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# (54) ELECTRONIC TEMPERATURE CONTROL APPARATUS AND CONTROL METHOD THEREOF

ELEKTRONISCHE TEMPERATURREGELUNGSVORRICHTUNG UND STEUERVERFAHREN DAFÜR

APPAREIL DE COMMANDE ÉLECTRONIQUE DE LA TEMPÉRATURE ET PROCÉDÉ DE COMMANDE DE CET APPAREIL

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(73) Proprietor: **Coway Co., Ltd.**
**Chungcheongnam-do 314-895 (KR)**

(72) Inventors:
- **LEE, Young-Jae**
**Seoul 151-185 (KR)**
- **MO, Byung-Sun**
**Seoul 151-185 (KR)**
- **SON, Joung-Ho**
**Seoul 151-185 (KR)**

(74) Representative: **Vidon Brevets & Stratégie**
**16B, rue de Jouanet**
**B.P. 90333**
**Technopole Atalante**
**35703 Rennes Cedex 7 (FR)**

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EP 2 737 266 B1

## Description

### Technical Field

**[0001]** The present invention relates to an electronic temperature control apparatus for controlling temperature of an object by using a thermoelectric module and a control method thereof.

### Background Art

**[0002]** A thermoelectric effect refers to energy conversion between heat and electricity, namely, a phenomenon in which carriers within a device move to generate electromotive force when a temperature difference exists between both ends of a conversion device.

**[0003]** Research into the thermoelectric phenomenon started in early 1900s and advanced sufficiently to allow the loffe Institute of the former Soviet Union to obtain conversion efficiency of about 4%, and currently, conversion efficiency stands at about 10%. Thermoelectricity may be divided into the Seebeck effect, in which electromotive force is obtained by using temperature differences between two parts, the Peltier effect in which cooling and heating are performed with electromotive force, and the Thomson effect in which electromotive force is caused by a temperature difference of a conductor wire or strip, and a core technology in terms of a materials field or a systems technology for a manufacturing process has come to the fore.

**[0004]** Thermoelectric materials may be divided into a room temperature material, a middle temperature material, and a high temperature material, according to temperature ranges based on thermoelectric characteristics. A BizTerbased solid solution alloy having a composition of $(Bi,Te)_2$ $Te_3$, and $Biz(Te,Se)_3$ has excellent thermoelectric characteristics. A thermoelectric cooling and generation module using such thermoelectric materials has a structure in which n-type thermoelectric devices and p-type thermo- electric devices are electrically connected in series and thermally connected in parallel.

**[0005]** In a thermoelectric module, when heat is transferred from a high temperature part to a low temperature part due to a temperature difference therebetween, electrons and holes are transferred from the high temperature part to the low temperature part in an n-type thermoelectric device and a p-type thermoelectric device, respectively, thus generating electricity, and in the thermoelectric module, when a current is made to flow, cooling occurs on one side thereof, while heating occurs on the other, due to a carrier movement, thus allowing for cooling and heating.

**[0006]** Efficiency of a thermoelectric module is determined by thermoelectric characteristics such as thermoelectromotive force, thermal conductivity, or resistivity of n-type and p-type thermoelectric materials and an amount of coupled thermoelectric devices.

**[0007]** Also, a cooling scheme using a thermoelectric module has high thermal response sensitivity, allows for locally selective cooling, and has a simple structure without moving parts, and thus it has been commercialized for partial cooling of electronic components such as a high output power transistor, a laser diode, and the like, and may also be used for general purposes such as for an ice box for vehicles, for domestic refrigerators and air-conditioners, and the like.

**[0008]** Also, as the use of chlorofluorocarbons (CFCs) in vehicles, household air-conditions and refrigerators, and the like, has been regulated, the development of air-conditioning systems using thermoelectric materials, able to be used for cooling without using a refrigerant, has emerged as a promising field.

**[0009]** A thermoelectric module uses the fact that heat is transferred from a low temperature region to a high temperature region due to the Peltier effect when a current flows to a circuit including a junction between different materials. Based on this concept, a thermoelectric refrigerator may be produced by connecting a plurality of junctions in senes.

**[0010]** US 5371665 discloses a voltage supply unit (32) providing DC voltage to a power control circuit (50). Figure 3 of this document shows variable voltage. The variable voltage is generated by a pulse positioning circuit (92), and is not generated by the power supply unit (32). Also, the variable voltage is output to a high current transistor (80) through a comparator (90) to control PWM signal. This document doesn't suggest supplying to a thermoelectric module:

- a constant voltage, when the difference between a temperature of the object or a first metal member and a target temperature is equal to or higher than a first pre-set value, and
- a variable voltage, when the temperature of the object or the first metal member has reached the target temperature.

US20080022696 discloses an electronic temperature control apparatus according to the preamble of claim 1 and a method of an electronic temperature control apparatus according to the preamble of claim 10.

## Disclosure of Invention

### Technical Problem

**[0011]** An aspect of the present invention provides an electronic temperature control apparatus for controlling a temperature of an object by using a thermoelectric module and a control method thereof.

### Solution to Problem

**[0012]** According to an aspect of the present invention, there is provided an electronic temperature control apparatus according to claim 1.

**[0013]** When the difference between a temperature of the object or the first metal member and the target temperature is equal to or greater than a first pre-set value, the controller is configured to control the voltage supply unit to supply the first voltage to the thermoelectric module, and when the difference between a temperature of the object or the first metal member and the target temperature is smaller than the first pre-set value, the controller may be configured to control the voltage supply unit to supply the variable voltage to the thermoelectric module.

**[0014]** When the difference between a temperature of the object or the first metal member and the target temperature is within a pre-set range, the controller may be configured to adjust the voltage supplied to the thermoelectric module, in proportion to the difference between the target temperature and the temperature of the object or the first metal member.

**[0015]** The controller may be configured to compare the target temperature with the temperature of the object or the first metal member and if the peaks of the temperatures are reversed, the controller may be configured to switch a connection state between the one end of the first metal member and the other end of the second metal member to reverse the peaks of potentials of the one end of the first metal member and the other end of the second metal member.

**[0016]** When the controller may be configured to further compare the temperature of the second metal member or an ambient temperature with the target temperature and the voltage supply unit supplies the variable voltage to the thermoelectric module, the controller may be configured to correct the amount of the supplied variable voltage.

**[0017]** When the difference between a temperature of the object or the first metal member and the target temperature is equal to or greater than a first pre-set value, the controller is configured to control the voltage supply unit to supply the first voltage to the thermoelectric module, when the difference between a temperature of the object or the first metal member and the target temperature is smaller than the first pre-set value, the controller may be configured to control the voltage supply unit to supply the variable voltage to the thermoelectric module, and when the difference between the temperature of the second metal member or the ambient temperature and the target temperature exceeds a second pre-set value, the controller may be configured to narrow the pre-set range.

**[0018]** The electronic temperature control apparatus may further include a fan disposed on the other side of the second metal member of the thermoelectric module.

**[0019]** When the difference between a temperature of the object or the first metal member and the target temperature is outside of the pre-set range, the controller may be configured to rotate the fan at a first speed, and when the difference between a temperature of the object or the first metal member and the target temperature is within a pre-set range, the controller may be configured to rotate the fan at a second speed, wherein the first speed may be faster than the second speed.

**[0020]** The controller may be configured to detect a voltage supplied to the thermoelectric module by the voltage supply unit and feedback-control the voltage supplied by the voltage supply unit to the thermoelectric module.

**[0021]** According to another aspect of the present invention, there is provided a control method according to claim 10.

## Advantageous Effects of Invention

**[0022]** As set forth above, in the case of the electronic temperature control apparatus and the control method thereof according to embodiments of the invention, a temperature of an object can be controlled by controlling the thermoelectric module at a low power level and with low noise.

## Brief Description of Drawings

**[0023]**

FIG. 1 is a view illustrating a temperature control method of a general cooler or heater;

FIG. 2 is a view schematically illustrating a configuration of a temperature control apparatus according to an embodiment of the present invention;

FIG. 3 is a graph showing a relationship between a temperature of an object and a voltage supplied to a thermoelectric module of an electronic temperature control apparatus according to an embodiment of the present invention;

FIG. 4 is a graph showing a relationship between a temperature of an object and a voltage supplied to a thermoelectric module of an electronic temperature control apparatus according to another embodiment of the present invention;

FIG. 5 is a graph showing a relationship between a temperature of an object and a voltage supplied to a thermoelectric module of an electronic temperature control apparatus according to another embodiment of the present invention;

FIG. 6 is a graph showing a relationship between a temperature of an object and a voltage supplied to a thermoelectric module of an electronic temperature control apparatus according to an embodiment of the present invention;

FIGS. 7 and 8 are flow charts illustrating a control method of an electronic temperature control apparatus according to an embodiment of the present invention, respectively;

FIGS. 9 to 11 are detailed flow charts illustrating a process of determining a voltage mode in the control method of the electronic temperature control apparatus according to an embodiment of the present in-

vention, respectively;

FIG. 12 is a view schematically illustrating a configuration of a voltage supply unit according to an embodiment of the present invention; and

FIG. 13 is a timing diagram illustrating an operation of the voltage supply unit according to an embodiment of the present invention.

**Best Mode for Carrying out the Invention**

**[0024]** Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings such that they could be easily practiced by those skilled in the art to which the present invention pertains.

**[0025]** In order to clarify the present invention, parts irrespective of description will be omitted, and similar reference numerals are used for the similar parts throughout the specification.

**[0026]** Unless explicitly described to the contrary, the word "comprise" and variations such as "comprises" or "comprising," will be understood to imply the inclusion of stated elements but not the exclusion of any other elements.

**[0027]** FIG. 1 is a view illustrating a temperature control method of a general cooler or heater.

**[0028]** A general cooler or heater includes a cooling unit and a heating unit, and upon receiving power, the cooling unit and the heating unit absorbs ambient heat or radiates heat. Here, the degree of cooling or heating is eventually proportional to power supplied to the cooling unit or the heating unit. Thus, temperature control of a general cooler or heater may be achieved by controlling the magnitude of a voltage or current supplied to a cooling unit or a heating unit.

**[0029]** Referring to FIG. 1(a), in order to control temperature, a voltage may be applied to a cooling unit or a heating unit in a pulse width modulation (PWM) manner.

**[0030]** Referring to FIG. 1(b), it can be seen that a voltage is applied to a cooling unit or a heating unit in a phase control manner, and referring to FIG. 1(c), it can be seen that a voltage is applied to a cooling unit or a heating unit in a zero-crossing manner.

**[0031]** The schemes shown in FIGS. 1(b) and 1(c) are employed when AC power is used, and FIG. 1(a) is employed when DC power is used. In all of the control methods illustrated in FIG. 1, temperature is controlled by adjusting a time duration in which a voltage is applied.

**[0032]** In the case of adjusting a voltage application time duration, switching is required to discontinuously apply a voltage. However, a considerable switching loss may occur in a switching operation, wasting power. Also, a potential great amount of switching loss may cause a considerable burden to a voltage application circuit to result in damage to the circuit.

**[0033]** However, in many cases, a heating unit or a cooling unit generally requires a significantly high level of power, and a supplied voltage or current is required to have a small amount of ripples. For this reason, equipment, such as a switching-mode power supply (SMPS), or the like, that stably provides high power is used in temperature control apparatuses.

