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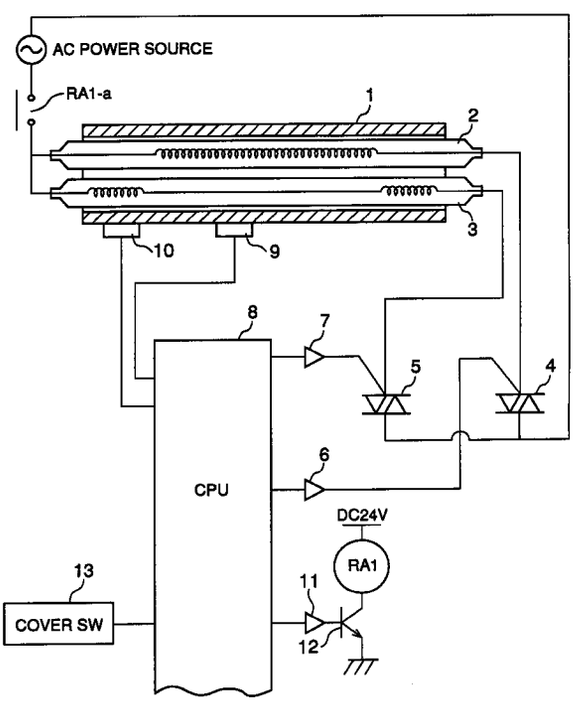
(54) Fixing apparatus for an image forming apparatus

(57) A fixing apparatus has heaters (2, 3) to provide heat to fix a toner image on print paper. The heaters are intermittently activated to maintain the fixing apparatus at a substantially constant temperature. The heaters are activated by a predetermined voltage (Vf). Deactivation of the heaters (2, 3) is controlled by providing a low voltage immediately before the heaters are completely turned off so that a rate of change in a current flowing to the heaters is reduced. A timing of deactivation of each of the heaters may be controlled so that a start time of deactivation of the heaters (2, 3) differs from each other. The heaters (3) excluding at least one (2) of the heaters (2, 3) may be maintained to be deactivated when the fixing apparatus is in a predetermined operational state such as a waiting state or pre-heating state.

FIG.1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to a fixing apparatus for an image forming apparatus and, more particularly, to a fixing apparatus using a heater for applying heat to a toner image to be fixed.

In recent years, the safety of products, which includes image forming apparatuses using a fixing apparatus, has been considered to be of great importance, especially, in the EU countries. For example, when an image forming apparatus is introduced on the EC market, the image forming apparatus must comply with the requirements specified by the EC instructions.

The EC instructions includes the Electromagnetic Compatibility (EMC) instructions which provides the Electromagnetic Interference (EMI) Standard and the Electromagnetic Susceptibility (EMS) Standard. A measuring method and limit values for these standards are specified in the IEC Standards and the EN Standards.

Among the test items in the ECM instructions, the power source fluctuation test and the harmonic current test are considered to be important test items since insufficient measures have been taken previously. The power source fluctuation test is provided to suppress a flicker value which represents a level of a flicker state. The flicker state refers to a state in which lights flicker due to frequent repletion of fluctuation in a power source voltage. The harmonic current test is performed to measure a harmonic current so as to suppress the harmonic current generated by, for example, office equipment and air conditioners using an inverter. The harmonic current is harmful for a power plant and a transmission facility because an increase of the harmonic current may cause a failure of a power receiving facility or decrease in a power factor.

It is predicted that the control of the flicker value and the harmonic current according to regulations will become more strict.

Additionally, in recent years, image forming apparatuses, such as a copy machine, perform a complex control process and require increased power to operate. This results in a large fluctuation in current consumption and an increased generation of electric noise and harmonic current. The electric noise and harmonic current generated by an image forming apparatus may intrude into other electronic equipment which may cause a malfunction or a failure of the electronic equipment.

Particularly, a fixing apparatus of an image forming apparatus having a large heater using a large amount of power causes a large fluctuation in the voltage of a power source to which the image forming apparatus is connected while a fixing operation is performed. Thus, it is desired to reduce a flicker value of such an image forming apparatus.

2. Description of the Related Art

Generally, a fixing apparatus used in an image forming apparatus such as a copy machine, a facsimile machine or a printer comprises a fixing unit for fixing a toner image on print paper, a heating unit for heating the fixing unit, a temperature sensor for sensing a temperature of the fixing unit and a control unit for controlling the heating unit based on a temperature signal supplied by the temperature sensor so as to maintain the fixing unit at an appropriate temperature. The heating unit may comprise a plurality of heaters and a plurality of temperature sensors may be provided to sense temperature at positions corresponding to the plurality of heaters so that each of the heaters can be separately controlled.

Japanese Patent Publication No.6-73053 discloses a fixing apparatus comprising a fixing roller having a plurality of heaters and a pressing roller being pressed to the fixing roller with print paper interposed therebetween. The fixation of a toner image on the print paper is achieved by heating and pressing. This fixing apparatus has a single temperature sensor so as to control the plurality of heaters based on a temperature signal output from the temperature sensor. Accordingly, when the temperature of the fixing roller sensed by the temperature sensor is below a predetermined temperature for fixation, the plurality of heaters are activated simultaneously so as to raise the temperature of the fixing roller.

In the fixing apparatus described in the above-mentioned Japanese Patent Publication No.6-73053 and, since the plurality of heaters are activated based on the signal output from the single temperature sensor, the plurality of heaters are activated at the same moment. This causes a problem in that a large rush current is generated when the plurality of heaters are activated at the same moment, resulting in a large fluctuation in a voltage output from a power source to which the fixing apparatus is connected.

Japanese Laid-Open Patent Application No.3-185482 discloses a fixing apparatus comprising a heating roller, a pressing roller and a heater control unit for controlling an operation of heaters provided in the heating roller. In this fixing apparatus, the heating roller has a first heater and a second heater. The first heater generates more heat at end portions of the heating roller than at a middle portion. On the other hand, the second heater generates more heat at the middle portion of the heating roller than the end portions. The heater control unit activates the first heater when the print paper is being conveyed or not being conveyed. The heater control unit activates the second heater only when print paper is being conveyed. The first and second heaters are simultaneously and intermittently activated when the heating roller is below a predetermined temperature so as to maintain the heating roller at or near the predetermined temperature.

In the fixing apparatus described in the above-mentioned Japanese Laid-Open Patent Application No.3-185482, the first and second heaters are activated at

the same moment. Thus, similar to the fixing apparatus of Japanese Patent Application No.6-73053, there is a problem in that a large rush current is generated when the plurality of heaters are activated at the same moment, resulting in a large fluctuation in a voltage output from a power source to which the fixing apparatus is connected.

Japanese Laid-Open Patent Application No.2-129681 discloses a fixing apparatus for an electro-photographic printer. This fixing apparatus comprises a pair of rollers, a heat source, a temperature sensor and a power source for the heat source. The pair of rollers conveys print paper having a toner image to be fixed. The heat source provides heat to at least one of the rollers. The temperature sensor senses a temperature of the one of the rollers. The power source outputs at least two voltages at different levels based on an output of the temperature sensor so that a lower voltage is supplied to the heat source first when the heat source is activated.

Japanese Laid-Open Patent Application No.61-94080 discloses a fixing temperature controlling device for maintaining a heat fixing roller at a predetermined temperature by controlling a power to be supplied to the heat fixing roller based on a temperature of the heat fixing roller sensed by a temperature sensor. The fixing temperature controlling device converts a temperature difference between the temperature sensed by the temperature sensor and the predetermined temperature into a pulse signal having a pulse width proportional to the temperature difference. The predetermined temperature can be set to a first temperature and a second temperature higher than the first temperature. Normally, the predetermined temperature is set to the first temperature. The predetermined temperature is set to the second temperature when print paper is being conveyed.

Japanese Laid-Open Patent Application No.59-111669 discloses a method for controlling a fixing apparatus having a plurality of heaters. In this method, when the plurality of heaters are activated, one of the heaters is activated first. Then, another one of heaters is activated with a time delay in response to a temperature of the fixing apparatus.

In the method for controlling a fixing apparatus described in the above-mentioned Japanese laid-Open Patent Application No.59-111669, since the plurality of heaters are not activated at the same moment, a rush current generated when the heaters are turned on is decreased. However, the decrease in the rush current is not sufficient for clearing the standard value specified by the power source voltage fluctuation test.

Japanese Laid-Open Patent Application No.4-168468 discloses an image forming apparatus performing a fixing operation by heating with electric heating elements using an alternating current source. This image forming apparatus comprises a plurality of heating elements, a temperature sensor for sensing temperatures of the heaters and a control unit for controlling activation of each of the heaters. Some heating elements are selectively activated from among the plurality of heaters in response to a temperature difference between the temperature sensed by the temperature sensor and a target temperature. The start timing of the activation of each of the selected heating elements is shifted to each other by at least a half cycle of the period of an alternating current source.

In the image forming apparatus described in the above-mentioned Japanese Laid-Open Patent Application No.4-168468, since the start timing of activation of the plurality of electric heating elements is shifted to each other, a rush current generated when the heating elements are turned on is decreased. However, the decrease in the rush current is not sufficient for clearing the standard value specified by the power source voltage fluctuation test.

Japanese Laid-Open Patent Application No.59-33480 discloses a heater driving device of a fixing apparatus of a copy machine. The heater driving device provides an alternating voltage to a heater of the fixing apparatus by detecting a zero cross of the alternating voltage. The heater comprises a plurality of heating elements having different power consumption. The heating elements are driven at a predetermined voltage after they are driven at voltages lower than the predetermined voltage in an ascending order of the power consumption of the heating elements.

In the heater driving apparatus described in the above-mentioned Japanese Laid-Open Patent Application No.59-33480, since the plurality of heating elements are driven at voltages lower than the predetermined voltage in an ascending order of the power consumption of the heating elements, a rush current generated when the heating elements are turned on is decreased. However, the decrease in the rush current is not sufficient for clearing the standard value specified by the power source voltage fluctuation test.

Japanese Laid-Open Patent Application No.6-236128 discloses an image forming apparatus having a fixing apparatus. The fixing apparatus has a plurality of heaters which are selectively activated in response to an operating condition of the image forming apparatus. When the plurality of heaters are activated simultaneously, a start timing of each of the heaters is shifted to each other.

In the image forming apparatus described in the above-mentioned Japanese Laid-Open Patent Application No.6-236128, since the start timing of activation of the plurality of heaters is shifted to each other, a rush current generated when the heaters are turned on is decreased. However, the decrease in the rush current is not sufficient for clearing the standard value specified by the power source voltage fluctuation test.

SUMMARY OF THE INVENTION

It is a general object of the present invention to provide an improved and useful fixing apparatus for an image forming apparatus in which the above-mentioned

problems are eliminated.

A more specific object of the present invention is to provide a fixing apparatus which reduces a fluctuation in a power source voltage while a harmonic current is maintained at a low level.

In order to achieve the above-mentioned object, there is provided according to one aspect of the present invention a fixing apparatus having at least one heater to provide heat to fix a toner image on a print paper, the heater being intermittently activated and deactivated to maintain the fixing apparatus at a substantially constant temperature, the heater being activated by a predetermined voltage provided thereto,

characterized in that:

deactivation of the heater is controlled so that a rate of change in a current flowing to the heater is reduced.

According to the present invention deactivation of the heater is controlled as well as activation of the heater. Since the deactivation of the heaters generates a great change in the current flowing to the fixing apparatus, the control of deactivation of the heaters reduces influence on the power source voltage fluctuation.

Activation of the heater may also be controlled so that a rate of change in the current flowing to the heater is reduced.

In one embodiment of the present invention, a first voltage less than the predetermined voltage is provided immediately before the heater is activated at the predetermined voltage, and a second voltage less than the predetermined voltage is provided immediately before the heater is deactivated.

As mentioned above, when the heater is turned on or off, the low voltage is provided to the heater before a full voltage (the rated voltage) is provided or before the voltage is decreased from the full voltage. Thus, a rate of change in a current flowing to the heater is decreased. This prevents an abrupt fluctuation of the power source voltage when the heater is turned on or off. Accordingly, flicker values Pst (short time flicker value) and Plt (long time flicker value), which are measurements of a flicker meter, are sufficiently decreased to clear standard values such as 1.0 or below for the short time flicker value Pst and 0.65 or below for the long time flicker value Plt. It should be noted that the flicker meter converts a level of voltage fluctuation (physical level) into a flicker level (sensation level). Additionally, the decrease in the flicker values can be achieved without additional parts such as an additional transformer and filter circuits (LCR circuits). That is, according to the present embodiment, sufficient measures against the influence to the power source voltage fluctuation can be achieved without increasing manufacturing cost and the size and weight of the copy machine.

In the fixing apparatus according to the present invention, a level of the first voltage provided while an image forming operation is being performed may be different from a level of the first voltage provided during a waiting state and a pre-heating state, and a level of the second voltage provided while an image forming operation is being performed may be different from a level of the second voltage provided during a waiting state and a pre-heating state.

Additionally, the levels of the first and second voltages provided during the waiting state and the pre-heating state may be equal to or less than 40% of the predetermined voltage.

The levels of the first and second voltages provided while the image forming operation is being performed may be equal to or less than 60% of the predetermined voltage.

The levels of the first and second voltage provided during the waiting state and the pre-heating state may be equal to or more than 20% of the predetermined voltage.

The levels of the first and second voltages while the image forming operation is being performed may be equal to or more than 50% of the predetermined voltage.

In one embodiment of the present invention, the first voltage may be provided for a first time period and the second voltage may be provided for a second time period while the image forming operation is being performed; and the first voltage may be provided for a third time period and the second voltage may be provided for a fourth time period during the waiting state and a pre-heating state.

This reduces a rush current when the heater is turned on and an abrupt change in the current flowing to the heater when the heater is turned off in a fashion in which the changes in the current in a copying state and a waiting state or a pre-heating state are separately controlled. Thus, both the short time flicker value Pst and the long time flicker value Plt are appropriately reduced.

In one embodiment, the third time period may be different from the first time period and the fourth time period may be different from the second time period.

The third time period and the fourth time period provided during the waiting state or the pre-heating state may be equal to or more than 300 msec.

The first time period and the second time period provided while the image forming operation is being performed may be equal to or more than 100 msec.

The third time period and the fourth time period provided during the waiting state or the pre-heating state may be equal to or less than 700 msec.

The first time period and the second time period provided while the image forming operation is being performed may be equal to or less than 500 msec.

In one embodiment of the present invention, a plurality of heaters are provided, and a timing of deactivation of each of the heaters is controlled so that a start time of deactivation of the heaters differs from each other.

In this invention, since the plurality of heaters are not turned off simultaneously, a change in the total current flowing to the fixing apparatus is less than that

when the heaters are simultaneously turned on. Thus, the change in the total current flowing to the fixing apparatus does not greatly influences the power source voltage.

A start time of deactivation of one of the heaters may be delayed from a start time of deactivation of another one of the heaters.

The heaters may be activated by an alternating voltage, and a start time of deactivation of one of the heaters may be delayed from a start time of deactivation of another one of the heaters by a delay time which is equal to or more than one cycle of the alternating voltage.

Additionally, a timing of activation of each of the heaters may be controlled.

A timing of activation of the heaters may be controlled so that a start time of activation of the heaters differs from each other.

A start time of activation of one of the heaters may be delayed from a start time of activation of another one of the heaters.

The heaters may be activated by an alternating voltage, and a start time of activation of one of the heaters may be delayed from a start time of activation of another one of the heaters by a delay time which is equal to or more than one cycle of the alternating voltage.

Additionally, there is provided according to another aspect of the present invention a fixing apparatus having a plurality of heaters each of which is separately controlled based on a temperature of a corresponding position of the fixing apparatus,

characterized in that:

the heaters excluding at least one of the heaters is maintained to be deactivated when the fixing apparatus is in a predetermined operational state.

