

POWER SEMICONDUCTOR PROTECTION APPARATUS FOR ELEVATOR AND PROTECTION METHOD THEREOF

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a power semiconductor protection apparatus for an elevator and a protection method thereof, and in particular to an improved power semiconductor protection apparatus for an elevator and a protection method thereof capable of detecting in a multi-step the temperature of a radiator for cooling a power semiconductor and of properly controlling the temperature of the radiator so that its temperature can not reach its maximum level, thus protecting heat damages of a power semiconductor.

2. Description of the Conventional Art

Generally, an elevator is controlled by a convertor and an inverter each including a power semiconductor, in which undesired over-heating can occur in accordance with repeated switching operations of the power semiconductor. Therefore, the undesired over-heating should be controlled to be within a predetermined range so as to protect the power semiconductor.

Referring to Fig. 1, the power semiconductor protection apparatus for an elevator includes a temperature detector 10 for detecting the temperature of a radiator 14 for cooling the over-heating caused in accordance with a switching operation of the power semiconductor, an operation controller 20 for controlling the operation of an elevator in accordance with the temperature detected by the temperature detector 10, a driving unit

30 for driving an induction motor M1 in accordance with a control of the operation controller 20, an error processing unit 40 for processing an error of the elevator in accordance with a control of the operation controller 20, and an error display unit 50 for displaying errors of the elevator in accordance with a result of the error processing of the error processing unit 40.

Here, the temperature detector 10, as shown in Fig. 3, includes a power semiconductor 12, a radiator 14, in which a power semiconductor 12 is disposed, for cooling over-heating caused by the power semiconductor 12, and a temperature detector 16 attached to the radiator 14 for detecting the heating temperature.

The operation of the power semiconductor protection apparatus for a conventional elevator will now be explained.

To begin with, in case that an operation control mode is performed by the operation controller 20, in a first step S1, the temperature detector 16 detects a temperature T_f of the radiator 14, and in a second step S2, the operation controller 20 compares the temperature T_f and the previously set temperature T_a . Here, the previously set temperature T_a is the highest level of the radiator 14 being able to protect the power semiconductor 12 from heat damages. As a result of the above mentioned comparison, if the temperature T_f is lower than the previously set temperature T_a , in a third step S3, the operation controller 20 outputs a control signal to a driving unit 30, and the driving unit 30 drives the induction motor M1, and the elevator runs normally.

Meanwhile, as a result of the above mentioned comparison, if the temperature T_f is higher than or the same as the previously set temperature T_a , in a fourth step, the operation controller 20 recognizes that the elevator is not operational and outputs a control signal to the error processing unit 40, and the error processing unit 40 performs an error process. In a fifth step S5, the error display unit 50 displays that the elevator is



not operational, and in a sixth step S6, the driving unit 30 stops the operation of the induction motor M1 in accordance with a control of the operation controller 20, and the elevator stops.

However, as described above, the conventional power semiconductor protection apparatus for elevator and protection method thereof has a disadvantage in that if an elevator runs for long time, the temperature of the radiator exceeds a predetermined level, so that the elevator can be damaged due to the over-heating of the radiator.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a controller for a microwave oven, which overcome the problems encountered in the conventional power semiconductor protection apparatus for an elevator.

It is another object of the present invention to provide an improved power semiconductor protection apparatus for an elevator and a protection method thereof capable of detecting in a multi-step the temperature of a radiator for cooling a power semiconductor and of properly controlling the temperature of the radiator so that its temperature can not reach its maximum level, thus protecting the heat damages of a power semiconductor.

To achieve the above objects, there is provided a power semiconductor protection apparatus for an elevator, which includes a multi-step temperature detector for detecting the temperature of a radiator in a method of a multi-step; a temperature controller for judging whether the temperature detected by the multi-step temperature detector reaches a corresponding level and for setting a step-by cooling time of the radiator; a n operation controller for controlling an operation of an elevator in accordance a judgement

of the temperature controller and a previously set cooling time; an elevator operation state display unit for displaying the operation state of the elevator based on a result of the multi-step temperature detection in accordance with a control of the temperature controller; a driving unit for controlling an induction motor in accordance with a control of the operation controller; an error processing unit for processing an error of the elevator in accordance with a control of the operation controller; and an error display unit for displaying errors of the elevator in accordance with a control of the error processing unit.

To achieve the above objects, there is provided a power semiconductor protection method for an elevator, which includes the steps of a first step which detects the temperature of a radiator using a multi-step temperature detector and judges whether the elevator is in operation in case that an operation control mode is operational; a second step which compares the temperature detected by the first step and a previously set temperature using a temperature controller when the elevator is in operation; a third step which processes errors of the elevator in accordance with a control of the operation controller when the temperature of the radiator exceeds a predetermined level, displays the error of the elevator, and stops the operation of the elevator; a fourth step which performs a normal operation when the temperature of the radiator is lower than a previously set temperature; a fifth step which judges whether the temperature of the radiator is between a first comparison temperature and a second comparison temperature using the temperature controller when the elevator is stopped as a result of the first step, and when the temperature of the radiator is therebetween, allows the elevator to have an idle time for a predetermined time for cooling a power semiconductor, and returns to an operation control mode; and a sixth step which, when the fifth condition is not met, judges whether the temperature of the radiator is between the second comparison temperature and a previously set temperature using the temperature controller, and when

the temperature is therebetween, allows the elevator to have an idle time for a predetermined time so that the temperature of the radiator is decreased, and returns to the operation control mode.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of a power semiconductor protection apparatus for a conventional elevator.