**[0034]** However, in general, the SMPS outputs a constant voltage (i.e., a fixed, uniform, regular voltage) in order to stably supply high power, and an SMPS outputting a variable voltage may be considerably expensive. Thus, a method for controlling the degree of heating or cooling of a heating unit or a cooling unit employs a scheme of controlling a connection between an SMPS and a heating unit or a cooling unit. Namely, in many cases, the degree of heating or cooling of a heating unit or a cooling unit is controlled by using PWM control.

**[0035]** However, as mentioned above, the use of a PWM control leads to a large amount of loss, based on a switching operation, which drastically degrades power saving capability which weighs with small home appliances, and the like.

**[0036]** Thus, an electronic temperature control apparatus, a cooler using the same, a heater using the same, and a control method thereof according to embodiments of the present invention save power by varying an application voltage according to a temperature section to reduce a switching loss.

**[0037]** FIG. 2 is a view schematically illustrating a configuration of a temperature control apparatus according to an embodiment of the present invention.

**[0038]** Referring to FIG. 2, an electronic temperature control apparatus according to an embodiment of the present invention may include a thermoelectric module 100, a voltage supply unit 200, and a controller 300. The electronic temperature control apparatus according to an embodiment of the present invention may further include a fan 400 as necessary.

**[0039]** The thermoelectric module 100 includes a first metal member 110 and a second metal member 120. The first metal member 110 and the second metal member 120 are joined so a current may flow to one another and heat may be transferred therebetween. Here, it is considered that the other end of the first metal member 110 and one end of the second metal member 120 are joined. One end of the first metal member 110 is in contact with an object which requires temperature control (or whose temperature is required to be controlled). When a voltage is applied to between one end of the first metal member 110 and the other end of the second metal member 120, a current flows between the first metal member 110 and the second metal member 120 and heat transmission may occur. Here, a first terminal and a second terminal may be installed in one end of the first metal member 110 and the other end of the second metal member 120, respectively. In the thermoelectric module 100, a direction of heat transmission may be determined according to a sign of a voltage applied between one end of the first metal member 110 and the other end of the second metal member 120. Namely, the direction of heat transmission may be determined according to a height

of a potential of one end of the first metal member 110 and the other end of the second metal member 120.

**[0040]** The voltage supply unit 200 may supply a first voltage (V1) or a voltage within a range from a second voltage (V2) to a third voltage (V3). Namely, the voltage supply unit 200 may supply the first voltage (V1) as a constant voltage or may supply a variable voltage having a range from the second voltage (V2) to the third voltage (V3). Here, the third voltage (V3) has a value smaller than that of the second voltage (V2), and the first voltage (V1) is higher than the second voltage (V1), a maximum variable value of a variable voltage. Namely, the voltage supply unit 200 may supply a high voltage as a constant voltage and a low voltage as a variable voltage. When it is considered that it is difficult to design the voltage supply unit 200 and unit fabrication costs of the voltage supply unit 200 rise as a range of a variable voltage and a voltage band of the variable voltage are higher, preferably, a high voltage is supplied as a constant voltage and a low voltage is supplied as a variable voltage.

**[0041]** The controller 300 is configured to control a voltage supplied from the voltage supply unit 200 to the thermoelectric module 100 according to a difference between a temperature of the object or the first metal member 110 and a target temperature. Namely, according to a temperature of the object as a target for temperature control, the controller 300 is configured to control the temperature of the object by varying a supply voltage from the voltage supply unit 200. Here, if it is difficult to directly measure the temperature of the object, the controller 300 is configured to control a temperature of the first metal member 110, equilibrated in temperature with the object, by varying a supply voltage from the voltage supply unit 200 according to the temperature of the first metal member 110.

**[0042]** In particular, an aspect of an output voltage from the voltage supply unit 200 may vary depending on whether or not a difference between the temperature of the object or the first metal member 110 and the target temperature exceeds a pre-set value, and when the voltage supply unit 200 supplies a variable voltage, the controller 300 may adjust the magnitude (or amplitude) of the voltage according to a difference between the temperature of the object or the first metal member 110 and the target temperature.

**[0043]** In addition, the controller 300 may be configured to control a voltage supplied by the voltage supply unit 200 to the thermoelectric module 100 by further comparing a temperature of the second metal member 120 or an ambient temperature around the second metal member 120 with the target temperature.

**[0044]** Namely, the controller 300 may be configured to control an operation of the thermoelectric module 100 by further reflecting the temperature of the second metal member 120 that radiates heat transmitted from the object or absorbs heat to be transmitted to the object and the temperature of a peripheral portion of the second metal member 120.

**[0045]** Also, the controller 300 may be configured to control a rotational speed of the fan 400 disposed at the other end of the second metal member 120 according to the difference between the temperature of the object or the first metal member 110 and the target temperature. This is because a circulation speed of ambient air around the second metal member 120 differs according to a rotational speed of the fan 400.

**[0046]** Hereinafter, a process of controlling a temperature of the object by the controller 300 of the electronic temperature control apparatus according to an embodiment of the present invention by controlling a voltage supplied from the voltage supply unit 200 to the thermoelectric module 100. However, only the temperature of the object will be described, but it may also be applied to the scheme of controlling a temperature of the first metal member 110.

**[0047]** FIG. 3 is a graph showing a relationship between a temperature of an object and a voltage supplied to the thermoelectric module of the electronic temperature control apparatus according to an embodiment of the present invention.

**[0048]** Referring to FIG. 3, a relationship between a temperature of an object and a supply voltage in performing cooling by using the electronic temperature control apparatus according to an embodiment of the present invention may be checked.

**[0049]** When a temperature of the object is higher than the target temperature Ts, a voltage supplied to the thermoelectric module 100 may be controlled according to the temperature of the target and supplied. When the temperature of the object is lower than the target temperature Ts, a voltage supply to the thermoelectric module 100 is stopped to save power and reduce noise.

**[0050]** Referring to FIG. 3, in the electronic temperature control apparatus according to an embodiment of the present invention, in case (a) that a difference between the temperature of the object and the target temperature Ts is equal to or greater than a first pre-set value AT, a first voltage V1 as a constant voltage is supplied to the thermoelectric module 100, and in cases (b, c, d) that the difference is smaller than the pre-set first value T, a variable voltage ranging from a third voltage V3 to a second voltage V2 is supplied to the thermoelectric module 100, to cool the object.

**[0051]** Referring to section b, in the electronic temperature control apparatus according to an embodiment of the present invention, when the difference between the temperature of the object and the target temperature Ts is less than the first pre-set value AT, the magnitude of the voltage may be adjusted in proportion to the difference between the temperature of the object and the target temperature Ts and supplied to the thermoelectric module 100.

**[0052]** Referring to section c, in the electronic temperature control apparatus according to an embodiment of the present invention, when the difference between the temperature of the object and the target temperature Ts

reaches the target temperature Ts, the electronic temperature control apparatus does not operate until the temperature of the object is changed by a certain value from the target temperature Ts, and when the temperature of the object is changed by a certain value, the electronic temperature control apparatus may apply a voltage in proportion to a difference between the temperature of the object and the target temperature Ts. This is to reduce energy loss and noise generation due to a frequency operation of the voltage supply unit 200.

**[0053]** Referring to section d, in the electronic temperature control apparatus according to an embodiment of the present invention, when the temperature of the object is different from the target temperature Ts, a voltage in proportion to the difference between the temperature of the object and the target temperature Ts is applied, and when the difference between the temperature of the object and the target temperature Ts is equal to or greater than the first pre-set value AT, the first voltage V1 as a constant voltage may be supplied to the thermoelectric module 100.

**[0054]** Here, the first pre-set value $\Delta T$ may be a temperature by which the temperature of the object may reach the target temperature Ts within a certain period of time when the second voltage V2 is supplied to the thermoelectric module 100. Namely, the first pre-set value $\Delta T$ may be set in consideration of the second voltage V2 and heat transmission ca- pability of the thermoelectric module 100.

**[0055]** Although not shown, the controller 300 may be configured to sense a voltage supplied to the thermoelectric module 100 from the voltage supply unit 200 to feedback-control the voltage supplied by the voltage supply unit 200 to the thermoelectric module 100. Namely, although a signal for controlling a voltage output from the voltage supply unit 200 is sent, the voltage supplied from the voltage supply unit 200 to the thermoelectric module 100 may vary due to various factors, so the controller 300 may apply an intended voltage to the thermoelectric module 100 through feedback control.

**[0056]** When the foregoing control methods are combined, the controller 300 may analyze the difference between the temperature of the object and the target temperature Ts to determine whether to rapidly cool the object by supplying a high constant voltage or whether to slowly cool the object by supplying a variable voltage having a low voltage band. Also, in the case of supplying a variable voltage, the magnitude of the variable voltage may be set by using the difference between the temperature of the object and the target temperature Ts.

**[0057]** FIG. 4 is a graph showing a relationship between a temperature of an object and a voltage supplied to a thermoelectric module of an electronic temperature control apparatus according to another embodiment of the present invention.

**[0058]** Referring to FIG. 4, in the electronic temperature control apparatus according to the present embodiment, in case (a) that a difference between the temperature of an object and a target temperature Ts is equal to or greater than a first pre-set value AT, a first voltage V1 as a constant voltage may be applied to the thermoelectric module 100, and when the temperature of the object reaches the target temperature Ts, a variable voltage having a range from a third voltage V3 to a second voltage V2 may be supplied to the thermoelectric module 100, to cool the object. Namely, the constant voltage may be continuously supplied to the object until such time as the temperature of the object reaches the target voltage Ts to thus rapidly cool the object, and when the temperature of the object reaches the target temperature Ts, the variable voltage may be supplied to maintain a cooled state.

**[0059]** Referring to a section b, since the temperature of the object is within the range of the target temperature Ts and the first pre-set value AT, the variable voltage may be supplied to the thermoelectric module 100 to maintain the temperature of the object within the range of the first pre-set value AT. Here, the magnitude of the variable voltage may be adjusted to be proportional to the difference between the temperature of the object and the target temperature Ts so as to be supplied to the thermoelectric module 100.

**[0060]** As discussed above, the first pre-set value $\Delta T$ may be a temperature by which the temperature of the object may be able to reach the target temperature Ts within a certain period of time when the second voltage V2 is supplied to the thermoelectric module 100. Namely, the first pre-set value $\Delta T$ may be set in consideration of the second voltage V2 and heat transmission capability of the thermoelectric module 100.

**[0061]** When the foregoing control methods are combined, the controller 300 may analyze the difference between the temperature of the object and the target temperature Ts and a cooling record (or cooling history) to determine whether to rapidly cool the object by supplying a high constant voltage or whether to slowly cool the object by supplying a variable voltage having a low voltage band, and the magnitude of the variable voltage may be set by using the difference between the temperature of the object and the target temperature Ts.

**[0062]** FIG. 5 is a graph showing a relationship between a temperature of an object and a voltage supplied to a thermoelectric module of an electronic temperature control apparatus according to another embodiment of the present invention.

