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(54) **IMAGE FORMING APPARATUS**

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**Related U.S. Application Data**

(63) Continuation of application No. 17/837,758, filed on Jun. 10, 2022, now Pat. No. 11,927,901, which is a continuation of application No. 17/233,749, filed on Apr. 19, 2021, now Pat. No. 11,385,579.

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Aug. 3, 2020 (JP) ..... 2020-131496

(51) **Int. Cl.**
***G03G 15/20*** (2006.01)
***G03G 15/00*** (2006.01)

(52) **U.S. Cl.**
CPC ..... ***G03G 15/2039*** (2013.01); ***G03G 15/5004*** (2013.01)

(58) **Field of Classification Search**
CPC .. G03G 15/2039; G03G 15/205; G03G 15/50; G03G 15/5004; G03G 15/55; G03G 15/80
See application file for complete search history.

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(57) **ABSTRACT**

According to at least one embodiment, an image forming apparatus includes a heater and a controller. The heater is configured to generate heat. The controller is configured to control AC power to the heater so that a part of the AC power which exceeds a threshold voltage is not applied to the heater.

**18 Claims, 5 Drawing Sheets**

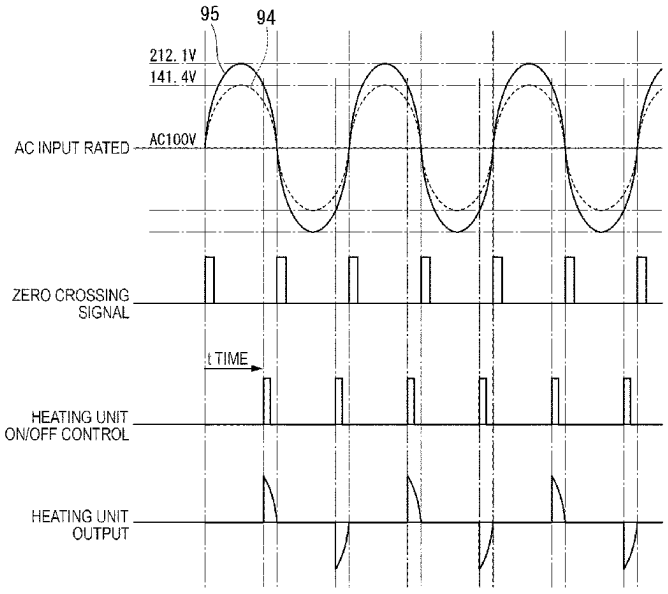

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FIG. 1

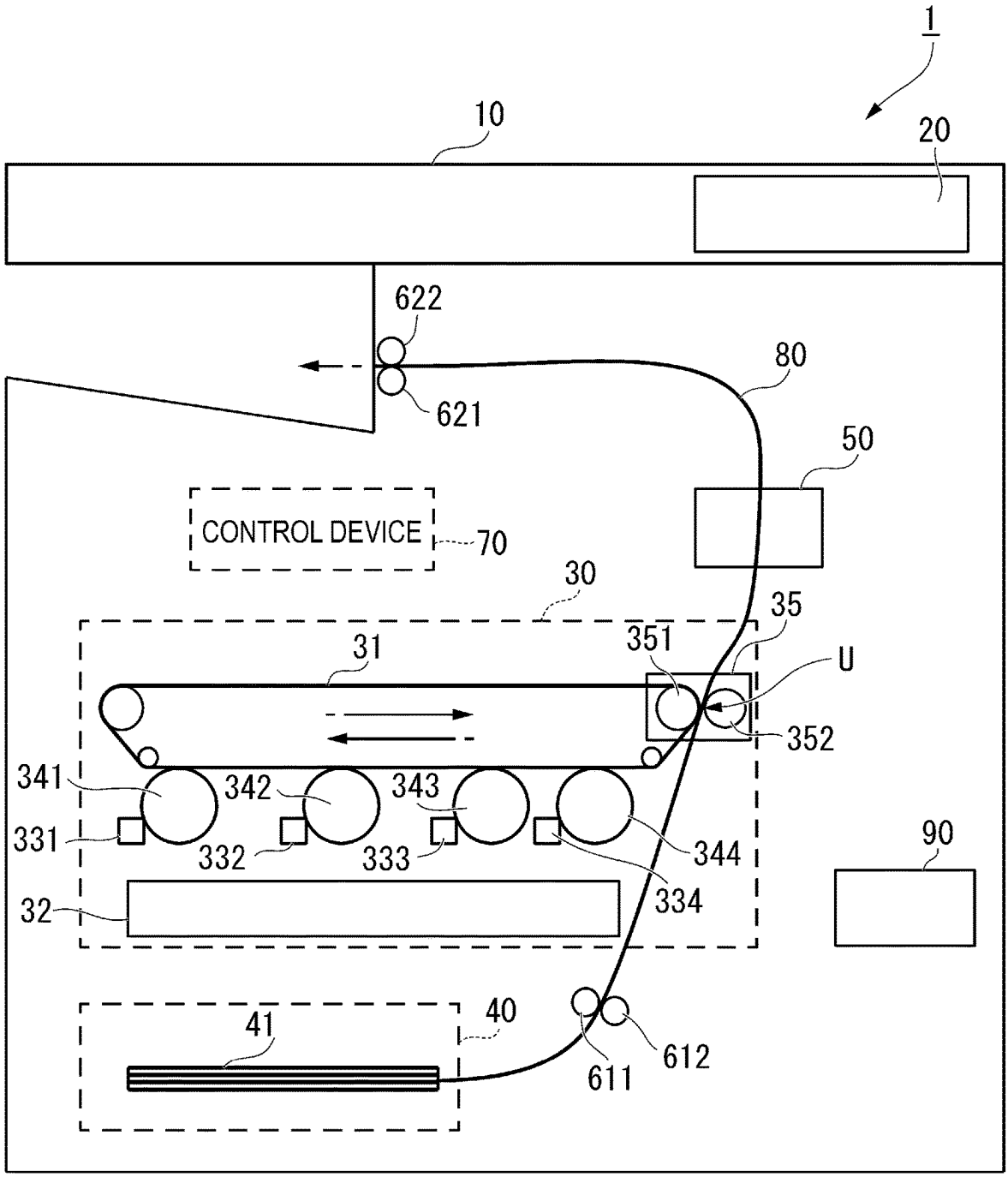

1
10
20
622
621
80
50
CONTROL DEVICE
70
30
35
31
351
U
352
341
342
343
331
332
333
344
334
32
90
40
41
611
612

FIG. 2

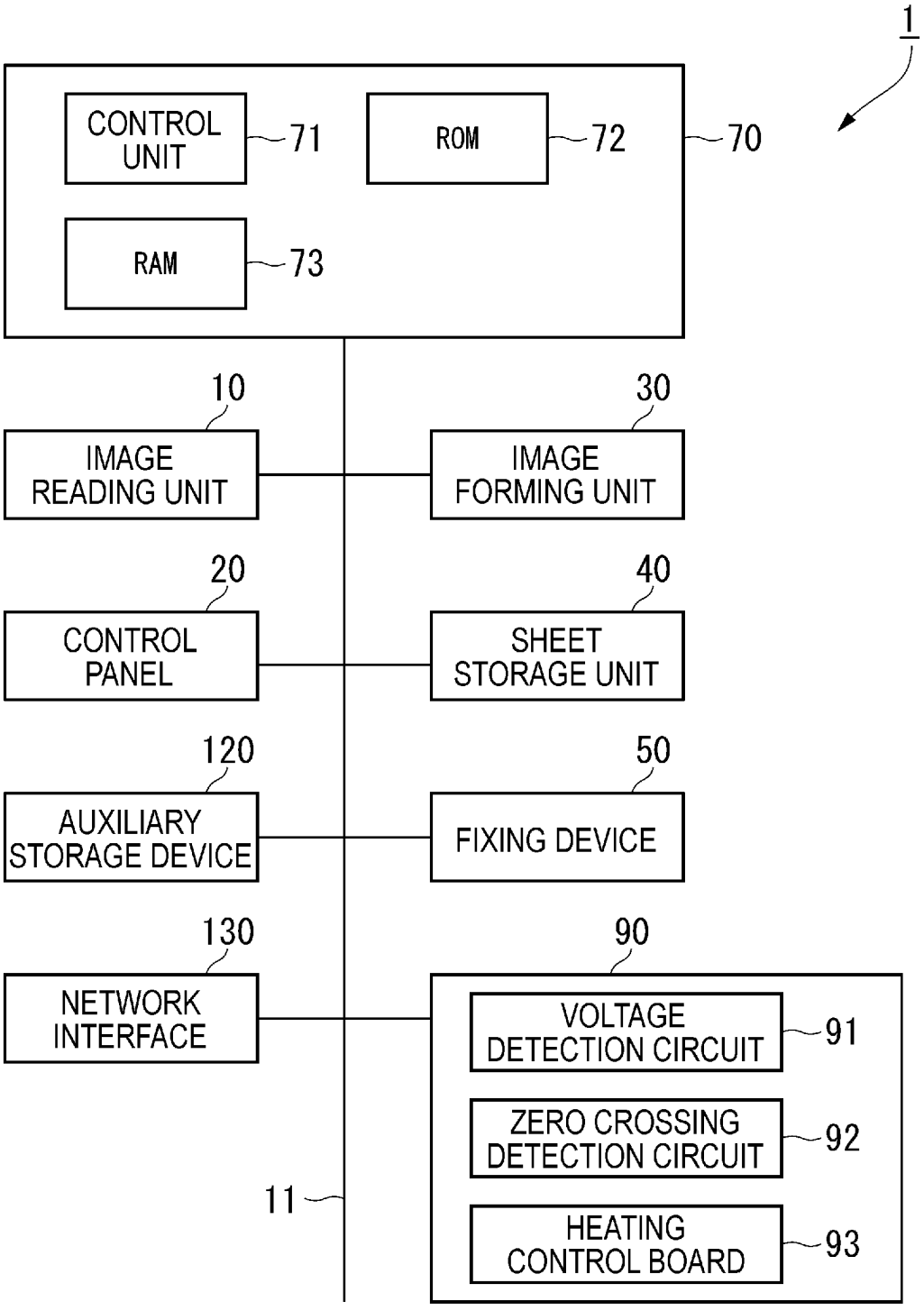

1
CONTROL UNIT
71
ROM
72
70
RAM
73
10
IMAGE READING UNIT
30
IMAGE FORMING UNIT
20
CONTROL PANEL
40
SHEET STORAGE UNIT
120
AUXILIARY STORAGE DEVICE
50
FIXING DEVICE
130
NETWORK INTERFACE
90
VOLTAGE DETECTION CIRCUIT
91
ZERO CROSSING DETECTION CIRCUIT
92
HEATING CONTROL BOARD
93
11