In this invention, since at least one of the heaters is turned on and off only when the power of the fixing apparatus is turned on, there is no rush current generated due to the activation of that heater while the fixing apparatus is operated after an initial operation is completed. Thus, the short time flicker value Pst is decreased and the long time flicker value Plt is also decreased from during a waiting state and a pre-heating state so that the measured flicker values pass the standard values.

Additionally, the decrease in the flicker values can be achieved without additional parts such as an additional transformer and filter circuits (LCR circuits). That is, according to the present embodiment, sufficient measures against the influence to the power source voltage fluctuation can be achieved without increasing manufacturing cost and the size and weight of the copy machine.

In one embodiment of the present invention, the predetermined operational state may include a waiting state where the fixing apparatus is waiting for supply of print paper having a toner image to be fixed while the temperature of the fixing apparatus is maintained at a fixing temperature.

Additionally, the predetermined operational state may include a pre-heating state where the fixing apparatus is waiting for supply of print paper having a toner image to be fixed while the temperature of the fixing apparatus is decreased to be less than a fixing temperature.

Further, the predetermined operational state may exclude a state where print paper is passing through the fixing apparatus.

The predetermined operational state may exclude an initial state where a temperature of the fixing apparatus is initially raised to a fixing temperature.

Additionally, the at least one of the heaters may consume a minimum amount of power among the heaters.

The at least one of the heaters may maintain a fixing temperature of the fixing apparatus by being continuously activated.

Further, the at least one of the heaters is located at a selected position where a temperature of the position is required to be at a fixing temperature.

Other objects, features and advantages of the present invention will become more apparent from the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 is an illustration of a fixing apparatus according to a first embodiment of the present invention;

FIG.2A is a graph of a voltage provided to a heaters with respect to time while a copy machine is performing a copying operation; FIG.2B is a graph of a voltage provided to the heaters with respect to time while the copy machine is in a waiting state or a pre-heating state;

FIG.3 is a flowchart of an operation for controlling a heater heating a middle portion of a fixing roller according to the first embodiment of the present invention;

FIG.4 is a flowchart of an operation for controlling a heater heating end portions of the fixing roller according to the first embodiment of the present invention;

FIG.5 is a chart indicating waveforms of an alternating voltage provided to the heater and a PWM pulse signal output from a CPU shown in FIG.1;

FIG.6 is a flowchart of a control operation for a heater performed in a fixing apparatus according to a second embodiment of the present invention;

FIG.7 is a flowchart of a control operation of another heater performed in the fixing apparatus according to the present invention;

FIG.8 is a waveform chart of a current flowing to a heater;

FIG.9 is a flowchart of a control operation of a heater performed in a fixing apparatus according to a third embodiment of the present invention; and

FIG.10 is a flowchart of a control operation of

another heater performed in the fixing apparatus according to the third embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A description will now be given, with reference to FIG.1, of a first embodiment of the present invention. FIG.1 is an illustration of a fixing apparatus according to the first embodiment of the present invention.

The fixing apparatus shown in FIG.1 comprises a fixing roller 1 having heaters 2 and 3 incorporated therein. A pressing roller (not shown)is pressed against the fixing roller 1 and is rotated by rotation of the fixing roller 1. The heater 2 generates heat mainly in the middle portion of the fixing roller 1. The heater 3 generates heat mainly near the end portions of the fixing roller 1.

One end of each of the heaters 2 and 3 is connected to a terminal of an alternate voltage AC 100V power source via a normally open terminal RA1-a of a relay RA1. The opposite end of each of the heaters 2 and 3 is connected to the other terminal of the AC 100V power source via the respective triacs 4 and 5. The triacs 4 and 5 are driven by control drivers 6 and 7, respectively. The on/off operation of the control drivers 6 and 7 are controlled by a CPU (micro computer) 8. A coil of the relay RA1 is provided between a DC 24V power source and the ground via a transistor 12. The transistor 12 is connected to a driver 11 which is connected to the CPU 8. The driver 11 is controlled by the CPU 8 so as to control an on/off operation of the transistor 12 which in turn controls an on/off operation of the relay RA1.

Accordingly, when the relay RA1 is turned on and both the triacs 4 and 5 are turned on, both the heaters 2 and 3 are turned on or activated to heat the middle portion and end potions of the fixing roller 1. Print paper carrying a toner image is passed between the fixing roller 1 and the pressing roller so that the toner image is fixed by the heat of the fixing roller 1 and the pressing force of the pressing roller.

Temperature detecting elements 9 and 10, each of which comprises a thermistor, are provided on an outer surface of the fixing roller 1. The temperature detecting element 9 is positioned at the end portion of the fixing roller 1 so as to detect a temperature at the end of the fixing roller 1. The temperature detecting element 10 is positioned in the middle portion of the fixing roller 1 so as to detect a temperature in the middle of the fixing roller 1. Temperature detection signals of the temperature detecting elements 9 and 10 are supplied to the CPU 8. The CPU 8 converts the analog temperature detection signals into digital signals so as to obtain temperature data of the fixing roller 1.

The CPU 8 controls the triac 4 via the driver 6 so as to control an on/off state of the heater 2 based on a temperature of the middle portion of the fixing roller 1 detected by the thermistor 9. The CPU 8 also controls the triac 5 via the driver 7 so as to control an on/off state of the heater 3 based on a temperature of the end portion of the fixing roller 1 detected by the thermistor 10. That is, the on/off state control of the heater 2 is performed with respect to the temperature of the middle portion of the fixing roller 1, and the on/off state control of the heater 3 is performed with respect to the temperature of the end portions of the fixing roller 1.

The CPU 8 controls the driver 11 to be turned off when a detection signal is input from a cover switch 13. The cover switch 13 outputs the detection signal when a cover of the image forming apparatus is open. Thus, the driver 11 is turned off when the cover of the image forming apparatus is open. When the driver 11 is turned off, the transistor 12 is turned off, and, in turn, the relay RA1 is turned off. Accordingly, the heaters 2 and 3 cannot be activated when the cover of the image forming apparatus is open. The driver is turned on when the cover is closed, and thus the transistor 12 and the relay RA1 are turned on, in turn. This allows the heaters 2 and 3 to be activated by an operation of drivers 6 and 7.

A description will now be given, with reference to FIG.2A and 2B, of a basic control of the heaters 2 and 3. It is assumed that the image forming apparatus having the fixing apparatus according to the present invention is a copy machine. FIG.2A is a graph of a voltage provided to the heater 2 with respect to time while the copy machine is performing a copying operation. FIG.2B is a graph of a voltage provided to the heater 2 with respect to time while the copy machine is in a waiting state or a pre-heating state.

In the present embodiment, the heater 2 is turned on or activated by CPU 8 via the driver 6 and the triac 4. The heaters 2 is activated at a rated voltage Vf (for example AC 100V). However, at the initial stage of activation of the heater 2 while the copy machine is performing a copying operation, the CPU 8 controls the voltage provided to the heater 2 to be less than the rated voltage Vf. That is, a voltage Vrc1 which is less than the rated voltage Vf is provided to the heater 2, as shown in FIG.2A, when the heater 2 is turned on. The voltage Vrc1 is provided for a time period Trc1, and then the voltage is increased to the rated voltage Vf. When the heater 2 is turned off or deactivated, the voltage provided to the heater 2 is decreased from the rated voltage Vf to a voltage Vrc2 for the time period Trc2, and then the heater 2 is completely turned off or deactivated.

When the heater 2 is activated while the copy machine is in a waiting state or a pre-heating state, the voltage provided to the heater 2 is controlled as shown in FIG.2B. That is, a voltage Vrs1 which is less than the rated voltage Vf is provided to the heater 2 when the heater 2 is turned on. The voltage Vrs1 is provided for a time period Trs1, and then the voltage is increased to the rated voltage Vf. When the heater 2 is turned off or deactivated, the voltage provided to the heater 2 is decreased from the rated voltage Vf to a voltage Vrs2 for the time period Trs2, and then the heater 2 is com-

pletely turned off or deactivated.

When the heater 2 is activated at the rated voltage Vf while the copy machine is performing a copying operation, the voltage Vrc1 provided for the time period Trc1 is set to be 50% to 60 % of the rated voltage Vf. That is, if the rated voltage Vf is AC 100V, the voltages Vrc1 is set to AC 50V, for example. When the heater 2 is turned off from the activated state at the rated voltage Vf while the copy machine is performing a copying operation, the voltage Vrc2 provided for the time period Trc2 is set to be 50% to 60 % of the rated voltage Vf. That is, if the rated voltage Vf is AC 100V, the voltage Vrc2 is set to AC 50V, for example. It should be noted that when a copying operation is being performed, the voltage Vrc1 when the heater 2 is turned on may be different from the voltage Vrc2 when the heater 2 is turned off.

When the heater 2 is turned on at the rated voltage Vf while the copy machine is in a waiting state or a pre-heating state, the voltage Vrs1 provided for the time period Trs1 is set to be 20% to 40% of the rated voltage Vf. When the heater 2 is turned off from the activated state at the rated voltage Vf while the copy machine is in a waiting state or a pre-heating state, the voltage Vrs2 provided for the time period Trs2 is set to be 20% to 40% of the rated voltage Vf. It should be noted that when the copy machine is in the waiting state or a pre-heating state, the voltage Vrs1 when the heater 2 is turned on may be different from the voltage Vrs2 when the heater 2 is turned off.

While the copy machine is performing a copying operation, the time period Trc1 for providing the voltage Vrc1 when the heater 2 is turned on is set to 100 msec to 500 msec. While the copy machine is performing a copying operation, the time period Trc2 for providing the voltage Vrc2 when the heater 2 is turned off is set to 100 msec to 500 msec. It should be noted that when the copy machine is performing a copying operation, the time period Trc1 when the heater 2 is turned on may be different from the time period Trc2 when the heater 2 is turned off.

While the copy machine is in a waiting state or a pre-heating state, the time period Trs1 for providing the voltage Vrs1 when the heater 2 is turned on is set to 300 msec to 700 msec. While the copy machine is in a waiting state or a pre-heating state, the time period Trs2 for providing the voltage Vrs2 when the heater 2 is turned off is set to 300 msec to 700 msec. It should be noted that the time period Trs1 when the copy machine is performing a copying operation may be different from the time period Trs2 when the copy machine is in a waiting state or a pre-heating state.

Additionally, a voltage provided to the heater 3 is controlled in a similar manner as that of the heater 2. That is, the heater 3 is turned on or activated by CPU 8 via the driver 7 and the triac 5. The heaters 3 is activated at the rated voltage Vf (for example AC 100V). However, at the initial stage of activation of the heater 3 while the copy machine is performing a copying operation, the CPU 8 controls the voltage provided to the heater 3 to be less than the rated voltage Vf. That is, a voltage Vrc1' which is less than the rated voltage Vf is provided to the heater 3 when the heater 3 is turned on. The voltage Vrc1' is provided for a time period Trc1', and then the voltage is increased to the rated voltage Vf. When the heater 3 is turned off or deactivated, the voltage provided to the heater 3 is decreased from the rated voltage Vf to a voltage Vrc2' for a time period Trc2', and then the heater 3 is completely turned off or deactivated.

When the heater 3 is activated while the copy machine is in a waiting state or a pre-heating state, the voltage provided to the heater 3 is controlled in a similar manner as shown in FIG.2B. That is, a voltage Vrs1' which is less than the rated voltage Vf is provided to the heater 3 when the heater 3 is turned on. The voltage Vrs1' is provided for a time period Trs1', and then the voltage is increased to the rated voltage Vf. When the heater 3 is turned off or deactivated, the voltage provided to the heater 3 is decreased from the rated voltage Vf to a voltage Vrs2' for a time period Trs2', and then the heater 3 is completely turned off or deactivated.

When the heater 3 is turned on at the rated voltage Vf while the copy machine is performing a copying operation, the voltage Vrc1' provided for the time period Trc1' is set to be 50% to 60 % of the rated voltage Vf. That is, if the rated voltage Vf is AC 100V, the voltage Vrc1' is set to AC 50V, for example. When the heater 3 is turned off from the activated state at the rated voltage Vf while the copy machine is performing a copying operation, the voltage Vrc2' provided for the time period Trc2' is set to be 50% to 60 % of the rated voltage Vf. That is, if the rated voltage Vf is AC 100V, the voltage Vrc2' is set to AC 50V, for example. It should be noted that when a copying operation is being performed, the voltage Vrc1' when the heater 3 is turned on may be different from the voltage Vrc2' when the heater 3 is turned off.

When the heater 3 is turned on at the rated voltage Vf while the copy machine is in a waiting state or a pre-heating state, the voltage Vrs1' provided for the time period Trs1' is set to be 20% to 40% of the rated voltage Vf. When the heater 3 is turned off from the activated state at the rated voltage Vf while the copy machine is in a waiting state or a pre-heating state, the voltage Vrs2' provided for the time period Trs2' is set to be 20% to 40% of the rated voltage Vf. It should be noted that when the copy machine is in the waiting state or a pre-heating state, the voltage Vrs1' when the heater 3 is turned on may be different from the voltage Vrs2' when the heater 3 is turned off.

While the copy machine is performing a copying operation, the time period Trc1' for providing the voltage Vrc1' when the heater 3 is turned on is set to 100 msec to 500 msec. While the copy machine is performing a copying operation, the time period Trc2' for providing the voltage Vrc2' when the heater 3 is turned off is set to 100 msec to 500 msec. It should be noted that when the copy machine is performing a copying operation, the

time period Trc1' when the heater 3 is turned on may be different from the time period Trc2' when the heater 3 is turned off.

While the copy machine is in a waiting state or a pre-heating state, the time period Trs1' for providing the voltage Vrs1' when the heater 3 is turned on is set to 300 msec to 700 msec. While the copy machine is in a waiting state or a pre-heating state, the time period Trs2' for providing the voltage Vrs2' when the heater 3 is turned off is set to 300 msec to 700 msec. It should be noted that when the copy machine is in a waiting state or a pre-heating state, the time period Trs1' may be different from the time period Trs2'.

A description will now be given, with reference to FIGS.3 and 4, of operations performed for controlling heaters 2 and 3 in the present embodiment. It is assumed that the image forming apparatus having the fixing apparatus according to the present invention is a copy machine. It should be noted that, as mentioned above, the heaters 2 and 3 are disconnected from the AC 100V power source when a cover of the copy machine is open or when the copy machine is in an abnormal condition such as an occurrence of a paper jam. The control of the driver 11 is performed by the CPU 8.

FIG.3 is a flowchart of the operation for controlling the heater 2 according to the first embodiment of the present invention. In FIG.3, a route indicated by an arrow A is the route for turning on or activating the heater 2, and a route indicated by an arrow B is the route for turning off or deactivate the heater 2.

When the operation of FIG.3 is started, the CPU 8 determines, in step 200, whether or not the temperature of the middle portion of the fixing roller 1 is equal to or less than a temperature calculated by subtracting 3°C from a target temperature M. This determination is made based on the temperature detection signal output from the thermistor 9. If it is determined that the temperature of the middle portion of the fixing roller 1 is equal to or less than the temperature (M-3)°C, the routine proceeds to step 210. That is, if it is determined that the temperature of the middle portion of the fixing roller 1 is equal to or less than the temperature (M-3)°C, the routine proceeds to route A. On the other hand, if it is determined that the temperature of the middle portion of the fixing roller 1 is not equal to or less than the temperature (M-3)°C, the routine proceeds to step 230. That is, if it is determined that the temperature of the middle portion of the fixing roller 1 is not equal to or less than the temperature (M-3)°C, the routine proceeds to route B.