**[0063]** With reference to FIG. 5, a relationship between a temperature of an object and a supply voltage in performing cooling by using the electronic temperature control apparatus according to an embodiment of the present invention may be checked. As for a voltage supplied to the thermoelectric module 100 of the electronic temperature control apparatus according to an embodiment of the present invention, when a temperature of the object is higher than a target temperature Ts, a constant voltage is supplied, and when the temperature of the object is lower than the target temperature Ts, a variable voltage

may be supplied. Also, as for the voltage supplied to the thermoelectric module 100 of the electronic temperature control apparatus according to an embodiment of the present invention, after the temperature of the object reaches the target temperature Ts, if the temperature of the object is increased to be higher than the target temperature Ts by a first pre-set value AT or higher, the constant voltage is supplied again.

**[0064]** Namely, when the temperature of the object is higher than the target temperature Ts, the constant voltage V 1 as a high voltage is supplied for rapid cooling. When the temperature of the object reaches the target temperature Ts, the second voltage V2 is supplied to maintain the cooled state. When the temperature of the object is lower than the target temperature Ts, a variable voltage having a range from the third voltage V3 to the second voltage V2 may be supplied to prevent overcooling. Here, the magnitude of the variable voltage may be selected in proportion to a difference between the temperature of the object and the target temperature Ts. When the temperature of the object is increased to be higher by the first pre-set value AT than the target temperature Ts, it may be determined that the cooled state cannot be maintained by supplying only the second voltage V2, and the constant voltage V 1 is supplied again.

**[0065]** FIG. 6 is a graph showing a relationship between a temperature of an object and a voltage supplied to a thermoelectric module of an electronic temperature control apparatus according to an embodiment of the present invention.

**[0066]** Referring to FIG. 6, a relationship between a temperature of an object and a supply voltage in performing heating by using the electronic temperature control apparatus according to an embodiment of the present invention may be checked. When a temperature of an object is lower than a target temperature Ts, a voltage supplied to the thermoelectric module 100 may be controlled according to the temperature of the object. Reversely, when the temperature of the object is higher than the target temperature Ts, a voltage is not applied thereto, to thus save power and reduce noise.

**[0067]** With reference to FIG. 6, in the electronic temperature control apparatus according to an embodiment of the present invention, when a difference between a temperature of the object and the target temperature Ts is equal to or greater than a first pre-set value AT, the first voltage V1 as a constant voltage may be supplied to the thermoelectric module 100, and when the temperature of the object reaches the target temperature Ts, a variable voltage having a range from a third voltage V3 to a second voltage V2 is supplied to the thermoelectric module 100, to heat the object. Namely, the constant voltage is continuously supplied until such time as the temperature of the object reaches the target voltage Ts to thus rapidly heat the object, and when the temperature of the object reaches the target temperature Ts, the variable voltage is supplied to maintain a heated state.

**[0068]** When the foregoing control methods are combined, the controller 300 may be configured to analyze the difference between the temperature of the object and the target temperature Ts and a heating record (or heating history) to determine whether to rapidly heat the object by supplying a high constant voltage or whether to slowly heat the object by supplying a variable voltage having a low voltage band, and the magnitude of the variable voltage may be derived by using the difference between the temperature of the object and the target temperature Ts.

**[0069]** According to the heating and cooling method as described above, by providing the high constant voltage and the voltage having a variable band having a relatively low maximum value according to the temperature of the object or the temperature of the first metal member 110, power saving can be promoted while increasing the temperature control speed.

**[0070]** In the case of the related art, since the switching operation is performed in the vicinity of a target temperature to maintain a temperature, a great deal of switching loss may occur due to the frequent voltage application and voltage interruption, and in particular, during such a switching operation, a great deal of heat may be generated from the voltage supply unit 200, involving a risk of a fire outbreak.

**[0071]** However, in the present embodiment, as described above, after the heating or cooling is performed up to a target temperature with a constant voltage, the target temperature is controlled to be maintained with a variable voltage. Thus, since a switching operation is not performed, a waste of power due to a switching operation and a risk of a fire outbreak due to heating can be remarkably reduced.

**[0072]** In addition, unlike the cases illustrated in FIGS. 3 through 5, when a temperature of the object is controlled to be maintained within a pre-set range above and below the target temperature, both cooling and heating are required to be performed on the object. In detail, since the direction of heat transmission is determined by a potential difference between both ends of the thermoelectric module 100, cooling and heating may be interchanged by changing a connection of a positive (+) pole and a negative (-) pole of the voltage supply unit 200 connected to one end of the first metal member 110 and the other end of the second metal member 120.

**[0073]** The respective embodiments of the cooling method may be applied to a heating method by altering the design.

**[0074]** Also, although not shown, when a temperature of the second metal member 120 or a temperature of air in contact with the other end of the second metal member 120 makes a significant difference from the target temperature, high temperature control capability is required. Thus, in this case, a voltage value supplied from the voltage supply unit 200 to the thermoelectric module 100 in the electronic temperature control apparatus is required to be corrected. Namely, the supply voltage value may be raised by a certain amount or rate or the section in

which the high constant voltage is applied may be raised.

**[0075]** In order to increase the section in which the constant voltage is applied, the first pre-set value may be lowered. In other words, when the difference between the temperature of the second metal member 120 or the ambient temperature and the target temperature exceeds a second pre-set voltage, the first pre-set value may be lowered.

**[0076]** In addition, when the difference between the temperature of the second metal member 120 or the ambient temperature and the target temperature is small, the first pre-set value may be raised.

**[0077]** Hereinafter, a control method of the electronic temperature control apparatus employing the foregoing temperature control scheme will be described.

**[0078]** FIGS. 7 and 8 are flow charts illustrating a control method of an electronic temperature control apparatus according to an embodiment of the present invention, respectively.

**[0079]** The electronic temperature control apparatus according to an embodiment of the present invention may include the thermoelectric module 100, and the control method according to an embodiment of the present invention may be performed by adjusting a voltage applied to the thermoelectric module 100.

**[0080]** With reference to FIGS. 7 and 8, the control method of the electronic temperature control apparatus according to an embodiment of the present invention includes a temperature setting operation 10, a temperature sensing operation 20, a voltage mode determining operation 30, and a voltage selecting operation 40.

**[0081]** In the temperature setting operation 10, a previously stored or input temperature is set as a target temperature. Namely, a pre-set target temperature or a target temperature desired by the user is set.

**[0082]** In the temperature sensing operation 20, a temperature of the object or the first metal member 110 may be sensed. The temperature sensing may be performed by using a temperature sensor.

**[0083]** In the voltage mode determining operation 30, whether to supply a first voltage to the thermoelectric module 100 or whether to supply a variable voltage having a range from a second voltage to a third voltage to the thermoelectric module 100 is de termined by using a difference between the temperature of the object or the first metal member 110 and the target temperature. The first voltage is higher than the second voltage and has a constant voltage value. When a difference between the temperature of the object or the first metal member 110 and the target temperature is equal to or greater than a first pre-set value, the high constant voltage is applied to adjust the temperature of the object to the target temperature at a fast speed, and when the difference between the temperature of the object or the first metal member 110 and the target temperature is smaller than the first pre-set value, a variable voltage is applied to maintain the temperature of the object at the target temperature without causing a switching loss.

**[0084]** In the voltage selecting operation 40, when the difference between the temperature of the object or the first metal member 110 and the target temperature is smaller than the first pre-set value, a variable voltage value to be applied to the thermoelectric module 100 may be selected within a range from the second voltage to the third voltage by using the difference between the temperature of the object or the first metal member 110 and the target temperature.

**[0085]** FIGS. 9 to 11 are detailed flow charts illustrating a process of determining a voltage mode in the control method of the electronic temperature control apparatus according to an embodiment of the present invention, respectively.

**[0086]** With reference to FIG. 9, in a voltage mode determining operation 30 of the electronic temperature control apparatus according to an embodiment of the present invention, a voltage mode may be determined according to whether or not a difference between a temperature of the object or the first metal member 110 and a target temperature is equal to or greater than a firstpre-set value.

**[0087]** In detail, the voltage mode determining operation 30 may include a determining operation 31 of determining whether or not the difference between the temperature of the object or the first metal member 110 and the target temperature is equal to or greater than the first pre-set value, a constant voltage mode operation 33 of outputting a first voltage as a constant voltage when the difference between the temperature of the object or the first metal member 110 and the target temperature is equal to or greater than the first pre-set value, and a variable voltage mode operation 35 of setting any one voltage within a range from the second voltage to the third voltage and applying the same, when the difference between the temperature of the object or the first metal member 110 and the target temperature is smaller than the first pre-set value.

**[0088]** According to the voltage mode determining operation 30 of the electronic temperature control apparatus according to an embodiment of the present invention illustrated in FIG. 7, the temperature of the object or the first metal member 110 may be quickly adjusted to the target temperature and to be within the first pre-set value.

**[0089]** Referring to FIG. 9, in the voltage mode determining operation 30 of the electronic temperature control apparatus according to an embodiment of the present invention, a voltage mode may be determined according to whether or not the difference between the temperature of the object or the first metal member 110 and the target temperature is equal to or greater than the first pre-set value or according to a current voltage mode.

**[0090]** In detail, the voltage mode determining operation 30 includes a determining operation 31 of determining whether or not the difference between the temperature of the object or the first metal member 110 and the target temperature is equal to or greater than the first pre-set value, a constant voltage mode operation 33 of

outputting a first voltage as a constant voltage until such time as the temperature of the object or the first metal member 110 reaches the target temperature, when the difference between the temperature of the object or the first metal member 110 and the target temperature is equal to or greater than the first pre-set value, an operation 34 of determining whether or not the temperature of the object or the first metal member 110 has reached the target temperature, and a variable voltage mode operation 35 of setting any one voltage within a range from the second voltage to the third voltage and applying the same, when the difference between the temperature of the object or the first metal member 110 and the target temperature is smaller than the first pre-set value. According to the voltage mode determining operation 30 of the electronic temperature control apparatus according to an embodiment of the present invention, the temperature of the object or the first metal member 110 is quickly adjusted to the target temperature and to be within the first pre-set value.

**[0091]** According to the voltage mode determining operation 30 of the electronic temperature control apparatus according to an embodiment of the present invention illustrated in FIG. 9, the temperature of the object or the first metal member 110 is quickly adjusted to the target temperature.

**[0092]** Referring to FIG. 11, in the voltage mode determining operation 30 of the electronic temperature control apparatus according to an embodiment of the present invention, a voltage mode is determined according to whether or not the temperature of the object or the first metal member 110 is equal to the target temperature, a current voltage mode, and according to whether or not the difference between the temperature of the object or the first metal member 110 and the target temperature is equal to or greater than the first pre-set value.