FIG. 3

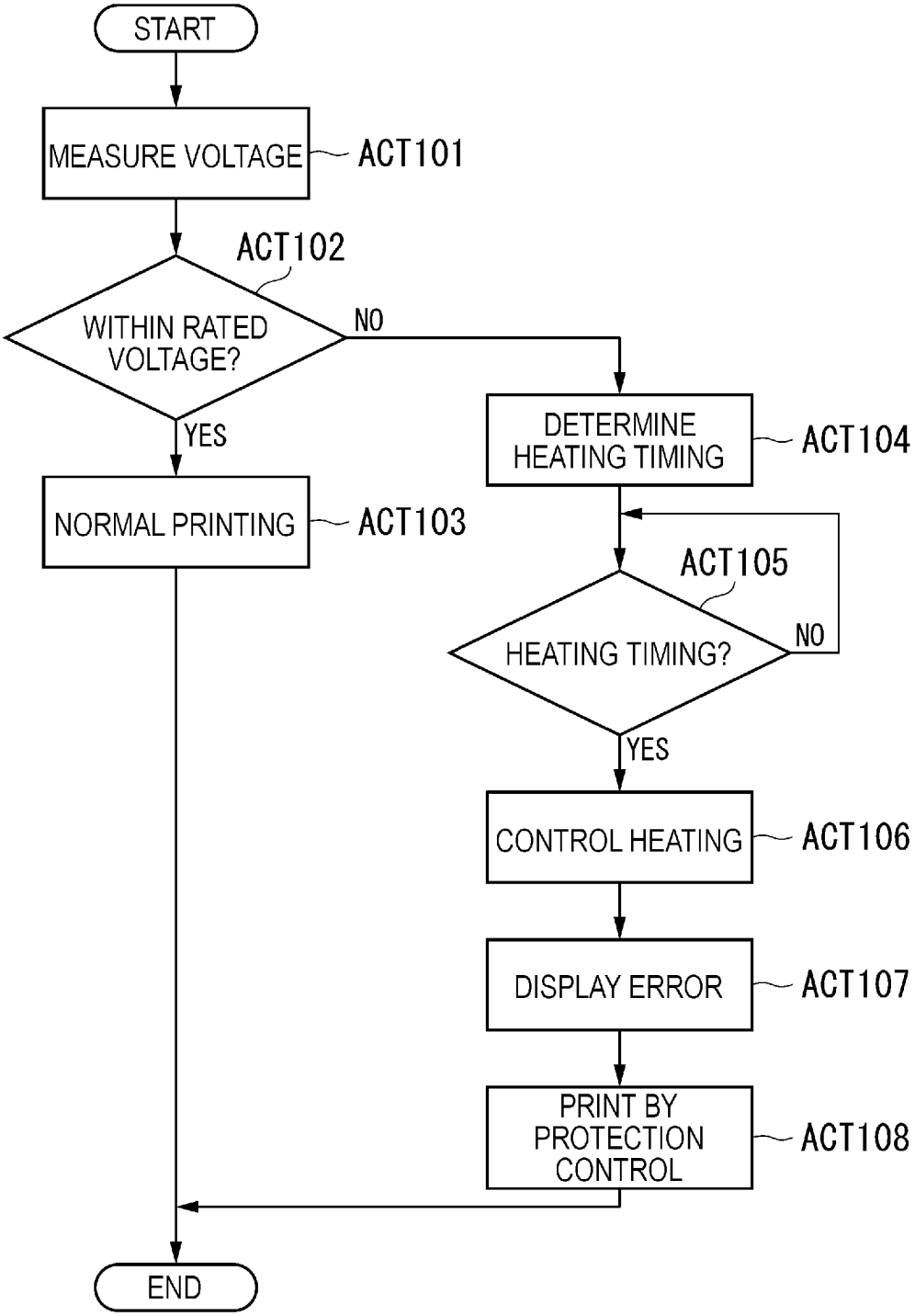

START
MEASURE VOLTAGE
ACT101
ACT102
WITHIN RATED VOLTAGE?
NO
YES
NORMAL PRINTING
ACT103
DETERMINE HEATING TIMING
ACT104
ACT105
HEATING TIMING?
NO
YES
CONTROL HEATING
ACT106
DISPLAY ERROR
ACT107
PRINT BY PROTECTION CONTROL
ACT108
END