When the routine proceeds to the route A, the CPU 8 determines, in step 212, whether or not the heater 2 is currently in an on state or activated at the rated voltage Vf. If it is determined that the heater 2 is currently in an on state or activated at the rated voltage Vf, the routine proceeds to step 218. In step 218, a process is performed for maintaining the on state of the heater 2 at the rated voltage Vf, and the routine proceeds to step 220. In step 220, the low voltage output timer 1 (Trs1) and the low voltage output timer 2 (Trc1) are cleared.

On the other hand, if the CPU 8 determines, in step 210, that the heater 2 is not currently in an on state or activated at the rated voltage Vf, the routine proceeds to step 212. Then, the CPU 8 determines, in step 212, whether or not the copy machine is performing a copying operation. That is, it is determined whether the copy machine is performing a copying operation or in a waiting state or pre-heating state. If it is determined that the copy machine is performing a copying operation, the routine proceeds to step 214. In step 214, the CPU 8 determines whether or not the time period Trc1 set by the low voltage output timer 2 (Trc1) has expired. The low voltage output timer 2 counts the time period Trc1.

If it is determined, in step 214, that the time period Trc1 set by the low voltage output timer 2 has expired, the routine proceeds to step 218 so as to turn on and maintain the heater 2 in the on state at the rated voltage Vf by turning the driver 6 on.

Thereafter, the low voltage output timer 1 (Trs1) and the low voltage output timer 2 (Trc1) are cleared in step 220.

If it is determined, in step 214, that the time period Trc1 set by the low voltage output timer 2 (Trc1) has not expired, the routine proceeds to step 216. In step 216, the heater 2 is turned on or activated at the voltage Vrc1 which is lower than the rated voltage Vf.

On the other hand, if it is determined, in step 212, that the copy machine is not performing a copying operation, the routine proceeds to step 222. In step 222, the CPU 8 determines whether or not the time period Trs1 set by the low voltage output timer 1 has expired. The low voltage output timer 1 counts the time period Trs1. If it is determined, in step 222, that the time period Trs1 set by the low voltage output timer 1 has expired, the routine proceeds to step 218 so as to turn on and maintain the heater 2 in the on state at the rated voltage Vf by turning on the driver 6. Thereafter, the low voltage output timer 1 (Trs1) and the low voltage output timer 2 (Trc1) are cleared in step 220. If it is determined that the time period Trs1 has not expired, the routine proceeds to step 224. In step 224, the CPU 8 turns on the driver 6 so as to turn on or activate the heater 2 at the voltage Vrs1 which is lower than the rated voltage Vf.

When the routine proceeds to the route B, the CPU 8 determines, in step 230, whether the temperature of the middle portion of the fixing roller 1 is equal to or greater than the target temperature M based on the temperature detection signal output from the thermistor 9. If it is determined that temperature of the middle portion of the fixing roller 1 is equal to or greater than the target temperature M, the routine proceeds to step 232. In step 232, the CPU determines whether or not the heater 2 is currently in an off state or deactivated. If it is determined that the heater 2 is currently in an off state or deactivated, the routine proceeds to step 240. In step 240, a process is performed for maintaining the off state of the heater 2, and the routine proceeds to step 242. In step 242, the low voltage output timer 1 (Trs2) and the low voltage output timer 2 (Trc2) are cleared.

On the other hand, if the CPU 8 determines, in step 232, that the heater 2 is not currently in an off state or deactivated, the routine proceeds to step 234. Then, the CPU 8 determines, in step 234, whether or not the copy machine is performing a copying operation. That is, it is determined whether the copy machine is performing a copying operation or in a waiting state or pre-heating state. If it is determined that the copy machine is performing a copying operation, the routine proceeds to step 236. In step 236, the CPU 8 determines whether or not the time period Trc2 set by the low voltage output timer 2 has expired.

If it is determined, in step 236, that the time period Trc2 set by the low voltage output timer 2 has expired, the routine proceeds to step 240 so as to turn off and maintain the heater 2 in the off state by turning the driver 6 off. Thereafter, the low voltage output timer 1 (Trs2) and the low voltage output timer 2 (Trc2) are cleared in step 242.

If it is determined, in step 236, that the time period Trs2 set by the low voltage output timer 2 has not expired, the routine proceeds to step 216. In step 216, the heater 2 is turned on or activated at the voltage Vrc which is lower than the rated voltage Vf.

On the other hand, if it is determined, in step 234, that the copy machine is not performing a copying operation, the routine proceeds to step 238. In step 238, the CPU 8 determines whether or not the time period Trs2 set by the low voltage output timer 1 has expired.

If it is determined, in step 238, that the time period Trs2 set by the low voltage output timer 1 has expired, the routine proceeds to step 240 so as to turn off and maintain the heater 2 in the off state by turning the driver 6 off. Thereafter, the low voltage output timer 1 (Trs2) and the low voltage output timer 2 (Trc2) are cleared in step 242.

If it is determined, in step 238, that the time period Trs2 set by the low voltage output timer 1 has not expired, the routine proceeds to step 224. In step 224, the CPU 8 turns on the driver 6 so as to turn on or activate the heater 2 at the voltage Vrs2 which is lower than the rated voltage Vf.

It should be noted that the low voltage output timer 1 (Trs2) and the low voltage output timer 2 (Trc2) perform the time count operation according to an interval process not shown in the flowchart. Additionally, the set times Trs1, Trs2, Trc1 and Trc2 of the low voltage output timers 1 and 2 can be set to arbitrary time periods, respectively. Further, the voltages Vrs1, Vrs2, Vrc1 and Vrc2 can be set to arbitrary voltages lower than the rated voltage Vf.

FIG.4 is a flowchart of the operation for controlling the heater 3 according to the first embodiment of the present invention. In FIG.4, a route indicated by an arrow A' is the route for turning on or activating the heater 3, and a route indicated by an arrow B' is the route for turning off or deactivate the heater 3.

When the operation of FIG.4 is started, the CPU 8 determines, in step 300, whether or not the temperature of the end portion of the fixing roller 1 is equal to or less than a temperature calculated by subtracting 3°C from a target temperature K. This determination is made based on the temperature detection signal output from the thermistor 10. If it is determined that the temperature of the end portion of the fixing roller 1 is equal to or less than the temperature (K-3)°C, the routine proceeds to step 310. That is, if it is determined that the temperature of the end portion of the fixing roller 1 is equal to or less than the temperature (K-3)°C, the routine proceeds to route A'. On the other hand, if it is determined that the temperature of the end portion of the fixing roller 1 is not equal to or less than the temperature (K-3)°C, the routine proceeds to step 330. That is, if it is determined that the temperature of the end portion of the fixing roller 1 is not equal to or less than the temperature (K-3)°C, the routine proceeds to route B'.

When the routine proceeds to the route A', the CPU 8 determines, in step 312, whether or not the heater 3 is currently in an on state or activated at the rated voltage Vf. If it is determined that the heater 3 is currently in an on state or activated at the rated voltage Vf, the routine proceeds to step 318. In step 318, a process is performed for maintaining the on state of the heater 3 at the rated voltage Vf, and the routine proceeds to step 320. In step 320, the low voltage output timer 3 (Trs1') and the low voltage output timer 4 (Trc1') are cleared.

On the other hand, if the CPU 8 determines, in step 210, that the heater 3 is not currently being in an on state or activated at the rated voltage Vf, the routine proceeds to step 312. Then, the CPU 8 determines, in step 312, whether or not the copy machine is performing a copying operation. That is, it is determined whether the copy machine is performing a copying operation or in a waiting state or pre-heating state. If it is determined that the copy machine is performing a copying operation, the routine proceeds to step 314. In step 314, the CPU 8 determines whether or not the time period Trc1' set by the low voltage output timer 4 has expired. The low voltage output timer 4 counts the time period Trc1'.

If it is determined, in step 314, that the time period Trc1' set by the low voltage output timer 4 has expired, the routine proceeds to step 318 so as to turn on and maintain the heater 3 in the on state at the rated voltage Vf by turning on the driver. Thereafter, the low voltage output timer 3 (Trs1') and the low voltage output timer 4 (Trc1') are cleared in step 320.

If it is determined, in step 314, that the time period Trc1' set by the low voltage output timer 4 has not expired, the routine proceeds to step 316. In step 316, the heater 3 is turned on or activated at the voltage Vrc1' which is lower than the rated voltage Vf.

On the other hand, if it is determined, in step 312, that the copy machine is not performing a copying operation, the routine proceeds to step 322. In step 322, the CPU 8 determines whether or not the time period Trs1' set by the low voltage output timer 3 has expired. The low voltage output timer 3 counts the time period Trs1'.

If it is determined, in step 322, that the time period

Trs1' set by the low voltage output timer 3 has expired, the routine proceeds to step 318 so as to turn on and maintain the heater 3 in the on state at the rated voltage Vf by turning the driver 7 on.

Thereafter, the low voltage output timer 3 (Trs1') and the low voltage output timer 4 (Trc1') are cleared in step 320. If it is determined that the time period Trs1' set by the low voltage output timer 3 has not expired, the routine proceeds to step 324. In step 324, the CPU 8 turns on the driver 7 so as to turn on or activate the heater 3 at the voltage Vrs1' which is lower than the rated voltage Vf.

When the routine proceeds to the route B', the CPU 8 determines, in step 330, whether the temperature of the end portion of the fixing roller 1 is equal to or greater than the target temperature K based on the temperature detection signal output from the thermistor 10. If it is determined that temperature of the end portion of the fixing roller 1 is equal to or greater than the target temperature K, the routine proceeds to step 332. In step 332, the CPU 8 determines whether or not the heater 3 is currently in an off state or deactivated. If it is determined that the heater 3 is currently in an off state or deactivated, the routine proceeds to step 340. In step 340, a process is performed for maintaining the off state of the heater 3, and the routine proceeds to step 342. In step 342, the low voltage output timer 3 (Trs2') and the low voltage output timer 4 (Trc2') are cleared.

On the other hand, if the CPU 8 determines, in step 332, that the heater 3 is not currently in an off state or deactivated, the routine proceeds to step 334. Then, the CPU 8 determines, in step 334, whether or not the copy machine is performing a copying operation. That is, it is determined whether the copy machine is performing a copying operation or in a waiting state or pre-heating state. If it is determined that the copy machine is performing a copying operation, the routine proceeds to step 336. In step 336, the CPU 8 determines whether or not the time period Trc2' set by the low voltage output timer 4 has expired.

If it is determined, in step 336, that the time period Trc2' set by the low voltage output timer 4 has expired, the routine proceeds to step 340 so as to turn off and maintain the heater 4 in the off state by turning off the driver 7. Thereafter, the low voltage output timer 1 (Trs2') and the low voltage output timer 4 (Trc2') are cleared in step 242.

If it is determined, in step 336, that the time period Trc2' set by the low voltage output timer 4 has not expired, the routine proceeds to step 316. In step 316, the heater 4 is turned on or activated at the voltage Vrc2' which is lower than the rated voltage Vf.

On the other hand, if it is determined, in step 334, that the copy machine is not performing a copying operation, the routine proceeds to step 338. In step 338, the CPU 8 determines whether or not the time period Trs2' set by the low voltage output timer 3 has expired.

If it is determined, in step 338, that the time period Trs2' set by the low voltage output timer 3 has expired, the routine proceeds to step 340 so as to turn off and maintain the heater 3 in the off state by turning off the driver 7. Thereafter, the low voltage output timer 3 (Trs2') and the low voltage output timer 4 (Trc2') are cleared in step 342.

If it is determined, in step 338, that the time period Trs2' set by the low voltage output timer 3 has not expired, the routine proceeds to step 324. In step 324, the CPU 8 turns on the driver 7 so as to turn on or activate the heater 3 at the voltage Vrs2' which is lower than the rated voltage Vf.

It should be noted that the low voltage output timer 3 (Trs2') and the low voltage output timer 4 (Trc2') perform the time count operation according to an interval process not shown in the flowchart. Additionally, the set times Trs1', Trs2', Trc1' and Trc2' of the low voltage output timers 3 and 4 can be set to arbitrary time periods, respectively. Further, the voltages Vrs1', Vrs2', Vrc1' and Vrc2' can be set to arbitrary voltages lower than the rated voltage Vf.

The voltages Vrc1, Vrc2, Vrs1' and Vrs2', which are lower than the rated voltage Vf, provided to the heater 2 can be generated by a phase control method which is generally used in a lighting control operation of an exposure lamp in an optical system provided in a conventional image forming apparatus such as a copy machine. That is, the CPU 8 outputs a pulse width modulation (PWM) pulse signal to the driver 6 in synchronization with the alternating voltage source so as to turn on and off the triac 4. Thus, the low voltages Vrc and Vrs provided to the heater 2 are generated by the phase control method.

FIG.5 shows waveforms of the alternating voltage provided to the heater 2 and the PWM pulse signal output from the CPU 8. The alternating voltage is provided to the heater 2 when the PWM pulse signal is at a high level. In FIG.5, the low voltages Vrc and Vrs is provided to the heater during periods t2 in which the PWM pulse signal is at the high level in the initial stage of an activation of the heater 2. The level of the voltage provided to the heater 2 can be varied by varying the period t2 with respect to a period t1 which corresponds to a half cycle of the alternating voltage. In FIG.4, the duration of the initial stage corresponds to two cycles of the alternating voltage. After the initial stage is completed, the PWM pulse signal is maintained to be at the high level. Thus, the complete alternating voltage is provided to the heater 2.

The voltages Vrc1', Vrc2', Vrs1' and Vrs2' provided to the heater 3 can be generated and varied in the same manner by the phase control method as mentioned above.

As mentioned above, when the heaters 2 and 3 are turned on or off, a low voltage such as the voltage Vrc1, Vrc2, Vrs1, Vrs2, Vrc1', Vrc2', Vrs1' or Vrs2' is provided to the heaters 2 and 3 before a full voltage (the rated voltage Vf) is provided or before the voltage is decreased from the full voltage. Thus, a rate of change in the current flowing to the heaters 2 and 3 is

decreased. This prevents an abrupt fluctuation of the power source voltage when the heaters 2 and 3 are turned on or off. Accordingly, flicker values Pst (short time flicker value) and Plt (long time flicker value), which are measurements of a flicker meter, are sufficiently decreased to clear standard values such as 1.0 or below for the short time flicker value Pst and 0.65 or below for the long time flicker value Plt. It should be noted that the flicker meter converts a level of voltage fluctuation (physical level) into a flicker level (sensation level). Additionally, the decrease in the flicker values can be achieved without additional parts such as an additional transformer and filter circuits (LCR circuits). That is, according to the present embodiment, sufficient measures against the influence to the power source voltage fluctuation can be achieved without increasing manufacturing cost and the size and weight of the copy machine.

In order to clear the allowable values in both a waiting or pre-heating state and a copying state, the CPU 8 may control the voltages Vrs1, Vrs2, Vrs1' and Vrs2' provided for a waiting or pre-heating state to be different from the voltages Vrc and Vrc' provided for a copying operation.

In the present embodiment, when the copy machine is in a waiting state or a pre-heating state, the CPU 8 controls the voltages Vrs1, Vrs2, Vrs1' and Vrs2' to be equal to or less than 40% of the rated voltage Vf. Measurements for the flicker values Pst and Plt at this condition were taken by the inventors. The result of the measurements indicated that the short time flicker value Pst is decreased from 1.453 to below 0.65 and the long time flicker value Plt is decreased from 1.371 to below 0.6. This corresponds to more than a 50% reduction in the flicker values.

Additionally, when the copy machine is performing a copying operation, the CPU 8 controls the voltages Vrc1, Vrc2, Vrc1' and Vrc2' to be equal to or less than 60% of the rated voltage Vf. Measurements for the flicker values Pst and Plt at this condition were taken by the inventors. The result of the measurements indicated that the short time flicker value Pst is decreased from 1.295 to below 0.9. This corresponds to more than a 30% reduction in the flicker value.