**[0093]** In detail, the voltage mode determining operation 30 includes an operation 31 of determining whether or not the temperature of the object or the first metal member 110 and the target temperature are equal, a first constant voltage mode operation 33 of outputting a first voltage as a constant voltage when the temperature of the object or the first metal member 110 is not equal to the target temperature, an operation 34 of determining whether or not the temperature of the object or the first metal member 110 and the target temperature are equal, a first variable voltage mode operation 35 of setting, by the voltage supply unit, any one voltage within a range from the second voltage to the third voltage, and supplying the same, when the temperature of the object or the first metal member 110 has reached the target temperature and the temperature of the object or the first metal member 110 is equal to or lower than the target temperature, an operation 36 of detecting whether or not a difference between the temperature of the object or the first metal member 110 and the target temperature exceeds the first pre-set value, a second constant voltage mode operation 37 of supplying, by the voltage supply unit, the first voltage to the thermoelectric module 100, when the temperature of the object or the first metal member 110 has reached the target temperature and the temperature of the object or the first metal member 110 exceeds the first pre-set value, and an operation 38 of determining whether or not the temperature of the object or the first metal member 110 has reached the target temperature through a second constant voltage mode operation. Although not shown, the voltage mode determining operation 30 may further include a second variable voltage mode operation of supplying, by the voltage supply unit, the third voltage to the thermoelectric module 100, when the temperature of the object or the first metal member 110 has reached the target temperature and the temperature of the object or the first metal member 110 exceeds the target temperature and is equal to or smaller than the first pre-set value unlike the first variable voltage mode. The voltage mode determining operation 30 illustrated in FIG. 11 may be used only for a heating operation or cooling operation.

**[0094]** Although not illustrated in FIG. 9 to 11, the control method of the electronic temperature control apparatus according to an embodiment of the present invention may further include a fan 400 driving operation of rotating the fan 400 disposed at the other end of the second metal member 120 at a first speed when the difference between the temperature of the object or the first metal member 110 and the target temperature is outside of the pre-set range, and rotating the fan 400 at a second speed when the difference between the temperature of the object or the first metal member 110 and the target temperature is within the pre-set range. Here, preferably, the first speed is faster than the second speed.

**[0095]** Hereinafter, a method for providing cold water in case of configuring a water purifier supplying cold water by using the electronic temperature control apparatus according to an embodiment of the present invention will be described.

**[0096]** A purified water tank of the water purifier may include a tank main body made of a synthetic resin and having an inlet and an outlet and a thermoelectric module in which one end of the first metal member 110 is hermetically connected to one open side of the tank main body. The other end of the second metal member 120 of the thermo electric module 100 is exposed to the outside, to which the fan 400 may be attached.

**[0097]** When it is assumed that a target temperature of cold water is controlled to be 5.5°C, a first pre-set value is set to be 2°C, a first voltage is set to be 21V, a third voltage is set to be 8.5V, and a second voltage is set to be 12V. The target temperature of cold water may be set to be any one value among temperatures ranging from 0°C to 7°C. Also, it may be set to be any one value among temperatures ranging from 0°C to 2°C. Here, however, preferably, the temperature of cold water does not exceed 10°C.

**[0098]** A temperature of purified water within the purified water tank when a cooling operation starts is equal

to room temperature. Thus, since it is different from the target temperature, the purified water may be rapidly cooled by applying the first voltage to the thermoelectric module 100. When a certain period of time has passed and the temperature of the purified water has reached the target temperature, the third voltage may be applied to the thermoelectric module 100 to maintain the temperature of cold water.

**[0099]** However, the temperature of cold water may be changed by various factors such as an ambient temperature, or the like, and here, when the temperature of cold water is dropped to 2°C, lower than the target temperature, the voltage supply may be stopped. When the temperature of cold water ranges from 5°C to 7°C, the second voltage may still be applied.

**[0100]** However, when the temperature of cold water reaches 7°C, the first voltage as a constant voltage may be applied to cool the cold water.

**[0101]** In addition, the second voltage may be adjusted to be lowered to 5V as necessary.

**[0102]** Feedback controlling may be performed such that the voltage supplied to the thermoelectric module 100 is a target voltage, and a consumed current may be measured and feedback controlling may be performed such that heat transmission capability of the thermoelectric module 100 is exerted at a target level, as necessary.

**[0103]** In addition, the configuration and operation of the voltage supply unit 200 of the electronic temperature control apparatus according to an embodiment of the present invention will be described with reference to the accompanying drawings.

**[0104]** FIG. 12 is a view schematically illustrating a configuration of the voltage supply unit according to an embodiment of the present invention.

**[0105]** Referring to FIG. 12, the voltage supply unit 200 may include a constant voltage generator 210, a variable voltage generator 220, and a voltage controller 230. The voltage supply unit 200 may further include any one of a switch unit 240 and a current direction controlled 250.

**[0106]** The constant voltage generator 210 generates a first voltage outlupon receiving power from a voltage source. The first voltage outl generated and output by the constant voltage generator 210 has a small amount of ripples and the constant voltage generator 210 may supply high power. Namely, the constant voltage generator 210 is a component for providing a high quality constant voltage. The constant voltage generator 210 may be implemented by using an SMPS, as necessary.

**[0107]** The variable voltage generator 220 generates a variable voltage out2 having a range from a second voltage to a third voltage according to a second control signal ctrl2 upon receiving the first voltage outl generated by the constant voltage generator 210. Namely, the variable voltage generator 220 may convert the first voltage outl into any one voltage out2 corresponding to the second control signal ctrl2, and here, the converted voltage out2 may be included within a range from the second voltage to the third voltage. As necessary, the variable voltage generator 220 may be implemented by using a DCDC converter, and the second control signal ctrl2 may be a signal for controlling a voltage conversion ratio of the DCDC converter. Here, the first voltage may be a voltage higher than the third voltage and may be a constant voltage. Namely, the voltage supply unit 200 according to an embodiment of the present invention may supply a constant voltage as a high voltage to the thermoelectric module 100 or supply a variable voltage having a relatively low voltage band.

**[0108]** As necessary, output terminals of the constant voltage generator 210 and the variable voltage generator 220 may be connected to form an annular shape, and a voltage may be output from the node at which the two terminals are connected, to the thermoelectric module 100. Namely, from the node at which the two output terminals are connected, one of the first voltage outl or the variable voltage out2 having a range from the second voltage to the third voltage may be output.

**[0109]** The switch unit 240 is disposed between the output terminal of the constant voltage generator 210 and the node at which the two output terminals are connected, and control a transfer of the first voltage outl output from the constant voltage generator 210 to the node at which the two terminals are connected. In particular, when the two output terminals are connected, the first voltage outl is relatively high, so if the first voltage outl is transferred simultaneously together with the variable voltage, only the first voltage outl, a voltage higher than the variable voltage, may be transferred, so the transfer of the first voltage outl is required to be controlled. In order to control the supply of the first voltage outl, a high voltage and high power, the switch unit 240 may be implemented as a power transistor or a power PET. This is to prevent the switch unit 240 from being damaged or short-circuited due to a high power signal.

**[0110]** The current direction controller 250 may be disposed between the variable voltage generator 220 and the node at which the two output terminals are connected, and control a current such that it is generated from the variable voltage generator 220 only to the node at which the two output terminals are connected. Namely, the current direction controller 250 may be implemented as an element for forming a unidirectional current path. Examples of an element for forming a unidirectional current path may include a diode, a transistor, and the like, and these elements may be utilized.

**[0111]** In particular, when the first voltage from the constant voltage generator 210 is being transferred to the node at which the two output terminals are connected, the output terminal or an internal circuit of the variable voltage generator 220 is required to be protected from the first voltage outl as a high voltage. In addition, since the first voltage is a high voltage, an element having characteristics of tolerating a high voltage and high power may be used as the current direction controller 250.

**[0112]** The voltage controller 230 may generate and output the first control signal ctrll to control whether to

interrupt the first voltage outl of the switch unit 240 or may generate and output the second control signal ctrl2 to control a voltage to be generated by the variable voltage generator 220. As necessary, the voltage controller 230 may control a magnitude of the voltage to be generated by the variable voltage generator 220 by using a voltage level of the second control signal ctrl2. Also, the second control signal ctrl2 may be output as a data signal comprised of a plurality of bits to provide information regarding a voltage level to be generated by the variable voltage generator 220.

**[0113]** According to the voltage supply unit 200 having the foregoing configuration, the constant voltage as a high voltage and the variable voltage having a relatively low voltage band may be selectively provided to the thermoelectric module 100.

**[0114]** FIG. 13 is a timing diagram illustrating an operation of the voltage supply unit according to an embodiment of the present invention.

**[0115]** With reference to FIG. 13, the voltage supply unit 200 may control a voltage VO of the node at which the two output terminals are connected, according to the first control voltage ctrll and the second control voltage ctrl2.

**[0116]** The constant voltage outl is output as the first voltage V 1 irrespective of the first control voltage ctrll and the second control voltage ctrl2. The variable voltage out2 is variably output as one of the second voltage V2 and the third voltage V3 according to the second control signal ctrl2.

**[0117]** As for the voltage VO of the node at which the two output terminals are connected, when the first control signal ctrll is applied, the first voltage V1 may be output from the node, and when the second control signal ctrl2, rather than the first control signal ctrll, is applied, a variable voltage having a range from the second voltage V2 to the third voltage V3 may be output therefrom.

## Claims

1. An electronic temperature control apparatus comprising:

   a thermoelectric module (100) including a first metal member (110) having one end to be in contact with an object and a second metal member (120) having one end joined with the other end of the first metal member (110);
   a voltage supply unit (200) to supply a first voltage (V1) or a variable voltage having a range from a second voltage (V2) to a third voltage (V3) to the thermoelectric module (100), the voltage being applied to one end joined with the other end of the first metal member (110); and
   a controller (300) configured to control a voltage supplied to the thermoelectric module (100) by the voltage supply unit (200) according to a difference between a temperature of the object or the first metal member (110) and a target temperature;
   wherein when the difference between a temperature of the object or the first metal member (110) and the target temperature is equal to or higher than a first pre-set value, the controller (300) is configured to control the voltage supply unit (200) to supply the first voltage to the thermoelectric module (100) until such time as the temperature of the object or the first metal member (110) reaches the target temperature, wherein the first voltage (V1) is a fixed voltage, **characterized in that**
   when the temperature of the object or the first metal member (110) has reached the target temperature, the controller (300) is configured to control the voltage supply unit (200) to supply the variable voltage to the thermoelectric module (100), wherein the first voltage (V1) is higher than the second voltage (V2).

2. The electronic temperature control apparatus of claim 1, wherein when the difference between a temperature of the object or the first metal member (110) and the target temperature is smaller than the first pre-set value, the controller (300) is configured to control the voltage supply unit (200) to supply the variable voltage to the thermoelectric module (100).

3. The electronic temperature control apparatus of claim 2, wherein when the difference between a temperature of the object or the first metal member (110) and the target temperature is within a pre-set range, the controller (300) is configured to adjust the voltage supplied to the thermoelectric module (100), in proportion to the difference between the target temperature and the temperature of the object or the first metal member (110).

4. The electronic temperature control apparatus of claim 1, wherein the controller (300) is configured to compare the target temperature with the temperature of the object or the first metal member (110) and if the peaks of the temperatures are reversed, the controller (300) is configured to switch a connection state between the one end of the first metal member (110) and the other end of the second metal member to reverse the peaks of potentials of the one end of the first metal member (110) and the other end of the second metal member (120).

5. The electronic temperature control apparatus of claim 1, wherein when the controller (300) is configured to further compare the temperature of the second metal member (120) or an ambient temperature with the target temperature and the voltage supply unit (200) supplies the variable voltage to the ther-

moelectric module (100), the controller (300) is configured to correct the amount of the supplied variable voltage.