Fig. 2 is a flow chart of a power semiconductor protection method for a conventional elevator.

Fig. 3 is a plan view of a temperature detector of Fig. 1.

Fig. 4 is a block diagram of a power semiconductor protection apparatus for an elevator according to the present invention.

Fig. 5 is a plan view of a multi-step temperature detector of Fig. 4.

Fig. 6 is a graph showing a relationship between the time and the temperature of a radiator for a power semiconductor protection method for an elevator according to the present invention.

Fig. 7 is a diagram showing a relationship between T1, T2, and T3 of a power semiconductor and a radiator of Fig 4.

Fig. 8 is a flow chart of a power semiconductor protection method for an elevator according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Fig. 4, a power semiconductor protection apparatus for an elevator

includes a multi-step temperature detector 60 for detecting the temperature of a radiator in a multi-step, a temperature controller 70 for judging whether the detected temperature is related to a predetermined step by comparing the temperature detected by the multi-step temperature detector 60 with a previously set temperature, an operation controller 20 for controlling the operation of an elevator in accordance with a judgement of the temperature controller 70, and an elevator operation state display unit 60 for displaying the operation state of the elevator based on a result of the multi-step temperature detector 60 in accordance with a control of the temperature controller 70. In addition, the present invention further includes a driving unit 30, an error processing unit 40, and an error display unit 50, which are all previously explained in the conventional art.

Here, as shown in Fig. 5, the multi-step temperature detector 60 includes a power semiconductor 12, a radiator 14, and a multi-step temperature detector 18. In addition, the multi-step temperature detector 18 includes a plurality of switches each of which is turned on/off in accordance with a step-by temperature.

The operation of a power semiconductor protection apparatus for an elevator according to the present invention will now be explained.

To begin with, referring to Figs. 6 and 8, in the power semiconductor protection method, whenever the temperature of the radiator 14 reaches a previously set step, the operation controller 2 has an idle time for cooling time $\Delta 1$ and $\Delta 2$.

In case that an operation control mode of the operation controller 20 is performed, in an eleventh step S11, the multi-step temperature detector 60 detects the temperature T_f of the radiator 14. That is, in the multi-step temperature detector 18 of the multi-step multi-step temperature detector 60, a switch is connected with a corresponding temperature step, and the temperature of the radiator 14 is transferred to the temperature controller 70 through the turned-on switch, and the temperature T_f of the radiator 14 is

detected.

Thereafter, in a twelfth step S12, the operation controller 20 judges whether the elevator is in operation.

Here, the temperature controller 70 compares the temperature T_f of the radiator 14 and a previously set multi-step temperature and judges whether the temperature T_f is related to a predetermined temperature step. For example, three temperatures steps can be set in the temperature controller 70. That is, a maximum temperature T_a of the radiator which is defined not to provide a power semiconductor 12 with heat damage, a first comparison temperature T_b lower than the temperature T_a , and a second comparison temperature T_c lower than the first comparison temperature T_b .

Therefore, as a result of the twelfth step 12, the elevator is judged as in operation, in a thirteenth step S13, the temperature controller 70 judges whether the temperature T_f is higher than or the same as the temperature T_a .

If the temperature T_f is higher than or the same as the temperature T_a , in a fourteenth step S14, the error processing unit 40 performs an error process in accordance with a control of the operation controller 20, and in a fifteenth step S15, the error display unit 50 displays that the elevator is not operational, and in a sixteenth step S16, the driving unit 30 drives the induction motor M1 in accordance with a control of the operation controller 20, and the elevator stops.

Meanwhile, in the thirteenth step S13, if the temperature T_f is lower than the temperature T_a , the elevator runs normally in accordance with a seventeenth step S17.

Meanwhile, in the twelfth step S12, if it is judged by the operation controller 20 that the elevator is not operational, in an eighteenth step S18, the temperature controller 70 judges whether the temperature T_f is lower than the first comparison temperature T_b and whether the temperature T_f is higher than or the same as the second comparison

temperature T_c .

Thereafter, if the conditions of the eighteenth step S18 are achieved, the temperature controller 70 outputs a control signal to the operation controller 20, and the driving unit 30 stops the induction motor M1, and in a nineteenth step, the elevator stops for a cooling time Δt_1 , and the temperature T_f of the radiator is decreased. In addition, in a twentieth step S20, the elevator operation state display unit 80 displays the contents that the elevator is in an idle state and the remaining idle time. In a twenty first step S21, if the temperature controller 70 judges that the cooling time Δt_1 is lapsed, the eleventh step S11 is performed. Here, the elevator operation state display unit 80 displays the remaining idle time on a car side or a hall side of the elevator system in a method of counting down the remaining time.