Further, when the copy machine is in a waiting state or a pre-heating state, the CPU 8 controls the voltages Vrs1, Vrs2, Vrs1' and Vrs2' to be equal to or more than 20% of the rated voltage Vf. This limitation provides less influence to the harmonics current. Measurements for the harmonic current at this condition was taken by the inventors. The result of measurement indicated that a level of the harmonic current has a sufficient margin to clear a standard value.

Further, when the copy machine is performing a copying operation, the CPU 8 controls the voltages Vrc1, Vrc2, Vrc1' and Vrc2' to be equal to or more than 50% of the rated voltage Vf. This limitation provides less influence to the harmonics current. Measurements for the harmonic current during this condition was taken by the inventors. The result of measurements indicated that a level of the harmonic current has a sufficient margin to clear a standard value.

In an image forming apparatus such as a copy machine, power consumption during a waiting or pre-heating state is less than that for power consumption during an image forming operation such as a copying operation. This is because less power is consumed by power consuming devices other than a heater of a fixing apparatus. Thus, activation and deactivation of the heater of the fixing apparatus during a waiting or pre-heating state provides more influence than during a copying operation. On the other hand, since the power consuming devices, which use switching power source, consume more power during a copying operation than that during a waiting or pre-heating state, a change in the consumed current is relatively small when a copying operation is performed. Thus, the influence to the fluctuation in the power source voltage during a copying operation is relatively less than during a waiting or pre-heating state. However, since other power consuming devices are operated during a copying operation, a harmonic current is increased.

The short time flicker value Pst is measured for an image forming state such as a copying state in which a fixing apparatus is operated and also for a waiting sate and a pre-heating state. However, the long time flicker value Plt is measured not for a copying state but only for a waiting state and a pre-heating state. An allowable value for the long time flicker value Plt is less than that for the short time flicker value Pst. That is, for example, according to a standard, the allowable short time flicker value Pst is equal to or less than 1.0, while the allowable long time flicker value Plt is 0.65. Thus, the flicker value during a waiting state and a pre-heating state must be less than the flicker value during an image forming operation such as a copying operation.

As mentioned above, a relationship between the power source voltage fluctuation and the harmonic current is reversed between a copying state and a waiting or pre-heating state. Thus, if the low voltages Vrc1, Vrc2, Vrs1 and Vrs2 for a copying operation are equal to the low voltages Vrc1', Vrc2', Vrs1' and Vrs2' for a waiting or a pre-heating state, there is a possibility that both of an allowable value for the power source voltage fluctuation and an allowable value for the harmonic current are not satisfied. Additionally, the time periods Trc1, Trc2, Trs1, Trs2, Trc1', Trc2', Trs1' and Trs2' may influence the measurements of the power source voltage fluctuation and the harmonic current, and thus there is a possibility that both of an allowable value for the power source voltage fluctuation and an allowable value for the harmonic current are not satisfied. That is, if the time periods Trc1, Trc2, Trs1, Trs2, Trc1', Trc2', Trs1' and Trs2' for providing the low voltages Vrc1, Vrc2, Vrs1, Vrs2, Vrc1', Vrc2', Vrs1' and Vrs2' are too short, the power source voltage fluctuation is increased, and if they are too long, the harmonic current is increased.

In the present embodiment, the CPU 8 controls the

time periods Trs and Trs' provided for a waiting state or a pre-heating state to be different from the time periods Trc and Trc' provided for a copying operation. This reduces a rush current when the heaters 2 and 3 are turned on and an abrupt change in the current flowing to the heaters 2 and 3 when the heaters 2 and 3 are turned off in a fashion in which the changes in the current in a copying state and a waiting state or a pre-heating state are separately controlled. Thus, both the short time flicker value Pst and the long time flicker value Plt are appropriately reduced.

In the present embodiment, when the copy machine is in a waiting state or a pre-heating state, the CPU 8 controls the time periods Trs1, Trs2, Trs1' and Trs2' for providing the voltages Vrs and Vrs' to the heaters 2 and 3 to be equal to or more than 300 msec. Measurements for the flicker values Pst and Plt at this condition were taken by the inventors. The result of the measurements indicated that the short time flicker value Pst is decreased from 1.453 to below 0.65 and the long time flicker value Plt is decreased from 1.371 to below 0.6. This corresponds to more than a 50% reduction in the flicker values.

Additionally, when the copy machine is performing a copying operation, the CPU 8 controls the time periods Trc1, Trc2, Trc1' and Trc2' for providing the voltages Vrc1, Vrc2, Vrc1' and Vrc2' to the heaters 2 and 3 to be equal to or more that 100 msec. Measurements for the flicker value Pst and Plt at this condition were taken by the inventors. The result of the measurements indicated that the short time flicker value Pst is decreased from 1.296 to below 0.8. This corresponds to more than a 40% reduction in the flicker value.

Further, when the copy machine is in a waiting state or a pre-heating state, the CPU 8 controls the time periods Trs1, Trs2, Trs1' and Trs2' for providing the voltages Vrs and Vrs' to the heaters 2 and 3 to be equal to or less than 700 msec. This limitation provides less influence to the harmonics current. Measurements for the harmonic current at this condition were taken by the inventors. The result of measurements indicated that a level of the harmonic current has a sufficient margin to clear a standard value.

Further, when the copy machine is performing a copying operation, the CPU 8 controls the time periods Trc1, Trc2, Trc1' and Trc2' for providing the voltages Vrc and Vrc' to the heaters 2 and 3 to be equal to or less than 500 msec. This limitation provides less influence to the harmonic current. Measurements for the harmonic current at this condition were taken by the inventors. The result of measurements indicated that a level of the harmonic current has a sufficient margin to clear a standard value.

A description will now be given of a fixing apparatus according to a second embodiment of the present invention. The basic construction of the fixing apparatus according to the second embodiment is the same as that of the fixing apparatus shown in FIG.1.

In the second embodiment, the activation and deactivation of the heater 2 is performed by monitoring an output of the heater 3. Similarly, the activation and deactivation of the heater 3 is performed by monitoring an output of the heater 2. The control of the heaters 2 and 3 is described below.

When the heater 2 is to be activated while the heater 3 is in a deactivated state, the CPU 8 starts a delay timer for activation of the heater 3 so that the heater 2 and the heater 3 are not turned on at the same time. That is, the delay timer sets a delay time for starting the activation of the heater 3 so that the start of activation of the heater 3 is delayed for the delay time.

When the heater 2 is activated while the heater 3 is in an activated state, the CPU 8 checks a delay timer for the heater 2 so as to determine whether the delay time for the heater 2 has expired. The CPU 8 activates the heater 2 only when the delay timer for the heater 2 has expired. When the heater 2 is turned on, the CPU 8 starts the delay timer for the heater 3 at the same time.

Additionally, when the heater 2 is to be deactivated while the heater 3 is in an activated state, the CPU 8 starts a delay timer for deactivation of the heater 3 so that the heater 2 and the heater 3 are not turned off at the same time. That is, the delay timer sets a delay time for starting deactivation of the heater 3 so that the start of deactivation of the heater 3 is delayed for the delay time.

When the heater 2 is deactivated while the heater 3 is in a deactivated state, the CPU 8 checks a delay timer for the heater 2 so as to determine whether the delay time for the heater 2 has expired. The CPU 8 deactivates the heater 2 only when the delay timer for the heater 2 has expired. When the heater 2 is turned off, the CPU 8 starts the delay timer for the heater 3 at the same time.

The CPU 8 controls the activation and deactivation of the heater 3 similar to the heater 2.

A description will now be given, with reference to FIGS.6 and 7, of control operations of the heaters 2 and 3. FIGS.6 and 7 are flowcharts of the control operations of the heaters 2 and 3, respectively. According to the control operations described below, the heaters 2 and 3 are controlled so that activation of the heaters 2 and 3 is not started at the same time and also deactivation of the heaters 2 and 3 is not started at the same time.

Basically, the CPU 8 turns on the heater 2 when the middle portion of the fixing roller 1 is below the target temperature M minus 3°C according to the temperature detection signal output from the thermistor 9. The heater 2 is turned off when the temperature of the middle portion of the fixing roller 1 reaches the target temperature M. Thus, the CPU controls the activation and deactivation of the heater 2 to maintain the temperature of the middle portion of the fixing roller 1 within a range between the target temperature M minus 3°C and the target temperature M.

Additionally, the CPU 8 turns on the heater 3 when the end portion of the fixing roller 1 is below the target temperature K minus 3°C according to the temperature

detection signal output from the thermistor 10. The heater 3 is turned off when the temperature of the end portion of the fixing roller 1 reaches the target temperature K. Thus, the CPU controls the activation and deactivation of the heater 3 to maintain the temperature of the end portion of the fixing roller 1 within a range between the target temperature K minus 3°C and the target temperature K except when a cover of the copy machine is open or a paper jam occurs in the copy machine.

In FIG.6, a route indicated by an arrow A corresponds to an operation for controlling the activation of the heater 2, and a route indicated by an arrow B corresponds to an operation for controlling the deactivation of the heater 2. Similarly, in FIG.7, a route indicated by an arrow A corresponds to an operation for controlling the activation of the heater 3, and a route indicated by an arrow B corresponds to an operation for controlling the deactivation of the heater 3.

When the control operation of the heater 2 shown in FIG.6 is started, it is determined, in step 400, whether or not a temperature of the middle portion of the fixing roller 1 is equal to or less than the target temperature M minus 3°C. If it is determined that the temperature of the middle portion is equal to or less than the target temperature M minus 3°C, the routine takes the route A by proceeding to step 402.

In step 402, it is determined whether or not the time period set by the delay timer for activating the heater 2 has expired. If it is determined that the time period set by the delay timer has not expired, the determination of step 402 is repeated. If it is determined that the time period set by the delay timer has expired, the routine proceeds to step 404. According to the process of step 404, the heater 2 is not turned on until the time period set by the delay timer for activating the heater 2 has expired.

In step 404, it is determined whether or not the heater 2 is in an activated state. If it is determined that the heater 2 is in the activated state, the routine is ended. If it is determined that the heater 2 is not in the activated state, the routine proceeds to step 406. In step 406, the CPU 8 turns on the heater 2. Then, in step 408, the CPU 8 starts the delay timer for activating the heater 3. The process of step 406 and the process of step 408 are performed substantially at the same time. Thus, the heater 3 cannot be turned on at the same time when the heater 2 is turned on.

On the other hand, if it is determined, in step 400, that the temperature of the middle portion of the fixing roller 1 is greater than the target temperature M minus 3°C, the routine takes the route B by proceeding to step 410. In step 410, the CPU 8 determines whether or not the temperature of the middle portion of the fixing roller 1 is equal to or greater than the target temperature M. If it is determined that the temperature of the middle portion is less than the target temperature M, the routine is ended. If it is determined that the temperature of the middle portion of the fixing roller 1 is equal to or greater than the target temperature M, the routine proceeds to step 412.

In step 412, it is determined whether or not the time period set by the delay timer for deactivating the heater 2 has expired. If it is determined that the time period set by the delay timer has not expired, the determination of step 412 is repeated. If it is determined that the time period set by the delay timer has expired, the routine proceeds to step 414. According to the process of step 412, the heater 2 is not turned on until the time period set by the delay timer for deactivating the heater 2 has expired.

In step 414, it is determined whether or not the heater 2 is in a deactivated state. If it is determined that the heater 2 is in the deactivated state, the routine is ended. If it is determined that the heater 2 is not in the deactivated state, the routine proceeds to step 416. In step 416, the CPU 8 turns on the heater 2. Then, in step 418, the CPU 8 starts the delay timer for deactivating the heater 3. The process of step 416 and the process of step 418 are performed substantially at the same time. Thus, the heater 3 cannot be turned off at the same time when the heater 2 is turned off.

Similar to the control operation of the heater 2, when the control operation of the heater 3 shown in FIG.7 is started, it is determined, in step 500, whether or not a temperature of the end portion of the fixing roller 1 is equal to or less than the target temperature K minus 3°C. If it is determined that the temperature of the end portion is equal to or less than the target temperature K minus 3°C, the routine takes the route A by proceeding to step 502.

In step 502, it is determined whether or not the time period set by the delay timer for activating the heater 3 has expired. If it is determined that the time period set by the delay timer has not expired, the determination of step 502 is repeated. If it is determined that the time period set by the delay timer has expired, the routine proceeds to step 504. According to the process of step 504, the heater 3 is not turned on until the time period set by the delay timer for activating the heater 3 has expired.

In step 504, it is determined whether or not the heater 3 is in an activated state. If it is determined that the heater 3 is in the activated state, the routine is ended. If it is determined that the heater 3 is in a deactivated state, the routine proceeds to step 506. In step 506, the CPU turns on the heater 3. Then, in step 508, the CPU 8 starts the delay timer for activating the heater 2. The process of step 506 and the process of step 508 are performed substantially at the same time. Thus, the heater 2 cannot be turned on at the same time when the heater 3 is turned on.

On the other hand, if it is determined, in step 500, that the temperature of the end portion of the fixing roller 1 is greater than the target temperature K minus 3°C, the routine takes the route B by proceeding to step 510. In step 510, the CPU 8 determines whether or not the temperature of the end portion of the fixing roller 1 is

equal to or greater than the target temperature K. If it is determined that the temperature of the end portion is less than the target temperature K, the routine is ended. If it is determined that the temperature of the end portion of the fixing roller 1 is equal to or greater than the target temperature K, the routine proceeds to step 512.

In step 512, it is determined whether or not the time period set by the delay timer for deactivating the heater 3 has expired. If it is determined that the time period set by the delay timer has not expired, the determination of step 512 is repeated. If it is determined that the time period set by the delay timer has expired, the routine proceeds to step 514. According to the process of step 512, the heater 3 is not turned on until the time period set by the delay timer for deactivating the heater 3 has expired.

In step 514, it is determined whether or not the heater 3 is in a deactivated state. If it is determined that the heater 3 is in the deactivated state, the routine is ended. If it is determined that the heater 3 is not in the deactivated state, the routine proceeds to step 516. In step 516, the CPU 8 turns on the heater 3. Then, in step 518, the CPU 8 starts the delay timer for deactivating the heater 2. The process of step 516 and the process of step 518 are performed substantially at the same time. Thus, the heater 2 cannot be turned off at the same time when the heater 3 is turned off.

As mentioned above, according to the control operations of the heaters 2 and 3, the heaters 2 and 3 are not turned on at the same time, and also not turned off at the same time.

Additionally, the delay time for activation and deactivation of the heaters 2 and 3 can be arbitrarily set by setting the time period of each of the delay timers for the heaters 2 and 3.

The level of an alternating current flowing to the heater 2 from the AC current source is high within the first cycle after the heater 2 is turned on (after the triac 4 is turned on) due to a rush current, as shown in FIG.8. The level of the alternating current is decreased as the time elapses from the first cycle to the second cycle and continuously decreased to an N cycle. The level of an alternating current flowing to the heater 3 is also decreased as the time elapses. Accordingly, if the timing of on and off of the heaters 2 and 3 is shifted to each other by more than one cycle, a change in the total current flowing to the heaters 2 and 3 is decreased. That is, for example, the rush current flowing to the heater 3 during the first cycle is not added to the rush current flowing to the heater 2 during the first cycle. Thus, the magnitude of fluctuation in the power source voltage supplying a current to the fixing apparatus can be decreased.

The change in the total current flowing to the heaters 2 and 3 is decreased as the delay time for on and off of the heaters 2 and 3 is increased from one cycle to two cycles and further to N cycles. This increases the effect of the reduction in the power source voltage fluctuation. However, if the delay time is too long, the temperature fluctuation range of the temperature of the fixing apparatus may be increased. This may result in influence on the temperature control of a fixing temperature. Considering such a condition, the delay time should be a few seconds at the maximum.

Generally, the frequency of 50Hz or 60Hz is used for a power source. If the copy machine is used with 50Hz power source, the period of one cycle of the alternating current is equal to 20 msec. Thus, the time periods set by the delay timers are preferably equal to or more than 20 msec.