**6.** The electronic temperature control apparatus of claim 5, wherein
when the difference between a temperature of the object or the first metal member (110) and the target temperature is smaller than the first pre-set value, the controller (300) controls the voltage supply unit (200) to supply the variable voltage to the thermoelectric module (100), and
when the difference between the temperature of the second metal member (120) or the ambient temperature and the target temperature exceeds a second pre-set value, the controller (300) is configured to narrow the pre-set range.

**7.** The electronic temperature control apparatus of claim 1, further comprising a fan (400) disposed on the other side of the second metal member (120) of the thermoelectric module (100).

**8.** The electronic temperature control apparatus of claim 7, wherein when the difference between a temperature of the object or the first metal member (110) and the target temperature is outside of the pre-set range, the controller (300) is configured to rotate the fan (400) at a first speed, and
when the difference between a temperature of the object or the first metal member (110) and the target temperature is within a pre-set range, the controller (300) is configured to rotate the fan (400) at a second speed, wherein the first speed is faster than the second speed.

**9.** The electronic temperature control apparatus of claim 1, wherein the controller (300) is configured to detect a voltage supplied to the thermoelectric module (100) by the voltage supply unit (200) and feedback-control the voltage supplied to the thermoelectric module (100) by the voltage supply unit.

**10.** A control method of an electronic temperature control apparatus including a thermoelectric module (100) including a first metal member (110) having one end in contact with an object and a second metal member (120) having one end joined with the other end of the first metal member (110), a voltage applied to one end of the first metal member (110) and the other end of the second metal member (120), the method comprising:

a temperature setting operation of setting a previously stored or input temperature as a target temperature;
a temperature sensing operation of sensing a temperature of the object or the first metal member (110);
a voltage mode determining operation of determining whether to supply a first voltage (V1) to the thermoelectric module (100) or whether to supply a variable voltage having a range from a second voltage (V2) to a third voltage (V3) to the thermoelectric module (100) by using a difference between the temperature of the object or the first metal member (110) and the target temperature; and
a voltage selecting operation of selecting a magnitude of the variable voltage by using the difference between the temperature of the object or the first metal member (110) and the target temperature when it is determined to supply the variable voltage to the thermoelectric module (100),
wherein the voltage mode determining operation comprises:

a constant voltage mode operation of supplying, by a voltage supply unit, the first voltage (V1) to the thermoelectric module (100) until such time as the temperature of the object or the first metal member (110) reaches the target temperature when the difference between the temperature of the object or the first metal member (110) and the target temperature is equal to or higher than the first pre-set value, wherein the first voltage (V1) is a fixed voltage;

**characterized in that** the voltage mode determination operation further comprises:

a variable voltage mode operation of supplying, by the voltage supply unit, the variable voltage to the thermoelectric module (100) when the temperature of the object or the first metal member (110) has reached the target temperature, wherein the first voltage (V1) is higher than the second voltage (2).

**Patentansprüche**

**1.** Elektronische Temperatursteuervorrichtung umfassend:

ein thermoelektrisches Modul (100) umfassend ein erstes Metallteil (110) mit einem Ende, das in Kontakt mit einem Objekt steht und ein zweites Metallteil (120) mit einem Ende, das mit dem anderen Ende des ersten Metallteils (110) verbunden ist;
eine Spannungsversorgungeinheit (200) zur Versorgung des thermoelektrischen Moduls mit einer erste Spannung (V1) oder einer variable

Spannung, die einen Bereich von einer zweiten Spannung (V2) bis zu einer dritten Spannung (V3) aufweist, wobei die Spannung an das Ende, das mit dem anderen Ende des ersten Metallteils (110) verbunden ist, angelegt wird; und

eine Steuerung (300), die eingerichtet ist, eine Spannung, mit der das thermoelektrische Modul (100) durch die Spannungsversorgungeinheit (200) versorgt wird, in Abhängigkeit eines Unterschieds zwischen einer Temperatur des Objekts oder des ersten Metallteils (110) und einer Zieltemperatur zu steuern;

wobei die Steuerung (300) eingerichtet ist, die Spannungsversorgungeinheit (200) zu steuern, um das thermoelektrische Modul (100) mit der ersten Spannung bis zu der Zeit zu versorgen, bei der die Temperatur des Objekts oder des ersten Metallteils (110) die Zieltemperatur erreicht, wenn der Unterschied zwischen der Temperatur des Objekts oder des ersten Metallteils (110) und der Zieltemperatur gleich oder höher als ein erster voreingestellter Wert ist, wobei die erste Spannung (V1) eine feste Spannung ist,

**dadurch gekennzeichnet, dass**

die Steuerung (300) eingerichtet ist, die Spannungsversorgungeinheit (200) zu steuern, um das thermoelektrische Modul (100) mit der variablen Spannung zu versorgen, wenn die Temperatur des Objekts oder des ersten Metallteils (110) die Zieltemperatur erreicht hat, wobei die erste Spannung (V1) höher als die zweite Spannung (V2) ist.

**2.** Elektronische Temperatursteuervorrichtung nach Anspruch 1, wobei die Steuerung (300) eingerichtet ist, die Spannungsversorgungeinheit (200) zu steuern, um das thermoelektrische Modul (100) mit der variablen Spannung zu versorgen, wenn der Unterschied zwischen einer Temperatur des Objekts oder des ersten Metallteils (110) und der Zieltemperatur geringer als ein erster voreingestellter Wert ist.

**3.** Elektronische Temperatursteuervorrichtung nach Anspruch 2, wobei die Steuerung (300) eingerichtet ist, die Spannung, mit der das thermoelektrische Modul (100) versorgt wird, proportional zum Unterschied zwischen der Zieltemperatur und der Temperatur des Objekts oder des ersten Metallteils (110) zu justieren, wenn der Unterschied zwischen der Temperatur des Objekts oder des ersten Metallteils (110) und der Zieltemperatur innerhalb eines voreingestellten Werts liegt.

**4.** Elektronische Temperatursteuervorrichtung nach Anspruch 1, wobei die Steuerung (300) eingerichtet ist, die Zieltemperatur mit der Temperatur des Objekts oder des ersten Metallteils (110) zu vergleichen und, wenn Spitzenwerte der Temperatur umgewendet werden, die Steuerung (300) eingerichtet ist, einen verbundenen Zustand zwischen dem einen Ende des ersten Metallteils (110) und dem anderen Ende des zweiten Metallteils zu schalten, um Spitzenwerte der Potenziale des ersten Endes des ersten Metallteils (110) und des anderen Endes des zweiten Metallteils (120) zu wenden.

**5.** Elektronische Temperatursteuervorrichtung nach Anspruch 1, wobei, wenn die Steuerung (300) eingerichtet ist, um weiter die Temperatur des zweiten Metallteils (120) oder einer Umgebungstemperatur mit der Zieltemperatur zu vergleichen und die Spannungsversorgungeinheit das thermoelektrische Modul (100) mit der variablen Spannung versorgt, die Steuerung (300) eingerichtet ist, den Betrag der zugeführten variablen Spannung zu korrigieren.

**6.** Elektronische Temperatursteuervorrichtung nach Anspruch 5, wobei, wenn der Unterschied zwischen einer Temperatur des Objekts oder des ersten Metallteils (110) und der Zieltemperatur geringer als der erste voreingestellte Wert ist, die Steuerung (300) die Spannungsversorgungeinheit (200) steuert, um das thermoelektrische Modul (100) mit der variablen Spannung zu versorgen und

wenn der Unterschied zwischen der Temperatur des zweiten Metallteils (120) oder der Umgebungstemperatur und der Zieltemperatur einen zweiten voreingestellten Wert überschreitet, die Steuerung (300) eingerichtet ist, den voreingestellten Bereich einzuengen.

**7.** Elektronische Temperatursteuervorrichtung nach Anspruch 1, ferner umfassend einen Lüfter (400), der auf der anderen Seite des zweiten Metallteils (120) des thermoelektrischen Moduls (100) angeordnet ist.

**8.** Elektronische Temperatursteuervorrichtung nach Anspruch 7, wobei die Steuerung (300) eingerichtet ist, den Lüfter (400) mit einer ersten Geschwindigkeit rotieren zu lassen, wenn der Unterschied zwischen einer Temperatur des Objekts oder des ersten Metallteils (110) und die Zieltemperatur außerhalb des voreingestellten Bereichs liegt, und

die Steuerung (300) eingerichtet ist, den Lüfter (400) mit einer zweiten Geschwindigkeit rotieren zu lassen, wenn der Unterschied zwischen einer Temperatur des Objekts oder des ersten Metallteils (110) und der Zieltemperatur innerhalb eines voreingestellten Bereichs liegt, wobei die erste Geschwindigkeit schneller als die zweite Geschwindigkeit ist.

**9.** Elektronische Temperatursteuervorrichtung nach Anspruch 1, wobei die Steuerung (300) eingerichtet ist, eine Spannung zu detektieren, mit der das thermoelektrische Modul (100) durch die Spannungsver-

sorgungeinheit (200) versorgt wird, und die Spannung, mit der das thermoelektrische Modul (100) durch die Spannungsversorgungeinheit versorgt wird, zu regeln.

**10.** Steuerungsverfahren einer elektronischen Temperatursteuervorrichtung umfassend ein thermoelektrisches Modul (100), das ein erstes Metallteil (110) mit einem Ende, das in Kontakt mit einem Objekt steht, und ein zweites Metallteil (120), das ein Ende aufweist, das mit dem anderen Ende des ersten Metallteils (110) verbunden ist, umfasst, wobei eine Spannung an das erste Ende des ersten Metallteils (110) und das andere Ende des zweiten Metallteils (120) angelegt wird, wobei das Verfahren umfasst:

eine Temperatureinstelloperation zur Einstellung einer zuvor gespeicherten oder eingegebenen Temperatur als Zieltemperatur;
eine Temperaturerfassungsoperation zur Erfassung einer Temperatur des Objekts oder des ersten Metallteils (110);
eine Spannungsmodusbestimmungsoperation zum Bestimmen, ob das thermoelektrische Modul (100) mit einer ersten Spannung (V1) zu versorgen ist, oder ob das thermoelektrische Modul (100) mit einer variablen Spannung, die einen Bereich von einer zweiten Spannung (V2) bis zu einer dritten Spannung (V3) aufweist, zu versorgen ist, durch Verwenden eines Unterschieds zwischen der Temperatur des Objekts oder des ersten Metallteils (110) und der Zieltemperatur; und
eine Spannungsauswahloperation zum Auswählen einer Größe der variablen Spannung durch Verwenden des Unterschieds zwischen der Temperatur des Objekts oder des ersten Metallteils (110) und der Zieltemperatur, wenn bestimmt wurde, dass das thermoelektrische Modul (100) mit der variablen Spannung zu versorgen ist,
wobei die Spannungsmodusbestimmungsoperation umfasst:

eine konstante Spannungsmodusoperation zum Versorgen des thermoelektrischen Moduls (100) durch eine Spannungsversorgungeinheit mit der ersten Spannung (V1) bis zu der Zeit, bei der die Temperatur des Objekts oder des ersten Metallteils (110) die Zieltemperatur erreicht, wenn der Unterschied zwischen der Temperatur des Objekts oder des ersten Metallteils (110) und der Zieltemperatur gleich oder höher als der erste voreingestellte Wert ist, wobei die erste Spannung (V1) eine feste Spannung ist;

**dadurch gekennzeichnet, dass** die Spannungsmodusbestimmungsoperation ferner umfasst:

eine variable Spannungsmodusoperation zum Versorgen des thermoelektrischen Moduls (100) durch eine Spannungsversorgungeinheit mit der variablen Spannung, wenn die Temperatur des Objekts oder des ersten Metallteils (110) die Zieltemperatur erreicht hat, wobei die erste Spannung (V1) höher als die zweite Spannung (2) ist.

