the door of the elevator door and transitions to the preparation for subsequent driving (step H18).

10 As has been described above, when the driving of the elevator is stopped, the demagnetization control is executed after the door is opened. Thereby, the residual magnetic flux of the current sensor 105A, 105B can more surely be demagnetized, and the current sensing precision at the time of subsequent driving can be enhanced.

15 In this description, the structure of FIG. 9, which includes the protection operation unit 115 and alarm issuance unit 116, has been exemplified. The present embodiment, however, is similarly applicable to the structure of FIG. 1 (the first embodiment) or the structure of FIG. 6 (the third embodiment).

20 (Ninth Embodiment)

Next, a ninth embodiment of the invention is described.

25 The first embodiment is configured to execute the demagnetization control of the current sensor when the driving of the elevator is stopped. On the other hand, the ninth embodiment is characterized by executing the demagnetization control before driving of the elevator

is started.

Next, referring to the structure of FIG. 9 (the fourth embodiment) by way of example, a process operation of the ninth embodiment is described.

5 FIG. 15 is a flowchart illustrating the process operation of the control device of the elevator according to the ninth embodiment.

 Upon occurrence of a car call or a hall call (Yes in step I11), a driving instruction is input to the
10 control device 110. Thereby, the control device 110 first executes the demagnetization control of the current sensor 105A, 105B and sets the current sensor 105A, 105B in a clear state (step I12).

 The demagnetization control may be executed by
15 supplying a preset sweep current to the current sensor 105A, 105B in a short time period, as in the above-described first embodiment. Alternatively, as in the second embodiment, the demagnetization control may be executed by calculating the reverse bias current and
20 supplying it to the current sensor 105A, 105B in a short time period.

 After the demagnetization control, the control device 110 detects the output voltage of the current sensor 105A, 105B (step I13) and determines whether the
25 output voltage value is within the preset range of normal values (step I14). If the output voltage value exceeds the preset range (No in step I14), the control

device 110 determines that the current sensor 105A, 105B is faulty. Immediately thereafter, the control device 110 activates the protection operation unit 115 and halts the service driving of the elevator (step I19) and activates the alarm issuance unit 116 to issue an alarm reporting an abnormality (step I20).

If the output voltage value falls within the preset range (Yes in step I14), the control device 110 controls the driving of the inverter device 104 and starts driving the elevator (car 13) (step I15). When the elevator arrives at a target floor (step I16), the control device 110 executes control to finish driving the elevator (step I17), opens/closes the door of the elevator door and transitions to the preparation for subsequent driving (step I18).

It is assumed that information (e.g., the position of the car, opening/closing of the door, etc.) during the driving of the elevator is successively input to the control device 110. In addition, the current, which is supplied from the inverter device 104 to the motor 106, is detected by the current sensor 105A, 105B, and the detected current is fed back to the control device 110. Based on the detection value, the control device 110 controls the driving of the inverter device 104 and runs the elevator at a target speed.

As has been described above, the demagnetization control is executed before driving of the elevator is

started. Thereby, as in the first embodiment, the current sensor 105A, 105B is restored in the reset state and accurate current detection can always be performed. Based on the current value that is detected
5 by the current sensor 105A, 105B, speed control with high accuracy can be executed.

In this description, the structure of FIG. 9, which includes the protection operation unit 115 and alarm issuance unit 116, has been exemplified. The
10 present embodiment, however, is similarly applicable to the structure of FIG. 1 (the first embodiment) or the structure of FIG. 6 (the third embodiment).

In brief, the present invention is not limited directly to the above-described embodiments. In
15 practice, the structural elements can be modified without departing from the spirit of the invention. Various modes can be made by properly combining the structural elements disclosed in the embodiments. For example, some structural elements may be omitted from
20 all the structural elements disclosed in the embodiments. Furthermore, structural elements in different embodiments may properly be combined.

According to the present invention, as described above, the residual magnetic flux of the current sensor
25 is demagnetized at a predetermined timing and the current sensor is restored to the reset state. Thereby, a detection error due to the residual magnetic

flux is eliminated, and high-accuracy speed control can always be executed by exact current detection.

WHAT IS CLAIMED IS:

1. A control device of an elevator which detects a current, which is supplied from an inverter device to a motor, by a magnetic-type current sensor, and controls driving of the inverter device on the basis of a detection value of the detected current, comprising:

a demagnetization control unit which supplies, in a short time period at a timing associated with an operation of the elevator, a current for demagnetizing a residual magnetic flux of the current sensor, thereby restoring the current sensor to a reset state.

2. The control device of an elevator according to claim 1, wherein the demagnetization control unit supplies to the current sensor a sweep current which attenuates from a preset initial value within a predetermined time period with a predetermined frequency.

3. The control device of an elevator according to claim 1, wherein the demagnetization control unit calculates a current corresponding to an output of the current sensor, and supplies the current as a reverse-bias current to the current sensor.

4. The control device of an elevator according to claim 1, wherein the demagnetization control unit executes a demagnetization control after turning off power supply to the current sensor.

5. The control device of an elevator according to

claim 1, wherein the demagnetization control unit executes a demagnetization control in a case where an abnormality is detected in an output from the current sensor.

5 6. The control device of an elevator according to claim 5, further comprising:

 a protection operation unit which performs a predetermined protection operation in a case where an abnormality is detected once again in the output from
10 the current sensor after the demagnetization control is executed by the demagnetization control unit; and

 an alarm issuance unit which issues an alarm reporting an abnormality in cooperation with the protection operation unit.

15 7. The control device of an elevator according to claim 1, wherein the demagnetization control unit executes a demagnetization control in a case where a variation of a preset value or more occurs in an output from the current sensor before and after driving of the
20 elevator.

 8. The control device of an elevator according to claim 1, wherein the demagnetization control unit executes demagnetization control in a case where a time that equals or exceeds a preset time has elapsed since
25 starting driving the elevator, when driving of the elevator is finished.

 9. The control device of an elevator according to

claim 1, wherein the demagnetization control unit executes a demagnetization control in a case where an output value of the current sensor is a preset value or more when driving of the elevator is stopped.

5 10. The control device of an elevator according to claim 1, wherein the demagnetization control unit executes a demagnetization control when a door of the elevator is opened after driving of the elevator is stopped.

10 11. The control device of an elevator according to claim 1, wherein the demagnetization control unit executes demagnetization control when driving of the elevator is started.