FIG. 4

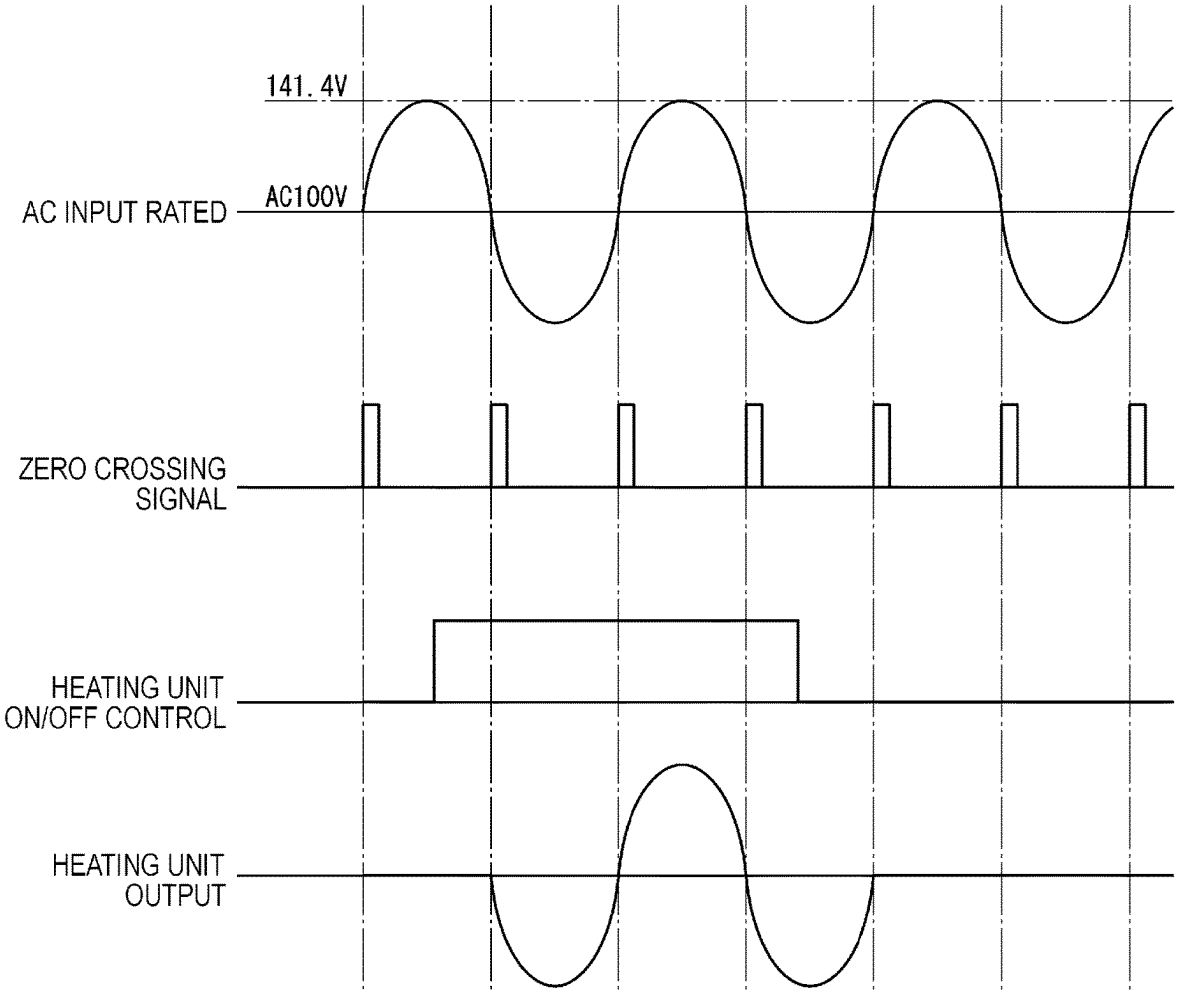
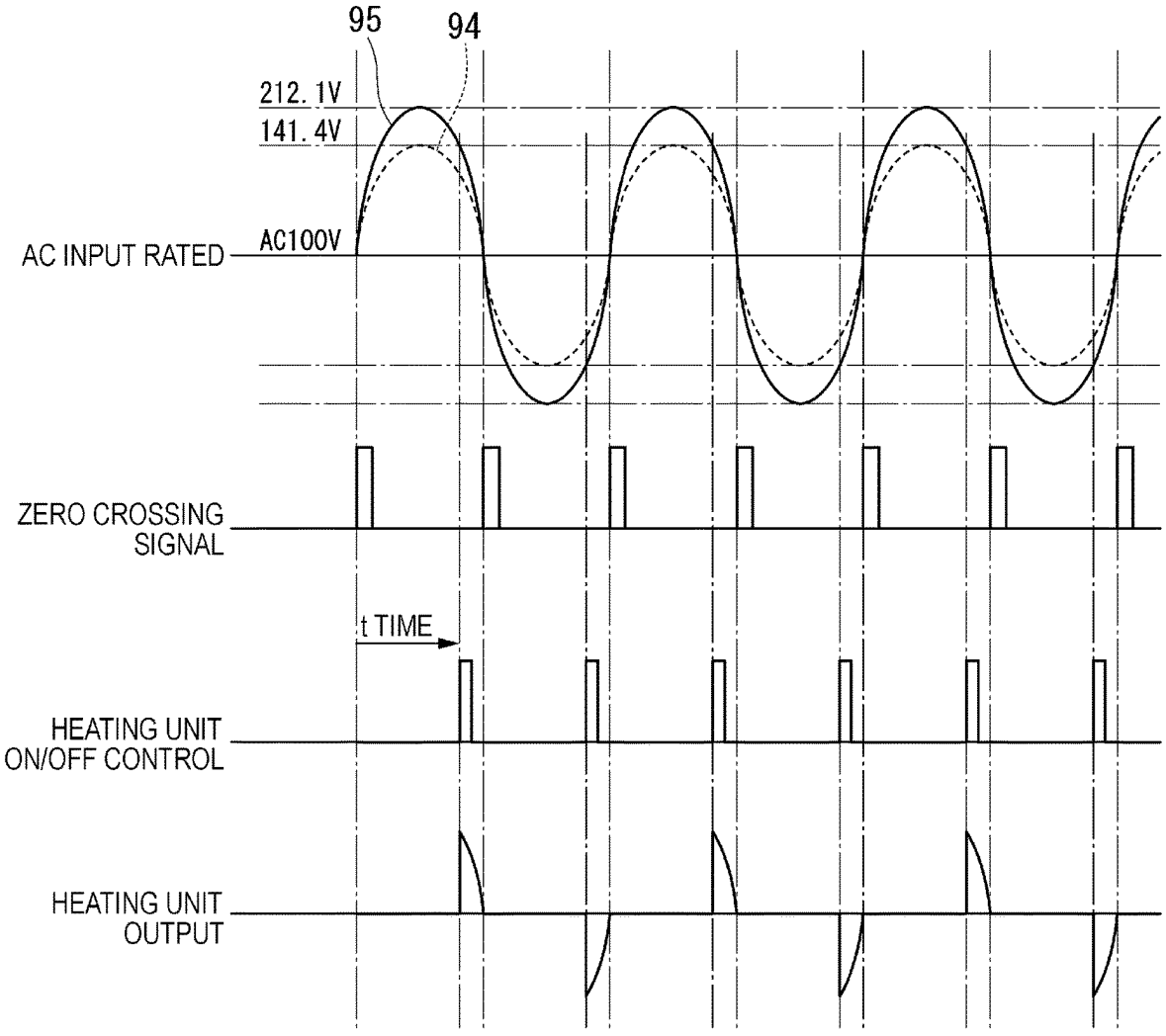

141.4V
AC100V
AC INPUT RATED
ZERO CROSSING SIGNAL
HEATING UNIT ON/OFF CONTROL
HEATING UNIT OUTPUT

FIG. 5


95
94
212.1V
141.4V
AC100V
AC INPUT RATED
ZERO CROSSING SIGNAL
t TIME
HEATING UNIT ON/OFF CONTROL
HEATING UNIT OUTPUT

# IMAGE FORMING APPARATUS

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims the benefit of priority from U.S. patent application Ser. No. 17/837,758, filed on Jun. 10, 2022 and U.S. patent application Ser. No. 17/233,749, filed on Apr. 19, 2021, now issued as U.S. Pat. No. 11,385,579, which is based on and claims the benefit of priority from Japanese Patent Application No. 2020-131496, filed on Aug. 3, 2020, the entire contents of each of which are incorporated herein by reference.

## FIELD

Embodiments described herein relate generally to an image forming apparatus.

## BACKGROUND

A heater of a fixing device in an image forming apparatus may be damaged if a high voltage higher than the product rating is received by the fixing device. Therefore, in a related art, when a high voltage higher than the product rating is input, the heating unit of the fixing device is protected by making the machine unusable.

However, if the machine becomes unusable, the printing operation cannot be continued, which may reduce the printing efficiency.

## DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram showing an overall configuration example of an image forming apparatus of at least one embodiment;

FIG. **2** is a block diagram showing a hardware configuration;

FIG. **3** is a flowchart showing a flow of printing control processing performed by the image forming apparatus according to at least one embodiment;

FIG. **4** is a diagram for illustrating the operation of the image forming apparatus when the input voltage is rated; and

FIG. **5** is a diagram for illustrating the operation of the image forming apparatus when the input voltage is high.

## DETAILED DESCRIPTION

The present disclosure describes at least one embodiment of an image forming apparatus that can be capable of suppressing a decrease in printing efficiency while protecting a heating unit of a fixing device at the time of high voltage input.