**Revendications**

**1.** Appareil de commande de température électronique comprenant :

un module thermoélectrique (100) comportant un premier organe en métal (110) ayant une extrémité pour être en contact avec un objet et un second organe en métal (120) ayant une extrémité jointe à l'autre extrémité du premier organe en métal (110) ;
une unité de fourniture de tension (200) pour fournir une première tension (V1) ou une tension variable ayant une plage d'une deuxième tension (V2) à une troisième tension (V3) au module thermoélectrique (100), la tension étant appliquée à une extrémité jointe à l'autre extrémité du premier organe en métal (110) ; et
un dispositif de commande (300) configuré pour commander une tension fournie au module thermoélectrique (100) par l'unité de fourniture de tension (200) selon une différence entre une température de l'objet ou du premier organe en métal (110) et une température cible ;
dans lequel, lorsque la différence entre une température de l'objet ou du premier organe en métal (110) et la température cible est supérieure ou égale à une première valeur préétablie, le dispositif de commande (300) est configuré pour commander à l'unité de fourniture de tension (200) de fournir la première tension au module thermoélectrique (100) jusqu'au moment où la température de l'objet ou du premier organe en métal (110) atteint la température cible, dans lequel la première tension (V1) est une tension fixe, **caractérisé en ce que**
lorsque la température de l'objet ou du premier organe en métal (110) a atteint la température cible, le dispositif de commande (300) est configuré pour commander à l'unité de fourniture de tension (200) de fournir la tension variable au module thermoélectrique (100), dans lequel la première tension (V1) est supérieure à la deuxième tension (V2).

**2.** Appareil de commande de température électronique selon la revendication 1, dans lequel
lorsque la différence entre une température de l'objet ou du premier organe en métal (110) et la température cible est inférieure à la première valeur préétablie, le dispositif de commande (300) est configuré pour commander à l'unité de fourniture de tension (200) de fournir la tension variable au module thermoélectrique (100).

**3.** Appareil de commande de température électronique selon la revendication 2, dans lequel, lorsque la différence entre une température de l'objet ou du premier organe en métal (110) et la température cible est dans les limites d'une plage préétablie, le dispositif de commande (300) est configuré pour ajuster la tension fournie au module thermoélectrique (100), proportionnellement à la différence entre la température cible et la température de l'objet ou du premier organe en métal (110).

**4.** Appareil de commande de température électronique selon la revendication 1, dans lequel le dispositif de commande (300) est configuré pour comparer la température cible avec la température de l'objet ou du premier organe en métal (110) et si les pics des températures sont inversés, le dispositif de commande (300) est configuré pour commuter un état de raccordement entre ladite extrémité du premier organe en métal (110) et l'autre extrémité du second organe en métal pour inverser les pics de potentiels de ladite extrémité du premier organe en métal (110) et de l'autre extrémité du second organe en métal (120).

**5.** Appareil de commande de température électronique selon la revendication 1, dans lequel, lorsque le dispositif de commande (300) est configuré pour comparer en outre la température du second organe en métal (120) ou une température ambiante avec la température cible et l'unité de fourniture de tension (200) fournit la tension variable au module thermoélectrique (100), le dispositif de commande (300) est configuré pour corriger la quantité de la tension variable fournie.

**6.** Appareil de commande de température électronique selon la revendication 5, dans lequel
lorsque la différence entre une température de l'objet ou du premier organe en métal (110) et la température cible est inférieure à la première valeur préétablie, le dispositif de commande (300) commande à l'unité de fourniture de tension (200) de fournir la tension variable au module thermoélectrique (100), et
lorsque la différence entre la température du second organe en métal (120) ou la température ambiante et la température cible dépasse une seconde valeur préétablie, le dispositif de commande (300) est configuré pour rétrécir la plage préétablie.

**7.** Appareil de commande de température électronique selon la revendication 1, comprenant en outre un ventilateur (400) disposé sur l'autre côté du second organe en métal (120) du module thermoélectrique (100).

**8.** Appareil de commande de température électronique selon la revendication 7, dans lequel, lorsque la différence entre une température de l'objet ou du premier organe en métal (110) et la température cible est en dehors de la plage préétablie, le dispositif de commande (300) est configuré pour mettre en rotation le ventilateur (400) à une première vitesse, et
lorsque la différence entre une température de l'objet ou du premier organe en métal (110) et la température cible est dans les limites d'une plage préétablie, le dispositif de commande (300) est configuré pour mettre en rotation le ventilateur (400) à une seconde vitesse, dans lequel la première vitesse est plus rapide que la seconde vitesse.

**9.** Appareil de commande de température électronique selon la revendication 1, dans lequel le dispositif de commande (300) est configuré pour détecter une tension fournie au module thermoélectrique (100) par l'unité de fourniture de tension (200) et commander en rétroaction la tension fournie au module thermoélectrique (100) par l'unité de fourniture de tension.

**10.** Procédé de commande d'un appareil de commande de température électronique comportant un module thermoélectrique (100) comportant un premier organe en métal (110) ayant une extrémité en contact avec un objet et un second organe en métal (120) ayant une extrémité jointe à l'autre extrémité du premier organe en métal (110), une tension étant appliquée à une extrémité du premier organe en métal (110) et à l'autre extrémité du second organe en métal (120), le procédé comprenant :

une opération de réglage de température consistant à régler une température précédemment stockée ou entrée en tant que température cible ;
une opération de détection de température consistant à détecter une température de l'objet ou du premier organe en métal (110) ;
une opération de détermination de mode de tension consistant à déterminer s'il faut fournir une première tension (V1) au module thermoélectrique (100) ou s'il faut fournir une tension variable ayant une plage d'une deuxième tension (V2) à une troisième tension (V3) au module thermoélectrique (100) en utilisant une différence entre

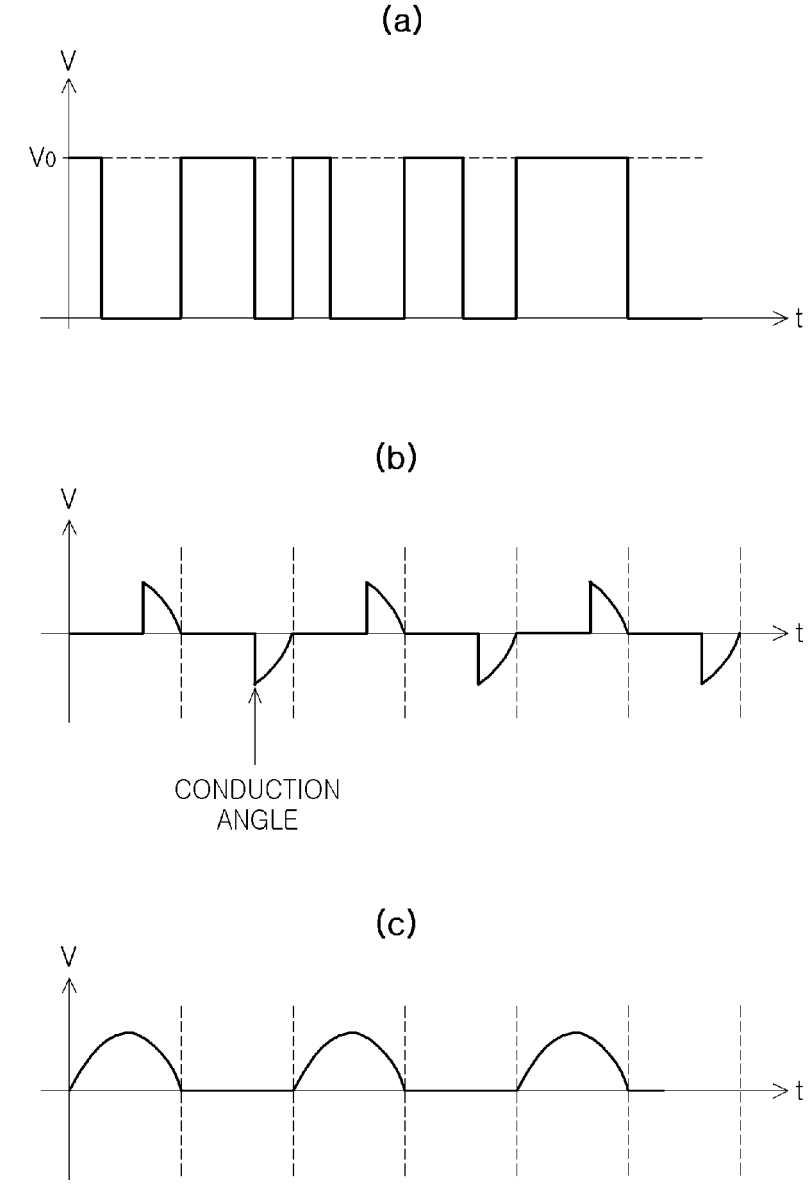
la température de l'objet ou du premier organe en métal (110) et la température cible ; et
une opération de sélection de tension consistant à sélectionner une grandeur de la tension variable en utilisant la différence entre la température de l'objet ou du premier organe en métal (110) et la température cible lorsqu'on détermine qu'il faut fournir la tension variable au module thermoélectrique (100),
dans lequel l'opération de détermination de mode de tension comprend :

une opération de mode de tension constante consistant à fournir, par une unité de fourniture de tension, la première tension (V1) au module thermoélectrique (100) jusqu'au moment où la température de l'objet ou du premier organe en métal (110) atteint la température cible lorsque la différence entre la température de l'objet ou du premier organe en métal (110) et la température cible est supérieure ou égale à la première valeur préétablie, dans lequel la première tension (V1) est une tension fixe ;

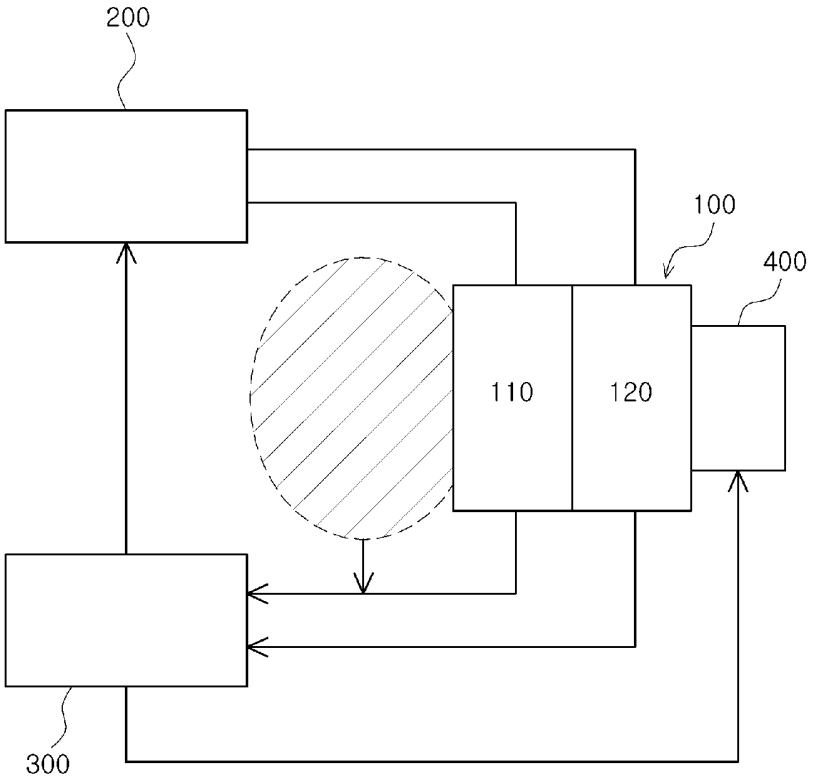
**caractérisé en ce que** l'opération de détermination de mode de tension comprend en outre :

une opération de mode de tension variable consistant à fournir, par l'unité de fourniture de tension, la tension variable au module thermoélectrique (100) lorsque la température de l'objet ou du premier organe en métal (110) a atteint la température cible, dans lequel la première tension (V1) est supérieure à la deuxième tension (2).