According to a standard, the flicker values Pst (short time flicker value) and Plt (long time flicker value), which are measurements of a flicker meter, must be decreased to clear standard values such as 1.0 or below for the short time flicker value Pst and 0.65 or below for the long time flicker value Plt.

Measurements for the flicker values Pst and Plt were taken by the inventors for the fixing apparatus which performs the control operations according to the present embodiment. The result of the measurements indicated that the short time flicker value Pst is decreased from 1.453 to below 0.634 and the long time flicker value Plt is decreased from 1.296 to below 0.566. This corresponds to more than a 50% reduction in the flicker values, and the measured flicker values passed the standard values.

Additionally, the decrease in the flicker values can be achieved without additional parts such as an additional transformer and filter circuits (LCR circuits). That is, according to the present embodiment, sufficient measures against the influence to the power source voltage fluctuation can be achieved without increasing manufacturing cost and the size and weight of the copy machine.

Especially, when a plurality of heaters are simultaneously turned on, the level of the total rush current is rapidly increased as high as 10 to 15 times of a normal current flowing to the heaters. On the other hand, when the plurality of heaters are simultaneously turned off, the level of total current flowing to the heaters is rapidly decreased as low as 1/10 to 1/20 of the normal current. However, according to the control operations of the heaters according to the present embodiment, if the delay time for the delay timers is set to equal to or more than the time period corresponding to one cycle of a power source frequency, the rapid change in the current flowing to the heaters is suppressed, resulting in the reduction of fluctuation in the power source voltage.

A description will now be given of a fixing apparatus according to a third embodiment of the present invention. The basic construction of the fixing apparatus according to the third embodiment is the same as that of the fixing apparatus shown in FIG.1.

In the present embodiment, the heater 2 is in a state where the heater 2 can be turned on and off whenever the copy machine is turned on except for a state where a cover of the copy machine is open or a paper jam occurs in the copy machine. The on/off control of the heater 2 is performed in accordance with the tem-

perature of the middle portion of the fixing roller 1 detected by the thermistor 9.

The CPU 8 controls the heater 3 based on the temperature of the end portion of the fixing roller 1 detected by the thermistor 9. The CPU 8 turns on and off the heater 3 only when the copy machine is performing a copying operation or when power of the copy machine is turned on. That is, the heater 3 is maintained in a deactivated state when the copy machine is in a waiting state or a pre-heating state.

A description will now be given, with reference to FIGS.9 and 10, of operations for controlling activation and deactivation of the heaters 2 and 3. FIG.9 is a flowchart of the operation for controlling the heater 2, and FIG.10 is a flowchart of the operation for controlling the heater 3. It should be noted that when the cover of the copy machine is open or when a paper jam occurs in the copy machine, the CPU 8 turns off the driver 11 to interrupt connection of the heaters 2 and 3 to the power source. That is, the transistor 12 is turned off and, in turn, the relay RA1 is turned off by turning off the driver 11.

When the operation for controlling the heater 2 shown in FIG.9 is started, it is determined, in step 600, whether or not a temperature of the middle portion of the fixing roller 1 is equal to or less than the target temperature M minus 3°C based on the temperature detection signal output from the thermistor 9. If it is determined that the temperature of the middle portion is equal to or less than the target temperature M minus 3°C, the routine proceeds to step 602.

In step 602, it is determined whether or not the heater 2 is in an activated state. If it is determined that the heater 2 is in the activated state, the routine is ended. If it is determined that the heater 2 is not in the activated state, the routine proceeds to step 604. In step 604, the CPU 8 turns on the heater 2 by turning on the triac 4 via the driver 6, and the routine is ended.

On the other hand, if it is determined, in step 600, that the temperature of the middle portion of the fixing roller 1 is greater than the target temperature M minus 3°C, the routine proceeds to step 606. In step 606, the CPU 8 determines whether or not the temperature of the middle portion of the fixing roller 1 is equal to or greater than the target temperature M. If it is determined that the temperature of the middle portion is less than the target temperature M, the routine is ended. If it is determined that the temperature of the middle portion of the fixing roller 1 is equal to or greater than the target temperature M, the routine proceeds to step 608.

In step 608, it is determined whether or not the heater 2 is in a deactivated state. If it is determined that the heater 2 is in the deactivated state, the routine is ended. If it is determined that the heater 2 is not in the deactivated state, the routine proceeds to step 610. In step 610, the CPU 8 turns on the heater 2 by turning off the triac 4 via the driver 6, and the routine is ended.

Accordingly, the CPU 8 controls the heater 2 to be turned on and off whenever the copy machine is turned on except for an abnormal state where a cover of the copy machine is open or a paper jam occurs in the copy machine. That is, the heater 2 is turned on when the temperature of the middle portion of the fixing roller 1 is equal to or less than the target temperature minus 3°C, and is turned off when the temperature of the middle portion of the fixing roller 1 reaches the target temperature M. This on/off operation of the heater 2 continues while the power of the copy machine is turned on.

When the control operation of the heater 3 shown in FIG.10 is started, the CPU 8 determines, in step 700, whether or not the copy machine is performing a copying operation. If it is determined that the copy machine is performing a copying operation, the routine proceeds and takes a route indicated by an arrow A, that is, the routine proceeds to step 702. In step 702, it is determined whether or not the temperature of the end portion of the fixing roller 1 is equal to or less than the target temperature K minus 3°C.

If the temperature of the end portion is equal to or less than the target temperature K minus 3°C, the routine proceeds to step 704. It is determined, in step 704, whether or not the heater 3 is in an activated state. If it is determined that the heater 3 is in the activated state, the routine is ended. If it is determined that the heater 3 is not in the activated state, the routine proceeds to step 706. In step 706, the heater 3 is turned on by turning on the triac 5 via the driver 7, and the routine is ended.

If it is determined, in step 702, that the temperature of the end portion is greater than the target temperature minus 3°C, the routine takes a route indicated by an arrow C, that is, the routine proceeds to step 710. In step 710, it is determined whether or not the temperature of the end portion of the fixing roller 1 is equal to or greater than the target temperature K. If it is determined that the temperature of the end portion is less than the target temperature K, the routine is ended. If it is determined that the temperature of the end portion is equal to or greater than the target temperature K, the routine proceeds to step 712. In step 712, a heater flag is set. The heater flag indicates that the temperature of the end portion of the fixing roller 1 has once reached the target temperature K. It should be noted that the heater flag is cleared when power of the copy machine is turned on.

Thereafter, the CPU 8 determines, in step 714, whether or not the heater 3 is in a deactivated state. If it is determined that the heater 3 is in the deactivated state, the routine is ended. If it is determined that the heater 3 is not in the deactivated state, the routine proceeds to step 716. In step 716, the CPU 8 turns off the heater 3 by turning off the triac 5 via the driver 7.

On the other hand, if it is determined, in step 700, that the copy machine is not performing a copying operation, the routine takes a route indicated by an arrow B, that is, the routine proceeds to step 708. In step 708, it is determined that the heater flag is set. If it is determined that the heater flag is not set, this means that the temperature of the end portion has not reached the tar-

get temperature K in the initial operation of the copy machine. Thus, in this case, the routine proceeds to step 702 to maintain the heater 3 in the activated state. If it is determined, in step 708, that the heater flag is set, the routine proceeds to step 714 to turn off the heater 3 so as to ensure that the heater 3 is in the deactivated state.

According to the above-mentioned control operation of the heater 3, the heater 3 is turned on only in the initial operation of the copy machine because the heater flag is set after the temperature of the end portion of the fixing roller 1 has once reached the target temperature k. That is, the heater 3 is maintained in the deactivated state when the copy machine is in a waiting state or in a pre-heating state.

In this embodiment, since the heater 3 is turned on and off only when the power of the copy machine is turned on, there is no rush current generated due to the activation of the heater 3 while the copy machine is operated after the initial operation is completed.

According to a standard, the flicker values Pst (short time flicker value) and Plt (long time flicker value), which are measurements of a flicker meter, must be decreased to clear standard values such as 1.0 or below for the short time flicker value Pst and 0.65 or below for the long time flicker value Plt.

Measurements for the flicker values Pst and Plt were taken by the inventors for the fixing apparatus which performs the control operations according to the present embodiment. The result of the measurements indicated that the short time flicker value Pst is decreased from 1.453 to below 0.616 and the long time flicker value Plt is decreased from 1.373 to below 0.603 during a waiting state and a pre-heating state. This corresponds to more than a 50% reduction in the flicker values, and the measured flicker values passed the standard values.

Additionally, the decrease in the flicker values can be achieved without additional parts such as an additional transformer and filter circuits (LCR circuits). That is, according to the present embodiment, sufficient measures against the influence to the power source voltage fluctuation can be achieved without increasing manufacturing cost and the size and weight of the copy machine.

When the copy machine is performing a copying operation, that is, when a fixing operation is being performed in the copy machine, a plurality of heaters must be activated to generate sufficient heat. However, if the copy machine is in a waiting state or a pre-heating state, the temperature of the fixing roller can be maintained with a power of a only few watts. Thus, the temperature of the fixing roller can be maintained by activating only one of the heaters and deactivating the remaining heaters.

In the present embodiment, the heater 3 is maintained in the deactivated state after the initial operation of the copy machine is completed. However, the determination as to whether the heater 3 should be maintained in the deactivated state may be made based on the fact that the copy machine is in a waiting state or a pre-heating state. That is, the heater 3 may be maintained in the deactivated state when the copy machine is in a waiting state or a pre-heating state.

In the fixing apparatus provided in the copy machine, if a halogen heater is used for the heaters, current consumption is low during a waiting state or a pre-heating state. However, the current consumption during a copying operation is increased up to 30 times of the current consumption during a waiting state or a pre-heating state. Additionally, a rush current of the halogen heater is as high as 10 to 15 times that of a normal current. Thus, if the halogen heaters are turned on at the same tine when the operation of the copy machine is changed from a waiting state or pre-heating state to a copying state, a total current flowing to the copy machine is rapidly increased. This greatly influences the fluctuation of the power source voltage. Considering a fixing operation, heat generated by the plurality of heaters is needed when print paper actually passes the fixing apparatus. That is, activation of the plurality of heaters is not required until the print paper actually passes the fixing apparatus. Thus, in the present embodiment, the heater 3 may be activated when the print paper actually passes the fixing apparatus while the copy machine is in a copying state. This causes the activation of the heater 3 to be performed a certain time period after the copy machine has entered the copying state.

Additionally, if a plurality of heaters are provided in the fixing apparatus, one of the heaters having the minimum power consumption may be selected to be maintained in a state where the heater can be activated. Preferably, the heater to be selected is determined by the power consumption of the heater so that the heater generates heat which can be continuously activated to maintain the temperature of the fixing apparatus slightly below the target temperature.

For Example, it is assumed that the target temperature of the fixing apparatus during a waiting state is 185°C and the appropriate fixing temperature ranges from 165°C to 190°C and further the target temperature during a pre-heating state is 145°C. If one of the heaters can generate a heat which can maintain the fixing apparatus at a temperature of 180°C but does not exceed 185°C, that particular heater should be selected since the heater continues to be activated, and no switching occurs. Thus, no change in the current flowing to the fixing apparatus occurs, resulting in a decrease in the power source voltage fluctuation. Such a heater is most suitable to be activated during a waiting state.

The next heater to be selected is the one of the heaters which raises the temperature of the fixing apparatus beyond 185°C but has a minimum power consumption from among the heaters. This is because such heater gently raises the temperature of the fixing apparatus and, thus, an on/off switching of the heater does not frequently occur.

Another heater to be selected is one of the heaters which cannot maintain the temperature of the fixing apparatus at 185°C but maintains the temperature above 165°C. Using such a heater requires additional heat when the copy machine is changed from a waiting state to a copying state. However, because the heater is continuously activated, there is an advantage in that there is no on/off switching of the heater during the waiting state. If the temperature of the fixing apparatus is maintained above 165°C, the transition from the waiting state to the copying state can be smooth.

Additionally, if a plurality of heaters are separately controlled with a plurality of temperature sensors, all of the heaters are not required to be controlled to maintain the temperature of each position to be at 185°C. That is, at least one position of the fixing apparatus which actually needs the target temperature 185°C should be maintained at 185°C, and other positions of the fixing apparatus may be at a temperature lower than 185°C. Thus, one of the heaters, corresponds to the position which actually needs the target temperature 185°C, may be activated during a waiting state while the remaining heaters are maintained in a deactivated state. Accordingly, a minimum number of heaters are activated to maintain a condition required by the waiting state. This reduces an on/off switching of the heaters, and thus the power source voltage fluctuation is reduced.

It should be noted that although the above-mentioned embodiments are described with a copy machine as one of image forming apparatuses having a fixing apparatus, the present invention is applicable to an image forming apparatus such as a printer or a facsimile apparatus.

The present invention is not limited to the specifically disclosed embodiments, and variations and modifications may be made without departing from the scope of the present invention.

Claims

1. A fixing apparatus having at least one heater (2, 3) to provide heat to fix a toner image on a print paper, said heater being intermittently activated and deactivated to maintain said fixing apparatus at a substantially constant temperature, said heater being activated by a predetermined voltage (Vf) provided thereto,

   characterized in that:

   deactivation of said heater (2, 3) is controlled so that a rate of change in a current flowing to said heater is reduced.

2. The fixing apparatus as claimed in claim 1, characterized in that activation of said heater (2, 3) is also controlled so that a rate of change in the current flowing to said heater is reduced.

3. The fixing apparatus as claimed in claim 2, characterized in that a first voltage (Vrc1, Vrc1', Vrs1, Vrs1') less than said predetermined voltage (Vf) is provided immediately before said heater is activated at said predetermined voltage (Vf), and a second voltage (Vrc2, Vrc2', Vrs2, Vrs2') less than said predetermined voltage (Vf) is provided immediately before said heater is deactivated.

4. The fixing apparatus as claimed in claim 3, characterized in that a level of said first voltage (Vrc1, Vrc1') provided while an image forming operation is being performed is different from a level of said first voltage (Vrs1, Vrs1') provided during a waiting state and a pre-heating state, and a level of said second voltage (Vrc2, Vrs2') provided while an image forming operation is being performed is different from a level of said second voltage (Vrs2, Vrs2') provided during a waiting state and a pre-heating state.

5. The fixing apparatus as claimed in claim 3 or 4, characterized in that the levels of said first and second voltages (Vrs1, Vrs1', Vrs2, Vrs2') provided during the waiting state and the pre-heating state are equal to or less than 40% of said predetermined voltage (Vf).

6. The fixing apparatus as claimed in one of claims 3 to 5, characterized in that the levels of said first and second voltages (Vrc1, Vrc1', Vrc2, Vrc2') provided while the image forming operation is being performed are equal to or less than 60% of said predetermined voltage (Vf).

7. The fixing apparatus as claimed in claims 3 to 6, characterized in that the levels of said first and second voltage (Vrs1, Vrs1', Vrs2, Vrs2') provided during the waiting state and the pre-heating state are equal to or more than 20% of said predetermined voltage (Vf).

8. The fixing apparatus as claimed in one of claims 3 to 7, characterized in that the levels of said first and second voltages (Vrc1, Vrc1', Vrc2, Vrc2') while the image forming operation is being performed are equal to or more than 50% of said predetermined voltage (Vf).

9. The fixing apparatus as claimed in one of claims 3-8, characterized in that said first voltage (Vrc1, Vrc1') is provided for a first time period (Trc1, Trc1') and said second voltage (Vrc2, Vrc2') is provided for a second time period (Trc2, Trc2') while the image forming operation is being performed; and said first voltage (Vrs1, Vrs1') is provided for a third time period (Trs1, Trs1') and said second voltage (Vrs2, Vrs2') is provided for a fourth time period (Trs2, Trs2') during the waiting state and a pre-heating state

10. The fixing apparatus as claimed in claim 9, characterized in that said third time period (Trs1, Trs1') is different from said first time period (Trc1, Trc1') and said fourth time period (Trs2, Trs2') is different from said second time period (Trc2, Trc2').