In general, according to at least one embodiment, the image forming apparatus includes a voltage measuring unit (e.g., a voltage measuring device), a fixing device, and a control unit (e.g., a controller). The voltage measuring unit measures the input voltage. The fixing device includes a heating unit (e.g., a heater) that heats the sheet. When the measured voltage becomes equal to or higher than a threshold value, the control unit determines a heating timing of the heating unit based on the voltage and controls the heating unit to be heated at the determined heating timing.

Hereinafter, the image forming apparatus of at least one embodiment will be described with reference to the drawings.



FIG. **1** is a diagram showing an overall configuration example of an image forming apparatus **1** of at least one embodiment. The image forming apparatus **1** of at least one embodiment is a multifunction peripheral (MFP). The image forming apparatus **1** executes printing by an image forming process and an image fixing process. The image forming process is a process of forming an image on a sheet. The image fixing process is a process for fixing the image formed on a sheet. The sheet is, for example, paper on which characters, images, and the like are formed. The sheet may be any material as long as the image forming apparatus **1** can form an image thereon.

The image forming apparatus **1** includes an image reading unit **10** (e.g., an image reader), a control panel **20**, an image forming unit **30** (e.g., an image forming device), a sheet storage unit **40** (e.g., a sheet storage device), a fixing device **50**, conveyance rollers **611** and **612**, sheet discharge rollers **621** and **622**, a control device **70**, and a control board **90**.

The image reading unit **10** reads the image on the document based on brightness and darkness of light. For example, the image reading unit **10** reads an image printed on a sheet set on a document reading table. The image reading unit **10** records the read image information. The recorded image information may be transmitted to another information processing device via a network. The recorded image information may be image-formed on a sheet by the image forming unit **30** as print data.

The control panel **20** includes a display unit (e.g., a display) and an operation unit (e.g., an operation device). The display unit is a display device such as a liquid crystal display and an organic electro luminescence (EL) display. The display unit displays various information regarding the image forming apparatus **1** according to the control of the control device **70**. The operation unit includes a plurality of buttons and the like. The operation unit receives the operations of the user. For example, the operation unit receives a printing execution instruction. The operation unit outputs a signal corresponding to the operation performed by the user to the control device **70**. The display unit and the operation unit may be configured as an integrated touch panel.

The image forming unit **30** executes the image forming process. Specifically, the image forming unit **30** forms an image on a sheet based on the image information generated by the image reading unit **10** or the image information received via a communication path. For example, the image forming unit **30** forms a toner image on a sheet with toner.

The image forming unit **30** includes a transfer belt **31**, an exposure unit **32** (e.g., an exposure device), a plurality of developing devices **33** (developing devices **331**, **332**, **333**, and **334**), a plurality of photoconductor drums **34** (photoconductor drums **341**, **342**, **343**, and **344**), and a transfer unit **35** (e.g., a transfer device).

The transfer belt **31** is an endless intermediate transfer body. The transfer belt **31** rotates in the direction indicated by the arrow (counterclockwise) due to the rotation of the roller.

The exposure unit **32** is provided at a position facing the photoconductor drum **34** between the developing device **33** and the charging device (not shown). The exposure unit **32** irradiates the surfaces (e.g., photoconductor layer) of each of the photoconductor drums **341**, **342**, **343**, and **344** with a laser beam based on image information. The direction in which the laser beam scans the photoconductor drum is the main scanning direction, and the direction orthogonal to the main scanning direction is the sub-scanning direction. For example, in at least one embodiment, the main scanning direction coincides with the axial direction of the photocon-

ductor drum, and the sub-scanning direction coincides with the rotation direction of the transfer belt.

By the irradiation of the laser beam, the electric charge on the surface (e.g., photoconductor layer) of each of the photoconductor drums **341**, **342**, **343**, and **344** disappears. As a result, an electrostatic pattern is formed on the surfaces of the photoconductor drums **341**, **342**, **343**, and **344** at the positions irradiated with the laser beam. That is, an electrostatic latent image is formed on the surfaces of the photoconductor drums **341**, **342**, **343**, and **344** by the irradiation of the laser beam by the exposure unit **32**. The exposure unit **32** may use light emitting diode (LED) light instead of the laser light.

The developing devices **331**, **332**, **333**, and **334** supply toner to the photoconductor drums **341**, **342**, **343**, and **344**. For example, the developing device **331** develops an electrostatic latent image on the surface of the photoconductor drum **341** with yellow (Y). Further, the developing device **332** develops an electrostatic latent image on the surface of the photoconductor drum **342** with magenta (M). Further, the developing device **333** develops an electrostatic latent image on the surface of the photoconductor drum **343** with cyan (C). Further, the developing device **334** develops an electrostatic latent image on the surface of the photoconductor drum **344** with black (K) toner.

The developing devices **331**, **332**, **333**, and **334** form a toner image as a visible image on the photoconductor drums **341**, **342**, **343**, and **344**. The toner images formed on the photoconductor drums **341**, **342**, **343**, and **344** are transferred (primary transfer) onto the transfer belt **31** by a plurality of primary transfer rollers (not shown). The plurality of primary transfer rollers are provided at positions facing each of the photoconductor drums **341**, **342**, **343**, and **344** with the transfer belt **31** interposed therebetween.

The transfer unit **35** includes a support roller **351** and a secondary transfer roller **352**. The transfer unit **35** transfers the toner image on the transfer belt **31** to a sheet **41** at a secondary transfer position U. The secondary transfer position U is a position where the support roller **351** and the secondary transfer roller **352** face each other with the transfer belt **31** interposed therebetween. The transfer unit **35** applies a transfer bias controlled by a transfer current to the transfer belt **31**. The transfer unit **35** transfers the toner image on the transfer belt **31** to the sheet **41** by the transfer bias. The transfer current is controlled by the control device **70**.

The sheet accommodating unit **40** includes a single or a plurality of sheet feed cassettes. The sheet feed cassette stores a predetermined size and a predetermined type of sheets **41**. The sheet feed cassette is provided with a pickup roller. The pickup roller picks up the sheets **41** one by one from the sheet feed cassette. The pickup roller supplies the picked-up sheet **41** to a conveyance unit **80** (e.g., a conveyance device).