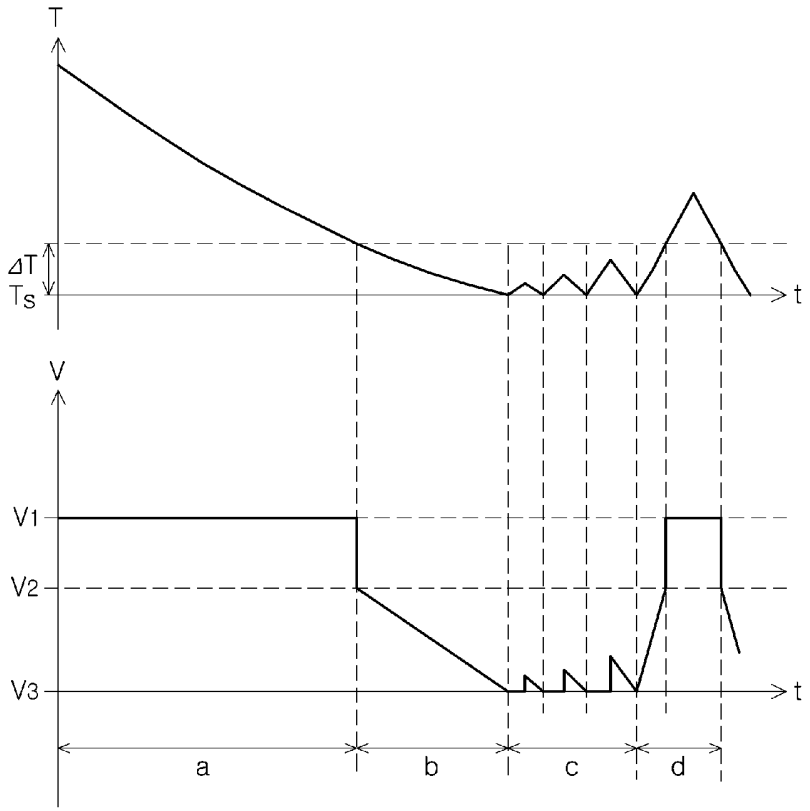
[Fig. 1]



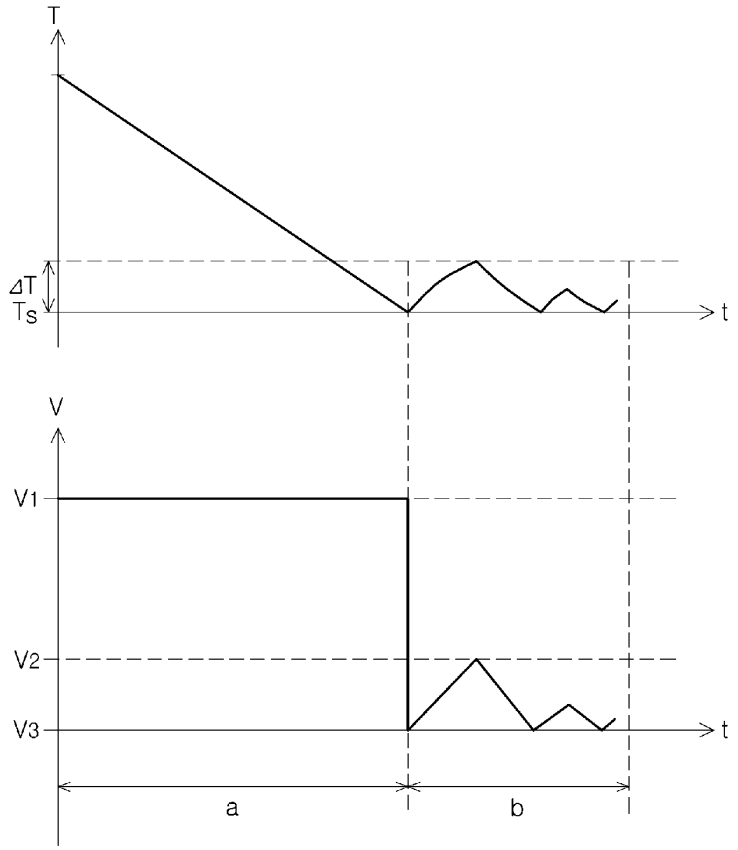
[Fig. 2]



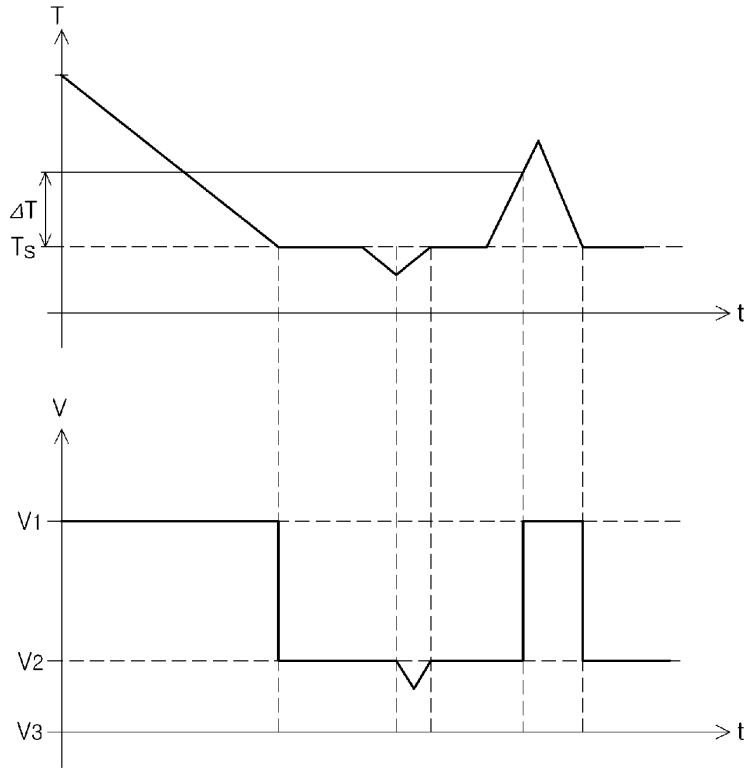

[Fig. 3]



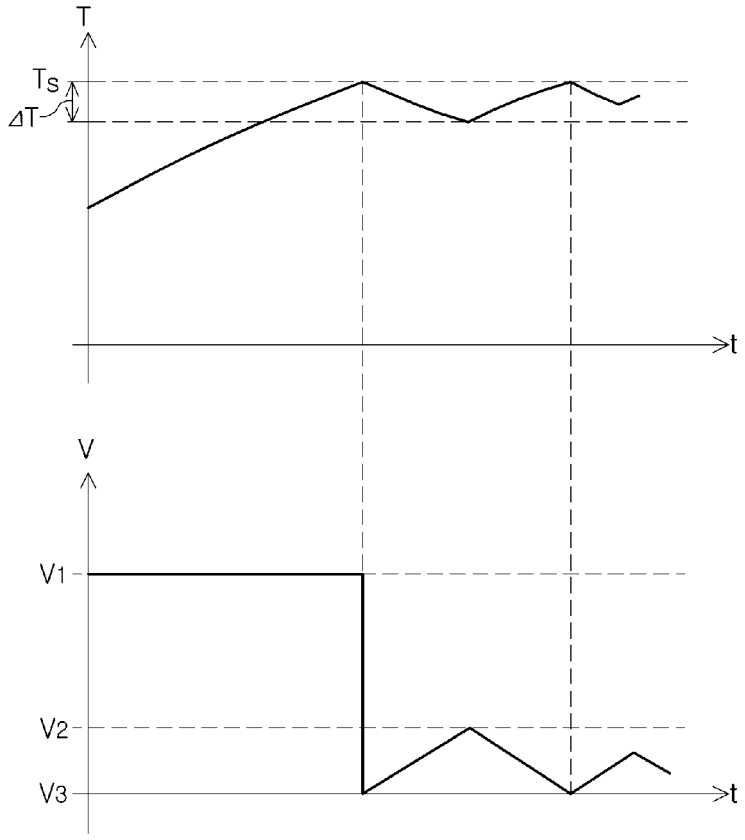
[Fig. 4]



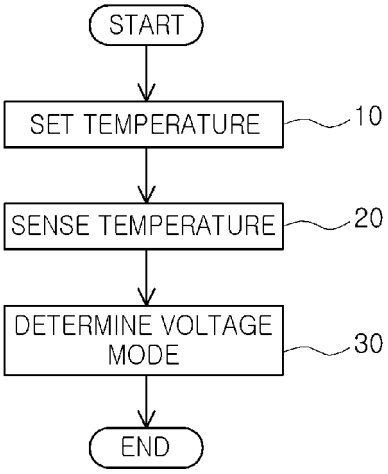

[Fig. 5]



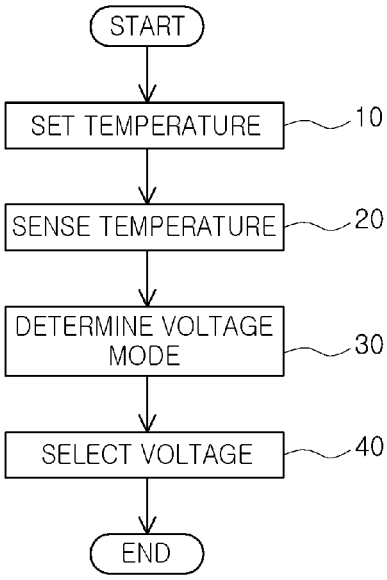
[Fig. 6]


T
Ts
ΔT
t
V
V1
V2
V3
t

[Fig. 7]