11. The fixing apparatus as claimed in claim 9 or 10, characterized in that said third time period (Trs1, Trs1') and said fourth time period (Trs2, Trs2') provided during the waiting state or the pre-heating state are equal to or more than 300 msec.

12. The fixing apparatus as claimed in claim 9 or 11, characterized in that said first time period (Trc1, Trc1') and said second time period (Trc2, Trc2') provided while the image forming operation is being performed are equal to or more than 100 msec.

13. The fixing apparatus as claimed in one of claims 9 to 12, characterized in that said third time period (Trs1, Trs1') and said fourth time period (Trs2, Trs2') provided during the waiting state or the pre-heating state are equal to or less than 700 msec.

14. The fixing apparatus as claimed in claim 9 or 13, characterized in that said first time period (Trc1, Trc1') and said second time period (Trc2, Trc2') provided while the image forming operation is being performed are equal to or less than 500 msec.

15. The fixing apparatus as claimed in claim 1, characterized in that a plurality of heaters (2, 3) are provided, and a timing of deactivation of each of said heaters (2, 3) is controlled so that a start time of deactivation of said heaters (2, 3) differs from each other.

16. The fixing apparatus as claimed in claim 15, characterized in that a start time of deactivation of one of said heaters (2, 3) is delayed from a start time of deactivation of another one of said heaters (2, 3).

17. The fixing apparatus as claimed in claim 16, characterized in that said heaters (2, 3) are activated by an alternating voltage, and a start time of deactivation of one of said heaters (2, 3) is delayed from a start time of deactivation of another one of said heaters (2, 3) by a delay time which is equal to or more than one cycle of said alternating voltage.

18. The fixing apparatus as claimed in one of claims 15 to 17, characterized in that a timing of activation of each of said heaters (2, 3) is controlled.

19. The fixing apparatus as claimed in claim 18, characterized in that a timing of activation of said heaters is controlled so that a start time of activation of said heaters (2, 3) differs from each other.

20. The fixing apparatus as claimed in claim 19, characterized in that a start time of activation of one of said heaters (2, 3) is delayed from a start time of activation of another one of said heaters (2, 3).

21. The fixing apparatus as claimed in claim 20, characterized in that said heaters (2, 3) are activated by an alternating voltage, and a start time of activation of one of said heaters (2, 3) is delayed from a start time of activation of another one of said heaters (2, 3) by a delay time which is equal to or more than one cycle of said alternating voltage.

22. A fixing apparatus having a plurality of heaters (2, 3) each of which is separately controlled based on a temperature of a corresponding position of said fixing apparatus,

characterized in that:

said heaters (3) excluding at least one (2) of said heaters (2, 3) is maintained to be deactivated when said fixing apparatus is in a predetermined operational state.

23. The fixing apparatus as claimed in claim 22, characterized in that said predetermined operational state includes a waiting state where said fixing apparatus is waiting for supply of print paper having a toner image to be fixed while the temperature of said fixing apparatus is maintained at a fixing temperature.

24. The fixing apparatus as claimed in claim 22, characterized in that said predetermined operational state includes a pre-heating state where said fixing apparatus is waiting for supply of print paper having a toner image to be fixed while the temperature of said fixing apparatus is decreased to be less than a fixing temperature.

25. The fixing apparatus as claimed in claim 22, characterized in that said predetermined operational state excludes a state where print paper is passing through said fixing apparatus.

26. The fixing apparatus as claimed in claim 22, characterized in that said predetermined operational state excludes an initial state where a temperature of said fixing apparatus is initially raised to a fixing temperature.

27. The fixing apparatus as claimed in one of claims 22 to 26, characterized in that said at least one (2) of said heaters (2, 3) consumes a minimum amount of power among said heaters (2, 3).

28. The fixing apparatus as claimed in one of claims 22 to 26, characterized in that said at least one (2) of said heaters (2, 3) maintains a fixing temperature of said fixing apparatus by being continuously acti-

vated.

29. The fixing apparatus as claimed in claim 22, characterized in that said at least one of said heaters (2, 3) is located at a selected position where a temperature of said position is required to be at a fixing temperature.