The fixing device **50** executes the image fixing process. Specifically, the fixing device **50** fixes an image (for example, a toner image) formed on the sheet **41** by heating and pressurizing the sheet **41**. The fixing device **50** includes a heating unit (e.g., a heater) that heats the sheet **41**. The heating unit is, for example, of a halogen lamp type, an induction heating (IH) type, or a planar heater type. The planar heater is a heater provided with a heat-generating resistor on the surface thereof.

The conveyance rollers **611** and **612** supply the sheet **41** fed from the sheet feed cassette to the image forming unit **30**. The conveyance rollers **611** and **612** are installed at opposite positions.

The sheet discharge rollers **621** and **622** discharges the sheet **41** on which the image is formed by the fixing device **50** to the discharge unit. The sheet discharge rollers **621** and **622** are installed at opposite positions.

The control device **70** controls each functional unit of the image forming apparatus **1**.

The conveyance unit **80** conveys the sheet **41**. The conveyance unit **80** includes a conveyance path and a plurality of rollers (not shown). The conveyance path is a path through which the sheet **41** is conveyed. The roller conveys the sheet **41** by rotating according to the control of the control device **70**.

The control board **90** controls the heating of the heating unit of the fixing device **50** according to the control of the control device **70**. Controlling the heating of the heating unit means controlling to heat the heating unit (e.g., activating the heater) or controlling to stop the heating of the heating unit (e.g., deactivating the heater).

FIG. **2** is a block diagram showing a hardware configuration of the image forming apparatus **1** of at least one embodiment. FIG. **2** shows only the characteristic hardware configuration of the image forming apparatus **1** in at least one embodiment.

The image forming apparatus **1** includes the image reading unit **10**, the control panel **20**, the image forming unit **30**, the sheet storage unit **40**, the fixing device **50**, the control device **70**, the control board **90**, an auxiliary storage device **120**, and a network interface **130**. Each functional unit is connected to be capable of data communication via a system bus **11**.

Since the specific configurations of the image reading unit **10**, the control panel **20**, the image forming unit **30**, the sheet storage unit **40**, and the fixing device **50** were described, the description thereof will be omitted. Hereinafter, the control device **70**, the control board **90**, the auxiliary storage device **120**, and the network interface **130** will be described.

The control board **90** includes a voltage detection circuit **91**, a zero crossing detection circuit **92**, and a heating control board **93**.

The voltage detection circuit **91** measures the voltage input to the image forming apparatus **1**. The voltage detection circuit **91** may measure the voltage for each job or may measure the voltage at a predetermined timing. The predetermined timing may be, for example, the timing at which the power of the image forming apparatus **1** is turned on, or the timing at which the predetermined time is reached. The voltage detection circuit **91** outputs the measured voltage value to the control device **70**. The voltage detection circuit **91** is an aspect of the voltage measuring unit.

The zero crossing detection circuit **92** detects the zero crossing point of the AC voltage input from the power supply. Zero crossing point detection is to detect the timing when the voltage of the AC power supply passes through zero volts. The zero crossing detection circuit **92** outputs a zero crossing signal indicating that the zero crossing point is detected to the control device **70** each time the zero crossing point is detected.

The heating control board **93** is a switching element that controls the power supply to the fixing device **50**. The heating control board **93** is, for example, a triac. The heating control board **93** can switch between an ON state and an OFF state based on a control signal transmitted from the control device **70**. When the heating control board **93** is in the ON state, the heating control board **93** and the fixing device **50** are electrically connected, and thus, power is supplied to the fixing device **50**. On the other hand, when the heating control board **93** is in the OFF state, the heating

control board **93** and the fixing device **50** are not electrically connected, and thus, power is not supplied to the fixing device **50**. The heating control board **93** is a non-zero crossing type triac. The non-zero crossing type can be turned on when a control signal is input, even at a point not near the alternating current zero volts.

The control device **70** includes a control unit **71** (e.g., a controller), a Read Only Memory (ROM) **72**, and a Random Access Memory (RAM) **73**. The control unit **71** is, for example, a processor such as a Central Processing Unit (CPU) or a Graphics Processing Unit (GPU). The control unit **71** controls the operation of each functional unit of the image forming apparatus **1**. The control unit **71** executes various processes by loading the program stored in the ROM **72** into the RAM **73** and executing the program. The Application Specific Integrated Circuit (ASIC) may have an appropriate function realized by the control unit **71**. The ASIC is a dedicated circuit for realizing a specific function.

The control unit **71** controls the heating unit to be heated (e.g., activates the heater) at the heating timing of the heating unit based on the voltage when the voltage measured by the voltage detection circuit **91** exceeds a threshold value. Here, the threshold value is a value higher than the rated voltage defined by the image forming apparatus **1**. The heating timing of the heating unit based on the voltage is the timing at which the time obtained from the voltage measured by the voltage detection circuit **91** elapsed. The control unit **71** controls the heating unit to be heated when the heating timing is reached, with reference to the zero crossing point detected by the zero crossing detection circuit **92**. The control unit **71** controls the heating unit to be heated where the heating timing is after the peak of the AC voltage input from the power source.

When the voltage measured by the voltage detection circuit **91** exceeds the threshold value, the control unit **71** executes the sheet printing process by a protection control. The protection control is a printing control that reduces the efficiency of the printing operation. There is also a limit to the power that can be used when operating with the protection control. Therefore, the control unit **71** performs one or more controls of the following (1) to (4) as the printing control that reduces the efficiency of the printing operation. Which control is to be performed may be set by the user at the time of printing or may be set in advance.

(1) Control for making the sheet conveyance speed slower than the normal conveyance speed
(2) Control for reducing the density during printing
(3) Control that enables printing of a specific sheet type
(4) Control that enables single-color printing

The normal time is a case where no abnormality occurs in the image forming apparatus **1**. Information on the sheet conveyance speed at the normal time and the sheet conveyance speed at the time of making it slower than the normal time is set in advance. The control for reducing the density at the time of printing is a control for printing at a density lower than the density set at the time of printing. The control that enables printing of a specific sheet type is a control that enables printing of only some types of sheets. For example, the control enables printing on plain paper and disables printing on thick paper. The control that enables single-color printing is a control that enables monochrome printing and disables color printing.