START
SET TEMPERATURE
10
SENSE TEMPERATURE
20
DETERMINE VOLTAGE MODE
30
END

[Fig. 8]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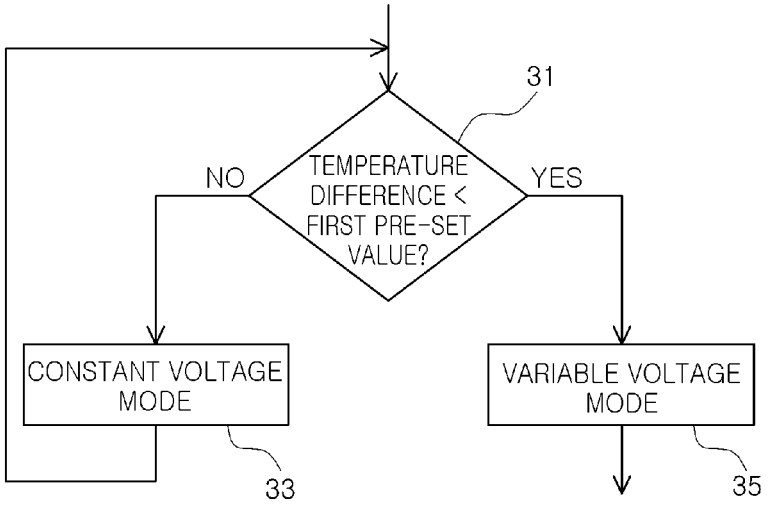
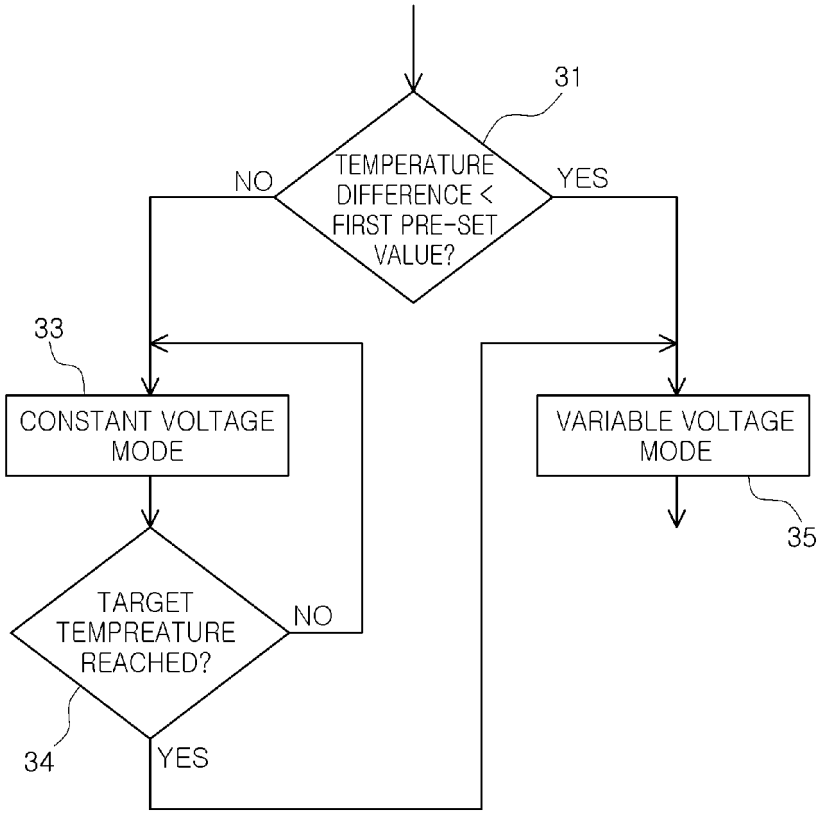
SET TEMPERATURE
10
SENSE TEMPERATURE
20
DETERMINE VOLTAGE MODE
30
SELECT VOLTAGE
40
END

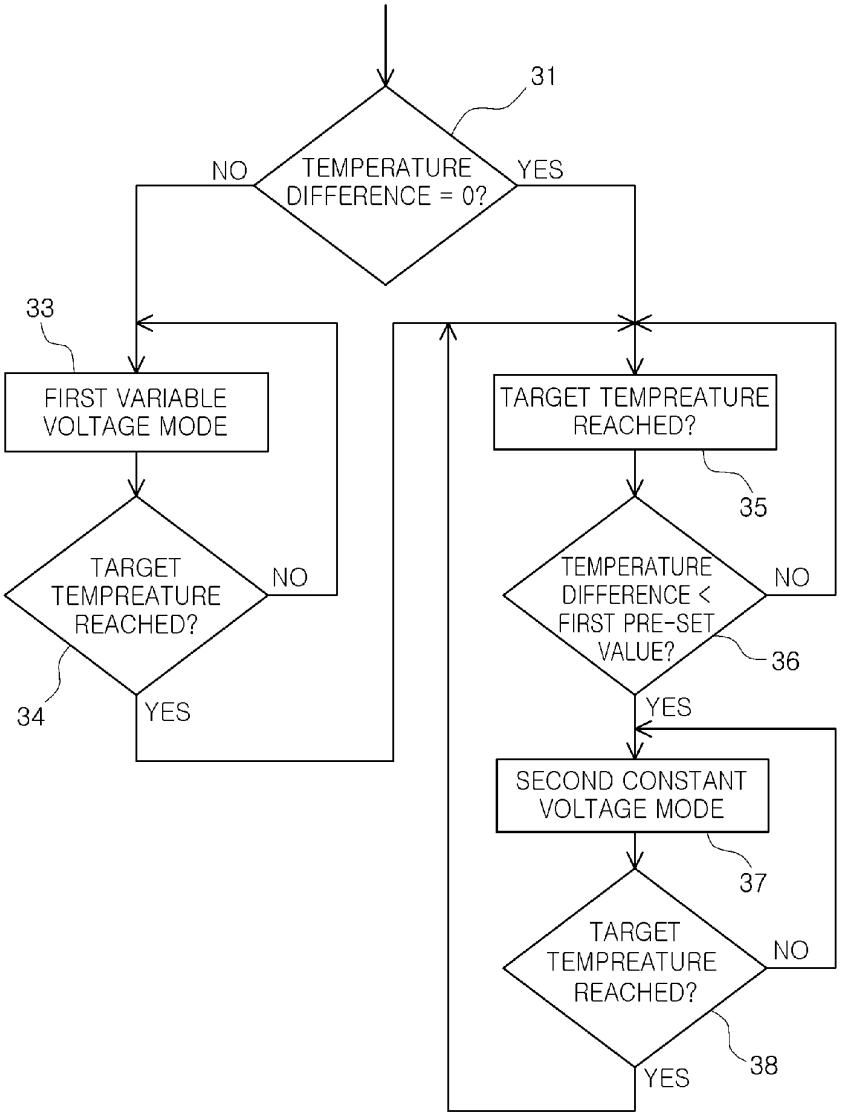
[Fig. 9]


31
TEMPERATURE DIFFERENCE < FIRST PRE-SET VALUE?
NO
YES
CONSTANT VOLTAGE MODE
VARIABLE VOLTAGE MODE
33
35

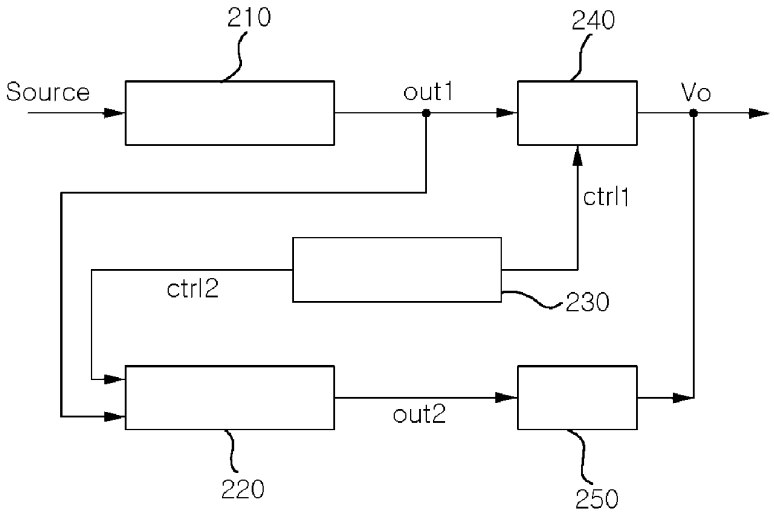
[Fig. 10]


31
TEMPERATURE DIFFERENCE < FIRST PRE-SET VALUE?
NO
YES
33
CONSTANT VOLTAGE MODE
VARIABLE VOLTAGE MODE
35
TARGET TEMPREATURE REACHED?
NO
34
YES

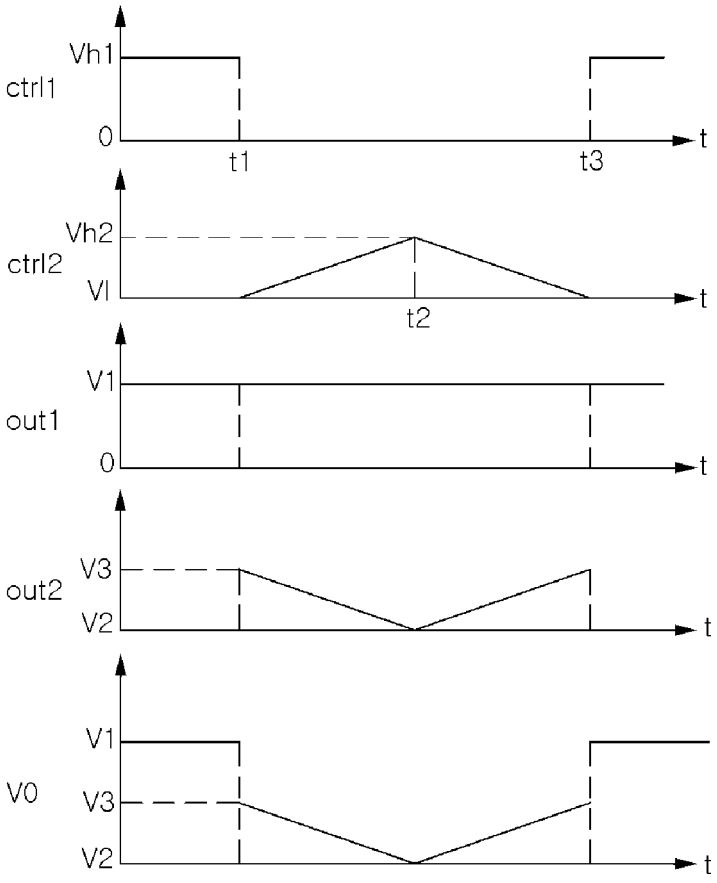
[Fig. 11]


31
TEMPERATURE DIFFERENCE = 0?
NO
YES
33
FIRST VARIABLE VOLTAGE MODE
TARGET TEMPREATURE REACHED?
NO
34
YES
TARGET TEMPREATURE REACHED?
35
TEMPERATURE DIFFERENCE < FIRST PRE-SET VALUE?
NO
36
YES
SECOND CONSTANT VOLTAGE MODE
37
TARGET TEMPREATURE REACHED?
NO
38
YES

[Fig. 12]


210
240
Source
out1
Vo
ctrl1
ctrl2
230
out2
220
250

[Fig. 13]


Vh1
ctrl1
0
t1
t3
t
Vh2
ctrl2
Vl
t2
t
V1
out1
0
t
V3
out2
V2
t
V1
V0
V3
V2
t

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


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