FIG.1

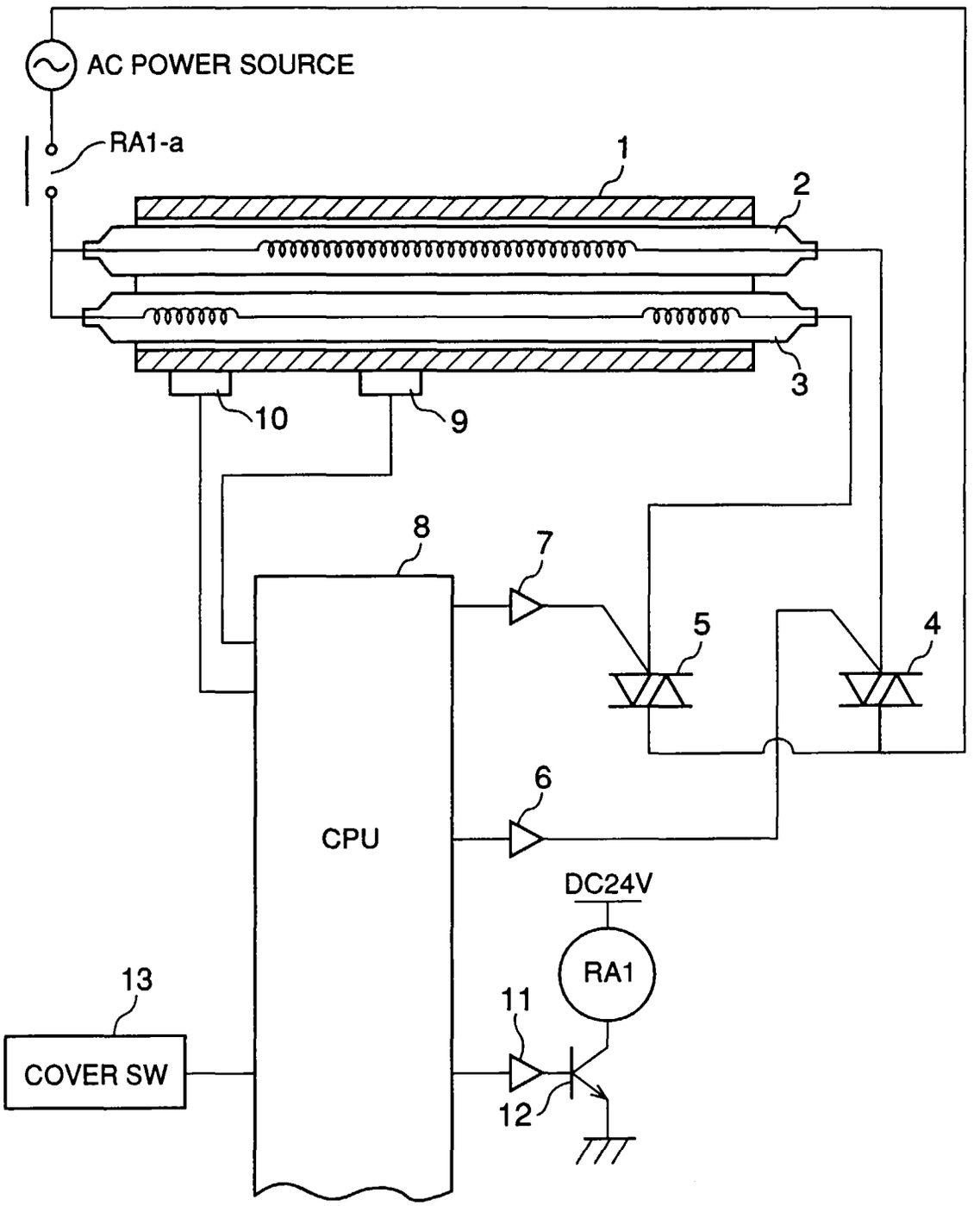

AC POWER SOURCE
RA1-a
1
2
3
10
9
8
7
5
4
6
CPU
DC24V
RA1
13
11
COVER SW
12

FIG.2A

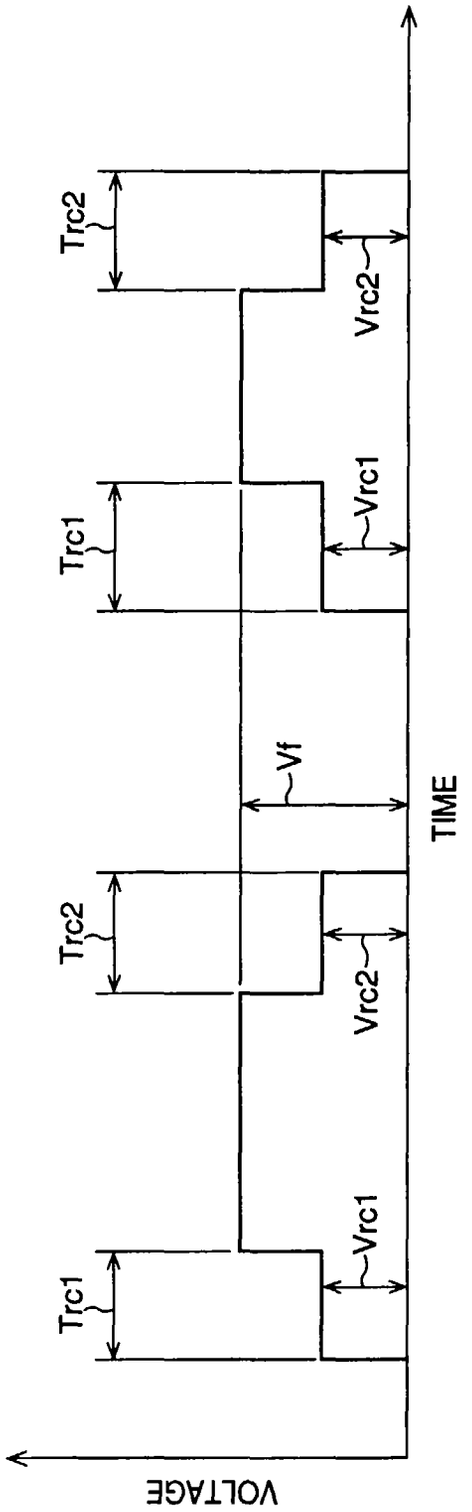

COPYING OPERATION
Trc2
Vrc2
Trc1
Vrc1
Vf
Trc2
Vrc2
Trc1
Vrc1
TIME
VOLTAGE

FIG.2B

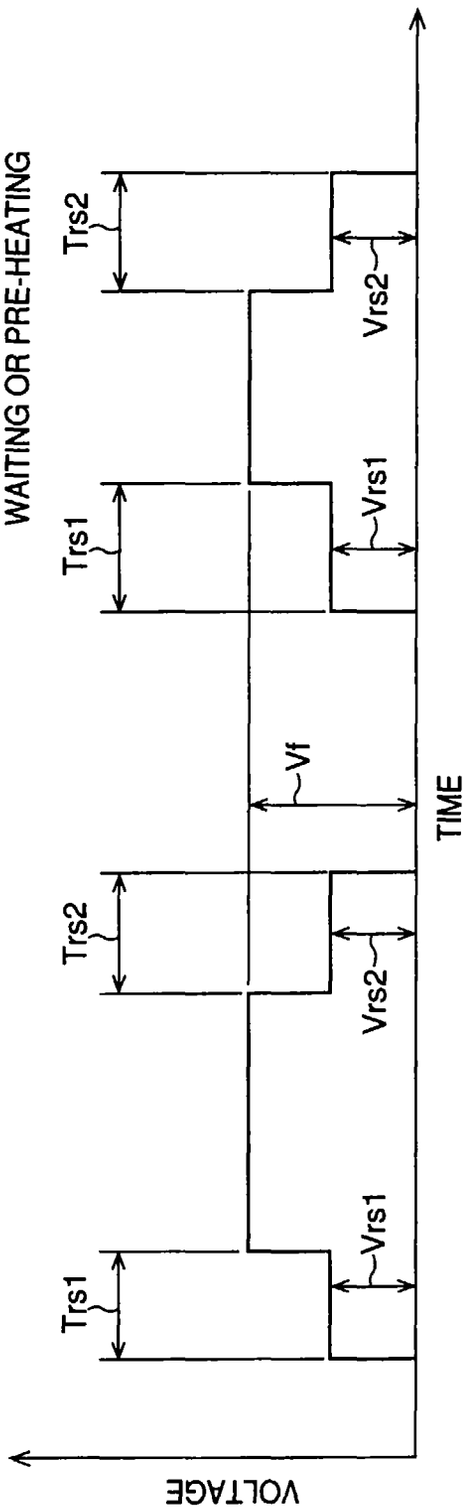

WAITING OR PRE-HEATING
Trs2
Vrs2
Trs1
Vrs1
Vf
Trs2
Vrs2
Trs1
Vrs1
TIME
VOLTAGE

FIG.3

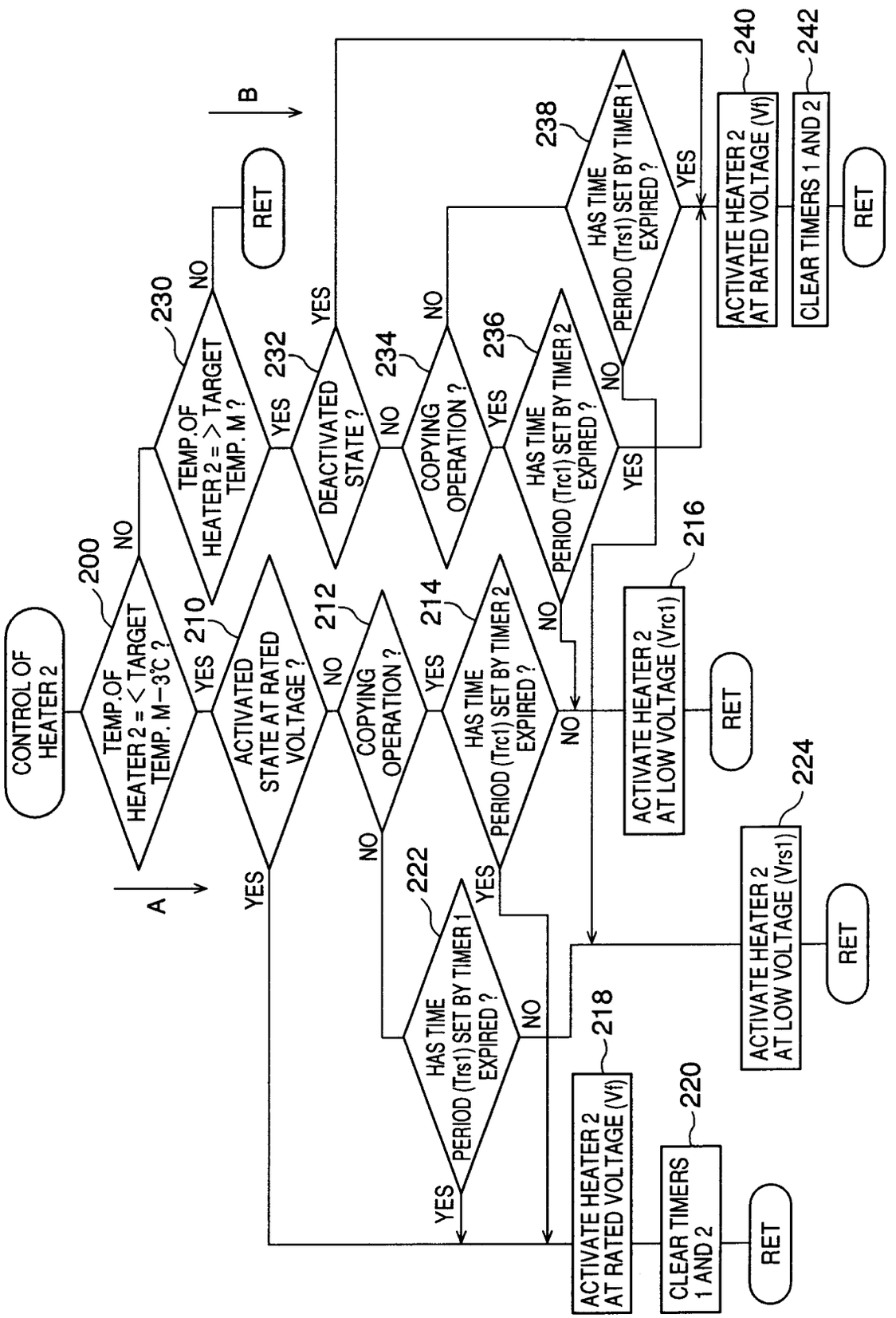

CONTROL OF HEATER 2
200
TEMP.OF HEATER 2 = < TARGET TEMP. M−3℃ ?
NO
YES
210
ACTIVATED STATE AT RATED VOLTAGE ?
NO
YES
212
COPYING OPERATION ?
NO
YES
214
HAS TIME PERIOD (Trc1) SET BY TIMER 2 EXPIRED ?
NO
YES
216
ACTIVATE HEATER 2 AT LOW VOLTAGE (Vrc1)
RET
222
HAS TIME PERIOD (Trs1) SET BY TIMER 1 EXPIRED ?
NO
YES
218
ACTIVATE HEATER 2 AT RATED VOLTAGE (Vf)
220
CLEAR TIMERS 1 AND 2
RET
224
ACTIVATE HEATER 2 AT LOW VOLTAGE (Vrs1)
RET
A
B
230
TEMP.OF HEATER 2 = > TARGET TEMP. M ?
NO
YES
RET
232
DEACTIVATED STATE ?
YES
NO
234
COPYING OPERATION ?
NO
YES
236
HAS TIME PERIOD (Trc1) SET BY TIMER 2 EXPIRED ?
NO
YES
238
HAS TIME PERIOD (Trs1) SET BY TIMER 1 EXPIRED ?
NO
YES
240
ACTIVATE HEATER 2 AT RATED VOLTAGE (Vf)
242
CLEAR TIMERS 1 AND 2
RET

FIG.4

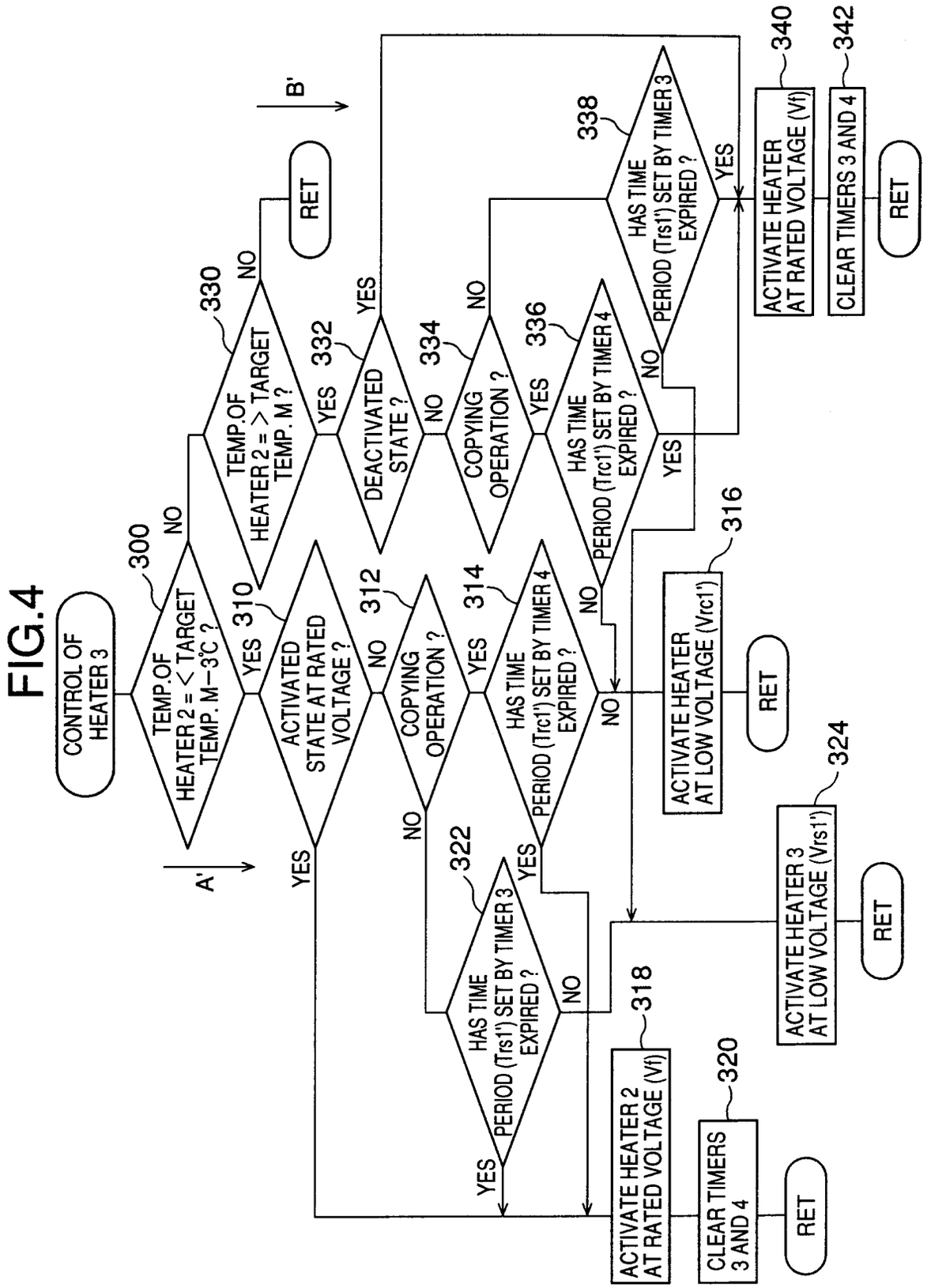

CONTROL OF HEATER 3
300
TEMP.OF HEATER 2 = < TARGET TEMP. M−3℃ ?
NO
YES
310
ACTIVATED STATE AT RATED VOLTAGE ?
NO
YES
312
COPYING OPERATION ?
NO
YES
314
HAS TIME PERIOD (Trc1') SET BY TIMER 4 EXPIRED ?
NO
YES
316
ACTIVATE HEATER AT LOW VOLTAGE (Vrc1')
RET
322
HAS TIME PERIOD (Trs1') SET BY TIMER 3 EXPIRED ?
NO
YES
318
ACTIVATE HEATER 2 AT RATED VOLTAGE (Vf)
320
CLEAR TIMERS 3 AND 4
RET
324
ACTIVATE HEATER 3 AT LOW VOLTAGE (Vrs1')
RET
A'
B'
330
TEMP.OF HEATER 2 = > TARGET TEMP. M ?
NO
YES
RET
332
DEACTIVATED STATE ?
YES
NO
334
COPYING OPERATION ?
NO
YES
336
HAS TIME PERIOD (Trc1') SET BY TIMER 4 EXPIRED ?
NO
YES
338
HAS TIME PERIOD (Trs1') SET BY TIMER 3 EXPIRED ?
NO
YES
340
ACTIVATE HEATER AT RATED VOLTAGE (Vf)
342
CLEAR TIMERS 3 AND 4
RET

FIG.5

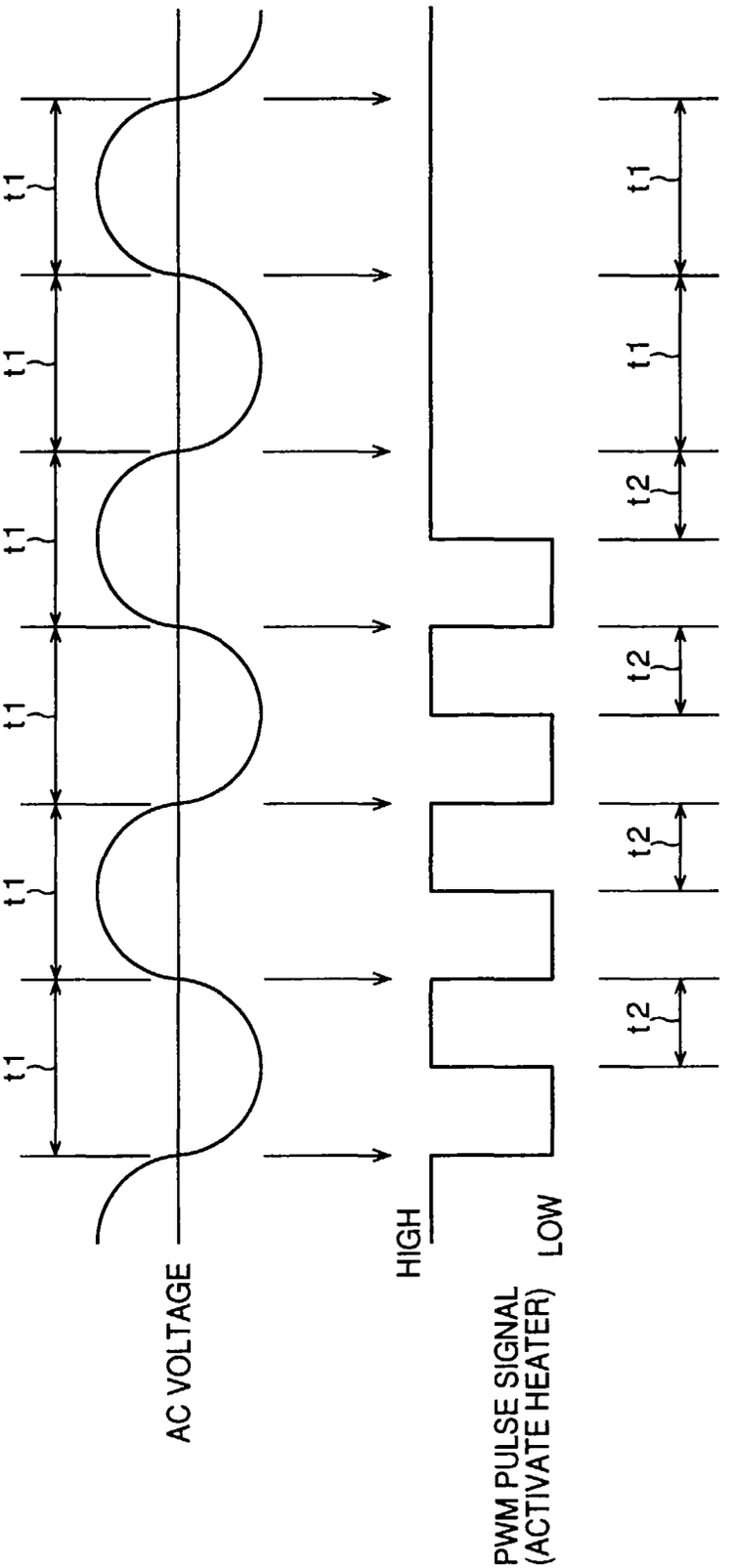


FIG.6

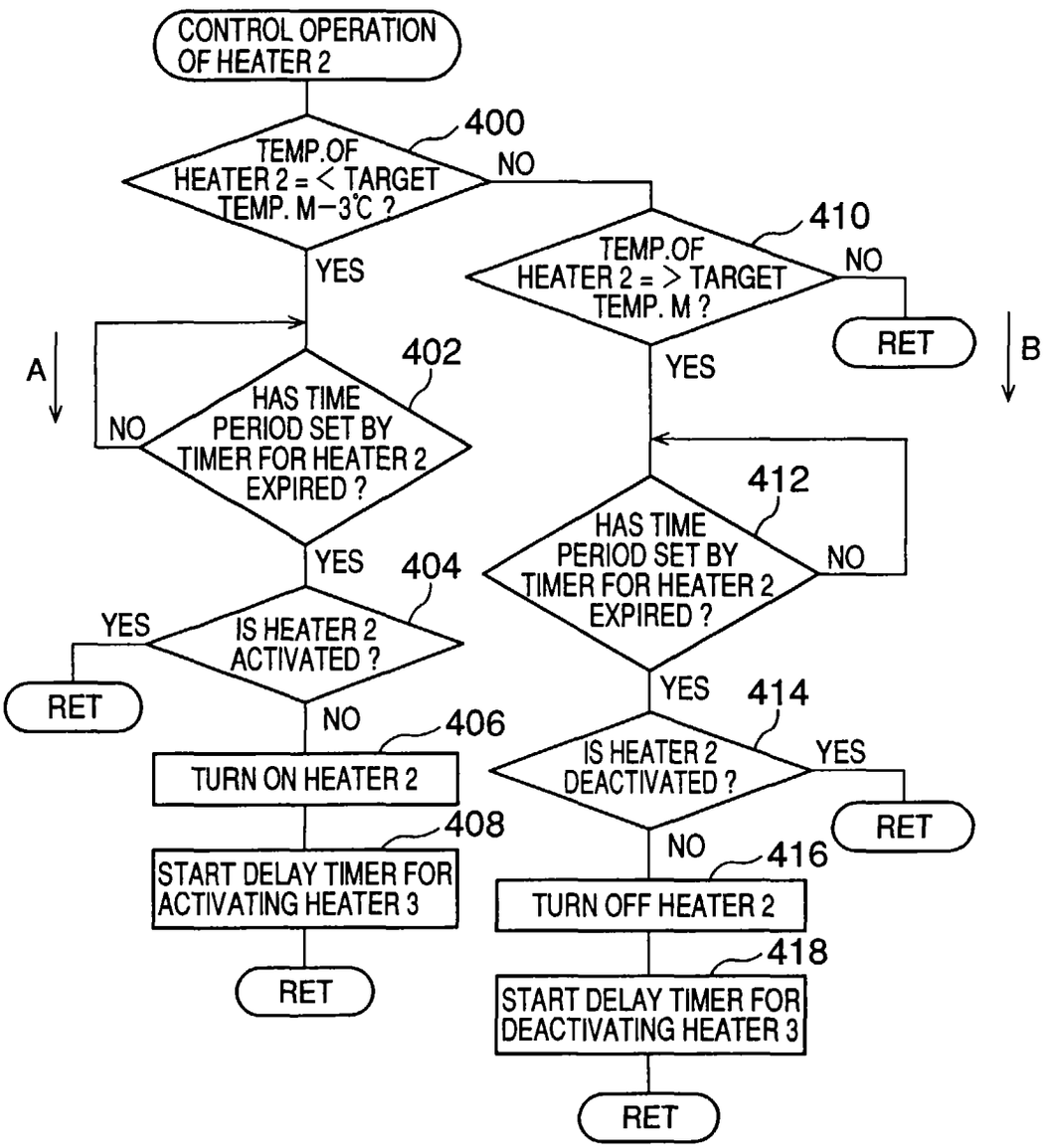

CONTROL OPERATION OF HEATER 2
400
TEMP.OF HEATER 2 = < TARGET TEMP. M−3℃ ?
NO
YES
410
TEMP.OF HEATER 2 = > TARGET TEMP. M ?
NO
RET
B
A
402
HAS TIME PERIOD SET BY TIMER FOR HEATER 2 EXPIRED ?
NO
YES
404
IS HEATER 2 ACTIVATED ?
YES
RET
NO
406
TURN ON HEATER 2
408
START DELAY TIMER FOR ACTIVATING HEATER 3
RET
YES
412
HAS TIME PERIOD SET BY TIMER FOR HEATER 2 EXPIRED ?
NO
YES
414
IS HEATER 2 DEACTIVATED ?
YES
RET
NO
416
TURN OFF HEATER 2
418
START DELAY TIMER FOR DEACTIVATING HEATER 3
RET