When the control unit **71** executes the sheet printing process by the protection control, the control panel **20** displays that the sheet printing process by the protection control is being executed.

The ROM **72** stores a program for operating the control unit **71**. The RAM **73** is a memory for temporarily storing data used by each functional unit included in the image forming apparatus **1**. The RAM **73** may store the digital data generated by the image reading unit **10**. The RAM **73** may temporarily store jobs and job logs.

The auxiliary storage device **120** is, for example, a hard disk or a solid state drive (SSD) and stores various data. The various data are, for example, digital data, jobs, job logs, and the like.

The network interface **130** transmits and receives data to and from other devices. Here, the other device is an information processing device such as a personal computer. The network interface **130** operates as an input interface and receives print data or instructions transmitted from other devices. Instructions transmitted from other devices include printing execution instructions and the like. In addition, the network interface **130** operates as an output interface and transmits data to other devices.

FIG. **3** is a flowchart showing the method of printing control processing performed by the image forming apparatus **1** in at least one embodiment. The processing shown in FIG. **3** is executed when a printing execution instruction is given to the image forming apparatus **1**.

The voltage detection circuit **91** measures the input voltage (ACT **101**). The voltage detection circuit **91** outputs the measured voltage value information to the control device **70**. The control unit **71** of the control device **70** determines whether or not the voltage value is within the rated voltage based on the voltage value information (ACT **102**). If the voltage value is within the rated voltage (ACT **102**: YES), an abnormally high voltage is not input to the image forming apparatus **1**. Therefore, the image forming apparatus **1** performs normal printing (ACT **103**). Specifically, the control unit **71** controls the image forming unit **30** and the fixing device **50** to execute printing for which an execution instruction is given.

If the voltage value is not within the rated voltage (ACT **102**: NO), it means that a voltage equal to or higher than the threshold value was input to the image forming apparatus **1**. Therefore, the control unit **71** determines a heating timing based on the input voltage value (e.g., a voltage equal to or higher than the threshold value) (ACT **104**). A method for determining the heating timing will be described. First, the control unit **71** calculates the maximum value based on the input voltage value. For example, when the rating of the AC voltage is 100 (V), the maximum value can be obtained based on the following Equation (1).

$$\text{Maximum value}=100\times\sqrt{2}=141.1(V) \quad \text{Equation (1)}$$

The instantaneous value of the sine wave of the AC voltage can be obtained based on the following Equation (2).

$$\text{Instantaneous value}=\text{maximum value}\times\sin\omega t \quad \text{Equation (2)}(\omega=2\pi f, f=50\ \text{Hz})$$

By transforming Equation (2), Equation (3) can be obtained.

$$\sin\omega t=\text{Instantaneous value/Maximum value}=(\text{Abnormal voltage}\times\sqrt{2})/141.1 \quad \text{Equation (3)}$$

By transforming Equation (3), Equation (4) is obtained.

$$t=\sin^{-1}\times 2\pi f\times(\text{Abnormal voltage}\times\sqrt{2})/141.1 \quad \text{Equation (4)}$$

The abnormal voltage shown in Equations (3) and (4) is a value of a voltage (V) equal to or higher than the threshold value input to the image forming apparatus **1**. The control unit **71** determines the heating timing to be the timing at which the time t elapses, which is determined by Equation (4), with reference to the zero crossing point. After that, the

control unit **71** determines whether or not the heating timing was reached (ACT **105**). A zero crossing signal output is input to the control unit **71** every time the zero crossing detection circuit **92** detects a zero crossing point. Therefore, the control unit **71** determines whether or not the heating timing is reached based on the zero crossing signal input after determining the heating timing. Specifically, the control unit **71** determines that the heating timing was reached when the time t elapsed since the zero crossing signal was input, with reference to the input zero crossing signal. On the other hand, the control unit **71** determines that the heating timing was not reached when the time t did not elapse since the zero crossing signal was input, with reference to the input zero crossing signal.

If the heating timing was not reached (ACT **105**: NO), the control unit **71** waits until the heating timing is reached.

On the other hand, when the heating timing is reached (ACT **105**: YES), the control unit **71** controls the heating of the fixing device **50** by outputting a control signal to the heating control board **93** (ACT **106**). Specifically, when a control signal is input to the heating control board **93**, the heating control board **93** and the fixing device **50** are electrically connected. As a result, power is supplied to the fixing device **50** to heat the heating unit (e.g., activate the heater).

The control unit **71** controls the control panel **20** and displays an error (ACT **107**). For example, the control unit **71** causes the control panel **20** to display a notification indicating that protective printing due to a voltage abnormality is in progress. The control unit **71** executes a printing operation under protection control (ACT **108**). Since the heating control board **93** has an avalanche breakdown, the control unit **71** outputs a control signal for turning off the heating control board **93** before zero crossing.

FIG. **4** is a diagram for illustrating the operation of the image forming apparatus **1** when the input voltage is rated. FIG. **5** is a diagram for illustrating the operation of the image forming apparatus **1** when the input voltage is a high voltage (a voltage larger than the rated voltage).

As shown in FIG. **4**, when the input voltage is rated (for example, 100 V), the printing process is executed without protection control. Therefore, the printing operation is continuously performed as shown in the heating unit ON and OFF control. On the other hand, as shown in FIG. **5**, when the input voltage is high, the image forming apparatus **1** controls the heating unit to be heated (e.g., activates) at the timing when time t elapses with reference to the zero crossing signal. Then, the image forming apparatus **1** stops the heating of the heating unit before the next zero crossing. As described above, when the input voltage is high, the image forming apparatus **1** periodically switches between the ON control and the OFF control of the heating unit to perform the printing operation. FIG. **5** shows the waveform **94** of the AC voltage at the time of rated voltage and the waveform **95** of the AC voltage at the time of high voltage.