Meanwhile, if the conditions of the eighteenth step S18 are not met, in a twenty second step S22, the temperature controller 70 judges whether the temperature T_f is lower than the temperature T_a and whether the temperature T_f is higher than or the same as the first comparison temperature T_b .

Thereafter, if the conditions of the twenty second step S22 are achieved, the temperature controller 70 outputs a control signal to the operation controller 20, and the driving unit 30 stops the induction motor M1, and in a twenty third step S23, the elevator stops for a predetermined cooling time Δt_2 , and the temperature T_f of the radiator is decreased. In addition, in a twenty fourth step S24, the elevator operation state display unit 80 displays the contents that the elevator is in an idle state and the remaining idle time, and in a twenty fifth step S25, if the temperature controller 70 is judged that the cooling time Δt_2 is lapsed, the eleventh step S11 is performed.

Meanwhile, if the conditions of the twenty second step S22 are not met, the thirteenth step S13 is performed.

Here, referring to Fig. 7, the difference between the internal temperature T_1 of the power semiconductor and the temperature T_2 of the radiator is an internal temperature ΔT_1 of a power semiconductor which is increased in accordance with an increase of using electric power. In addition, the difference between the temperature T_2 of the radiator and its surrounding temperature T_3 is ΔT_2 of the radiator increased in accordance with an increase of using electric power. That is, the conditions can be given as follows: $T_1 = T_2 + \Delta T_1$, $T_2 = T_3 + \Delta T_2$, and $T_1 = T_3 + \Delta T_1 + \Delta T_2$.

In addition, the cooling time Δt_1 can be defined as a duration of taking while the internal temperature ΔT_1 of the power semiconductor is cooled off, and the cooling time Δt_2 can be defined as a duration of taking while the temperature ΔT_2 of the radiator is cooled off.

As described above, the power semiconductor protection apparatus for an elevator and a protection method thereof are capable of advantageously detecting the temperature of the radiator in a method of a multi-step and of providing a proper cooling time when the detected temperature reaches to a corresponding temperature step, thus preventing the power semiconductor from heat damages caused by the over-heating of the radiator when the elevator runs for long time.

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What is claimed is:



1. A power semiconductor protection apparatus for an elevator, comprising:
 - a multi-step temperature detector for detecting the temperature of a radiator in a method of a multi-step;
 - a temperature controller for judging whether the temperature detected by said multi-step temperature detector reaches a corresponding level and for setting a step-by cooling time of said radiator;
 - an operation controller for controlling an operation of an elevator in accordance a judgement of said temperature controller and a previously set cooling time;
 - an elevator operation state display unit for displaying the operation state of said elevator based on a result of the multi-step temperature detection in accordance with a control of said temperature controller;
 - a driving unit for controlling an induction motor in accordance with a control of the operation controller;
 - an error processing unit for processing an error of the elevator in accordance with a control of the operation controller; and
 - an error display unit for displaying errors of the elevator in accordance with a control of said error processing unit.
2. The apparatus of claim 1, wherein said elevator operation state display unit is directed to displaying a remaining idle time of the elevator.
3. A power semiconductor protection method for an elevator, comprising the steps of:



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a first step which detects the temperature of a radiator using a multi-step temperature detector and judges whether the elevator is in operation in case that an operation control mode is operational;

a second step which compares the temperature detected by said first step and a previously set temperature using a temperature controller when the elevator is in operation;

a third step which processes errors of the elevator in accordance with a control of the operation controller when the temperature of the radiator exceeds a predetermined level, displays said error of the elevator, and stops the operation of the elevator;

a fourth step which performs a normal operation when the temperature of the radiator is lower than a previously set temperature;

a fifth step which judges whether the temperature of the radiator is between a first comparison temperature and a second comparison temperature using the temperature controller when the elevator is stopped as a result of said the first step, and when the temperature of the radiator is therebetween, allows the elevator to have an idle time for a predetermined time for cooling a power semiconductor, and returns to an operation control mode; and

a sixth step which, when said fifth condition is not met, judges whether the temperature of the radiator is between the second comparison temperature and a previously set temperature using the temperature controller, and when the temperature is therebetween, allows the elevator to have an idle time for a predetermined time so that the temperature of the radiator is decreased, and returns to the operation control mode.

4. The method of claim 3, wherein said previously set temperature is a maximum temperature of the radiator not causing any heat damages to the power

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semiconductor.

5. The method of claim 3, wherein said previously set temperature is higher than a second comparison temperature, and said second comparison temperature is higher than a first comparison temperature.

6. The method of claim 3, wherein when in said fifth step and said sixth step the elevator is in an idle state, the remaining idle time is displayed on a car side or a hall side of the elevator system in a method of counting down the remaining time.