FIG.7

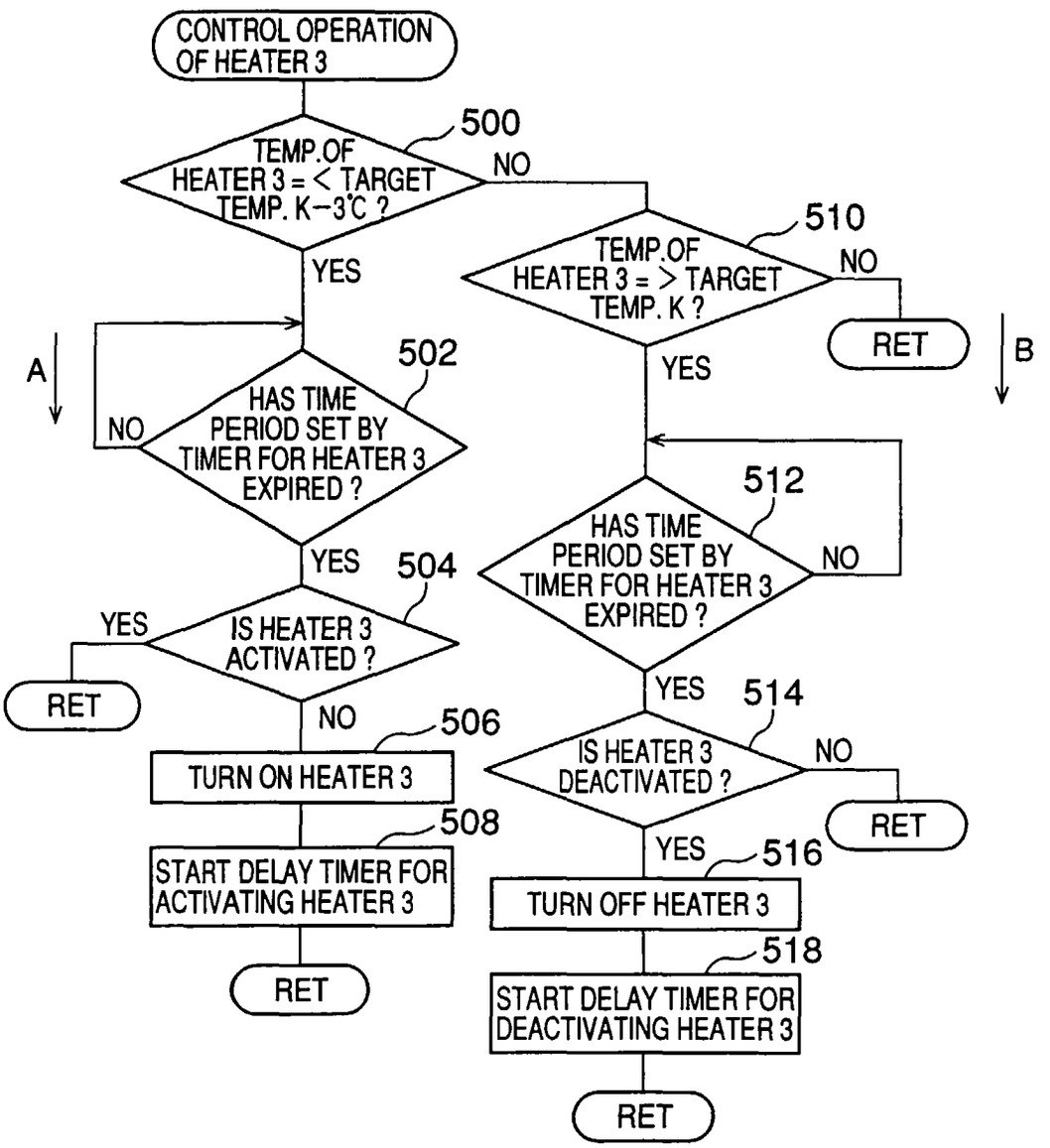

CONTROL OPERATION OF HEATER 3
500
TEMP.OF HEATER 3 = < TARGET TEMP. K−3℃ ?
NO
YES
510
TEMP.OF HEATER 3 = > TARGET TEMP. K ?
NO
RET
B
A
502
HAS TIME PERIOD SET BY TIMER FOR HEATER 3 EXPIRED ?
NO
YES
504
IS HEATER 3 ACTIVATED ?
YES
RET
NO
506
TURN ON HEATER 3
508
START DELAY TIMER FOR ACTIVATING HEATER 3
RET
YES
512
HAS TIME PERIOD SET BY TIMER FOR HEATER 3 EXPIRED ?
NO
YES
514
IS HEATER 3 DEACTIVATED ?
NO
RET
YES
516
TURN OFF HEATER 3
518
START DELAY TIMER FOR DEACTIVATING HEATER 3
RET

FIG.8

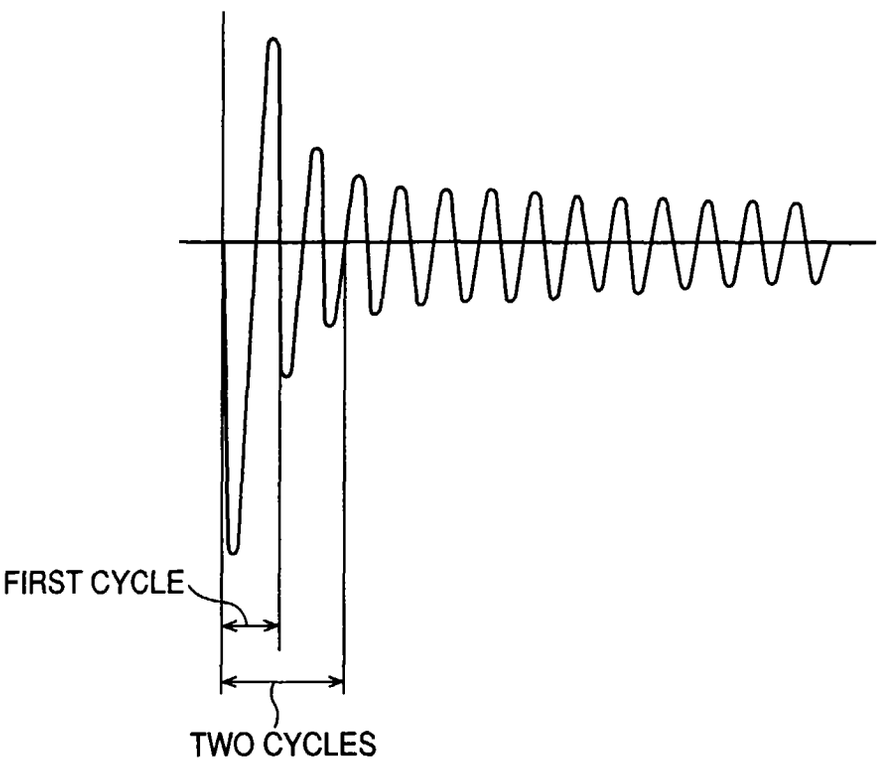


FIG.9

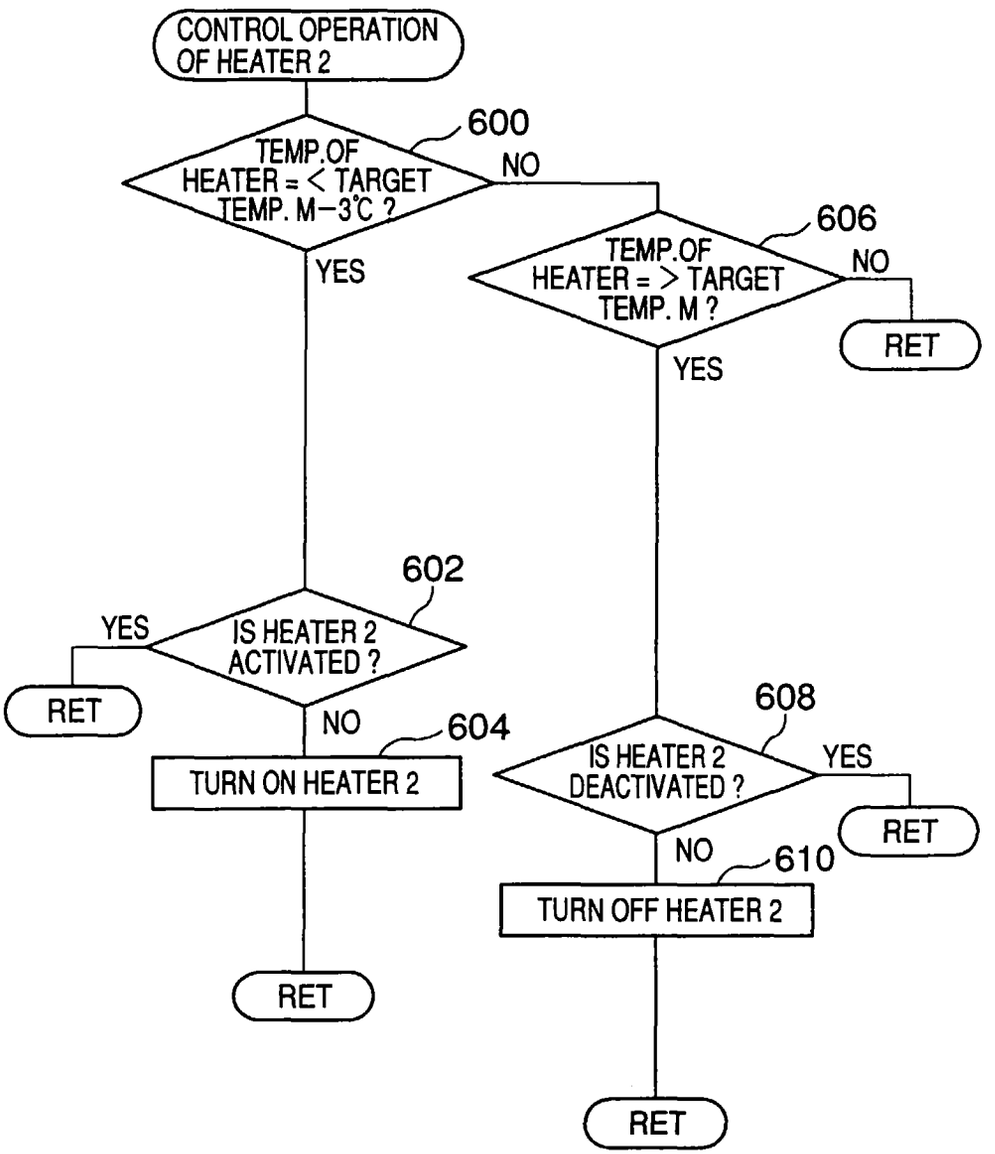
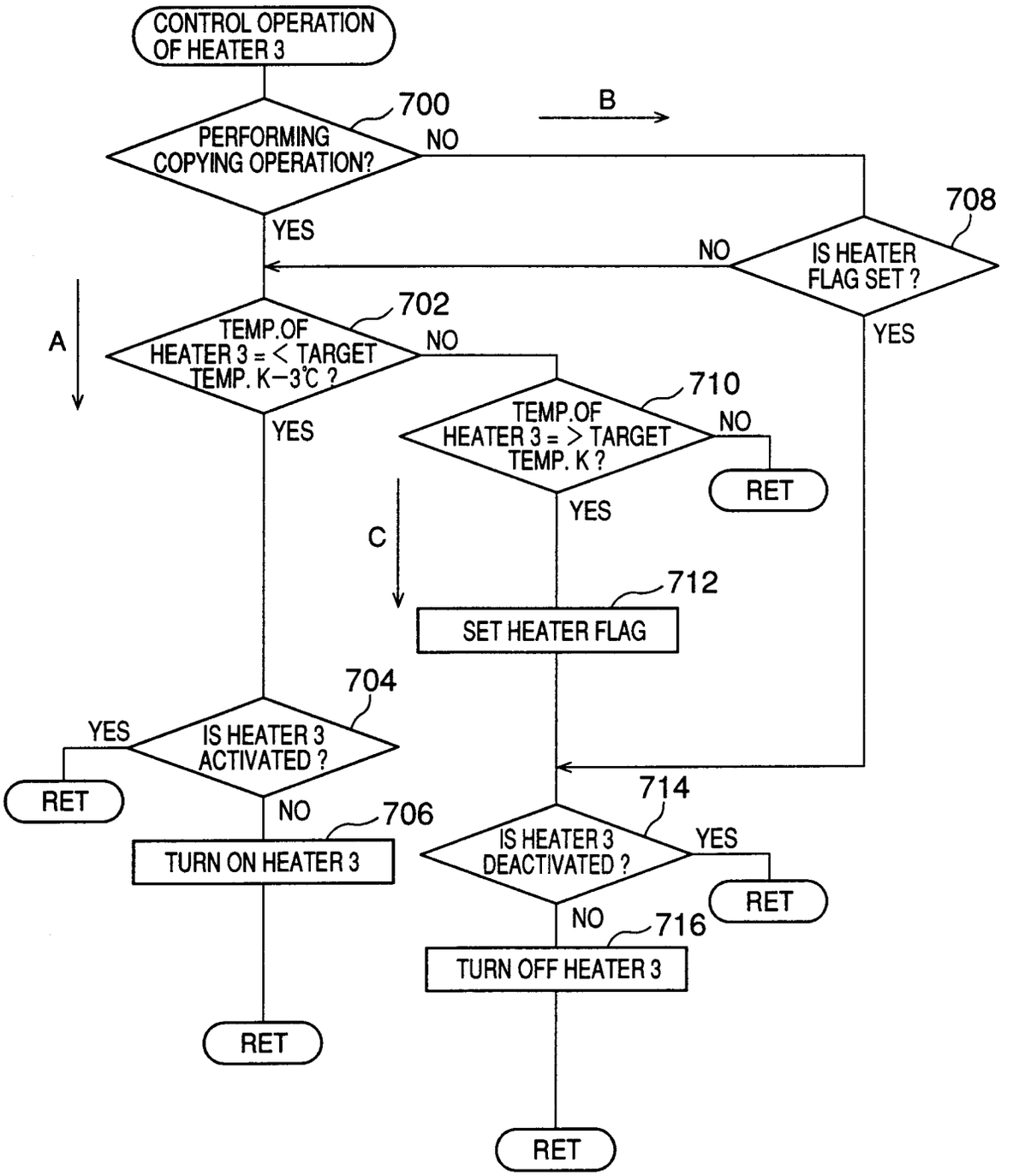

CONTROL OPERATION OF HEATER 2
600
TEMP.OF HEATER = < TARGET TEMP. M−3℃ ?
NO
YES
606
TEMP.OF HEATER = > TARGET TEMP. M ?
NO
RET
YES
602
YES
IS HEATER 2 ACTIVATED ?
RET
NO
604
TURN ON HEATER 2
RET
608
IS HEATER 2 DEACTIVATED ?
YES
RET
NO
610
TURN OFF HEATER 2
RET

FIG.10


CONTROL OPERATION OF HEATER 3
700
PERFORMING COPYING OPERATION?
NO
B
YES
708
IS HEATER FLAG SET ?
NO
YES
A
702
TEMP.OF HEATER 3 = < TARGET TEMP. K−3℃ ?
NO
YES
710
TEMP.OF HEATER 3 = > TARGET TEMP. K ?
NO
RET
YES
C
712
SET HEATER FLAG
704
IS HEATER 3 ACTIVATED ?
YES
RET
NO
706
TURN ON HEATER 3
RET
714
IS HEATER 3 DEACTIVATED ?
YES
RET
NO
716
TURN OFF HEATER 3
RET