According to the image forming apparatus **1** configured as described above, it is possible to suppress a decrease in printing efficiency while protecting the heating unit of the fixing device **50** at the time of high voltage input. Specifically, first, the image forming apparatus **1** determines the heating timing of the heating unit based on the voltage when the measured voltage becomes equal to or higher than the threshold value. The image forming apparatus **1** controls the heating unit to be heated at a determined heating timing. In this way, the image forming apparatus **1** determines the heating timing of the heating unit based on the input voltage. Then, the image forming apparatus **1** does not execute the printing process immediately even if the printing instruction is input, and does not print until the determined heating timing is reached. As a result, even when an abnormally high voltage whose input voltage exceeds the product rating is input, an abnormal voltage is not applied to the heating unit (for example, a heater) of the fixing device. Therefore, it is possible to prevent damage to the heating unit of the fixing device. Further, the image forming apparatus **1** prints when the determined heating timing is reached. Therefore, even if the input voltage is an abnormally high voltage, the heating unit of the fixing device can be heated, and thus, the printing operation can be executed although the full performance is not achieved. In this way, the image forming apparatus **1** can suppress a decrease in printing efficiency while protecting the heating unit of the fixing device **50** at the time of high voltage input.

The image forming apparatus **1** includes the zero crossing detection circuit **92** that detects a zero crossing point of an AC voltage. Then, the image forming apparatus **1** controls the heating unit to be heated when the heating timing is reached, with reference to the zero crossing point detected by the zero crossing detection circuit **92**. In this way, the image forming apparatus **1** can control the heating unit to be heated at the timing when the same time elapses from the zero crossing point by using the zero crossing point as a reference. Therefore, printing can be performed based on substantially the same voltage. Therefore, printing unevenness can be reduced.

The image forming apparatus **1** controls the heating of the heating unit at the timing after the peak of the AC voltage input from the power source as the heating timing. For example, the image forming apparatus **1** controls the heating of the heating unit at the timing when the absolute value of the voltage waveform becomes equal to or lower than the voltage rated by the product. By performing such control, it is possible to prevent damage to the heating unit even when a high voltage is input.

When the voltage measured by the voltage detection circuit **91** exceeds the threshold value, the image forming apparatus **1** executes the sheet printing process by performing printing control that reduces the efficiency of the printing operation. As a result, although the performance is reduced, the printing operation can be continuously executed. Therefore, it becomes possible to improve convenience.

The image forming apparatus **1** performs one or more controls of the above (1) to (4) as a printing control that reduces the efficiency of the printing operation. As a result, although the performance is reduced, the printing operation can be continuously executed. Therefore, it becomes possible to improve convenience.

When the input voltage is abnormal, if a step-down circuit is provided in all stages to protect the heating unit, the cost will increase. On the other hand, in the image forming apparatus **1** of at least one embodiment, this control can be realized by combining the voltage detection circuit **91** and the zero crossing detection circuit **92** provided in the image forming apparatus **1**. Therefore, an increase in product cost can be suppressed.

If the pattern width is widened in order to increase the pressure resistance of the heating unit, it will heat other than the nip part, which will not save energy. The cost becomes higher. On the other hand, since the image forming apparatus **1** is a control that operates when an abnormal voltage is input, the image forming apparatus **1** operates in a normal state when a voltage at the product rating is input, which does not affect the fixing control. Therefore, it is possible to take advantage of TPH.

Hereinafter, a modification of the image forming apparatus **1** will be described.

In the above description, the voltage detection circuit **91**, the zero crossing detection circuit **92**, and the heating control board **93** are configured to be provided in the control board **90**. The voltage detection circuit **91**, the zero crossing detection circuit **92**, and the heating control board **93** may be individually provided in the image forming apparatus **1**.

A part of the functions of the image forming apparatus **1** in at least one embodiment may be realized by a computer. In that case, the program for realizing this function is recorded on a computer-readable recording medium. Then, the program recorded on the recording medium on which the above-mentioned program was recorded may be read into a computer system and executed. The term "computer system" as used herein includes an operating system and hardware such as peripheral devices. Further, the "computer-readable recording medium" refers to a portable medium, a storage device, or the like. The portable medium is a flexible disk, a magneto-optical disk, a ROM, a CD-ROM, or the like. The storage device is a hard disk or the like built in a computer system. Further, the "computer-readable recording medium" is a medium that dynamically holds a program for a short period of time, such as a communication line when a program is transmitted via a communication line. The communication line is a network such as the Internet, a telephone line, or the like. Further, the "computer-readable recording medium" may be a volatile memory inside a computer system serving as a server or a client. The volatile memory holds a program for a certain period of time. Further, the above program may be for realizing a part of the above-mentioned functions. Further, the above program may further realize the above-mentioned functions in combination with a program already recorded in the computer system.

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

What is claimed is:

**1**. An image forming apparatus comprising:
- a heater configured to generate heat;
- a voltage detection circuit configured to measure a voltage of AC power input to the image forming apparatus; and
- a controller configured to:
  - determine a part of the measured voltage of AC power input that exceeds a threshold voltage; and
  - periodically switch AC power to the heater between an ON state and an OFF state according to the determination,
- wherein the controller periodically switches AC power to the heater between the ON state and the OFF state so that the part of the measured voltage of AC power which exceeds the threshold voltage is not applied to the heater.

**2**. The apparatus of claim **1**, further comprising a zero crossing detection circuit which outputs a zero crossing signal indicating that a zero crossing point in voltage in the AC power is detected,
- wherein the controller controls the AC power so that the AC power is not applied to the heater, after the zero crossing signal is output, while the AC power exceeds the threshold voltage.

**3**. The apparatus of claim **1**, further comprising a zero crossing detection circuit which outputs a zero crossing signal indicating that a zero crossing point in voltage in the AC power is detected,
- wherein the controller controls the AC power so that the AC power is not applied to the heater, after the zero crossing signal is output and a peak of the AC power, while the AC power exceeds the threshold voltage.

**4**. The apparatus of claim **1**, further comprising a zero crossing detection circuit which outputs a zero crossing signal indicating that a zero crossing point in voltage in the AC power is detected,
- wherein the controller controls the AC power so that the AC power is not applied to the heater, after the zero crossing signal is output and a peak of the AC power, before the AC power becomes lower than the threshold voltage.

**5**. The apparatus of claim **1**, further comprising a zero crossing detection circuit which outputs a zero crossing signal indicating that a zero crossing point in voltage in the AC power is detected,
- wherein the controller determines a timing at which the AC power becomes lower than the threshold voltage after the zero crossing signal is output and the AC power becomes higher than the threshold voltage, and
- the controller controls the AC power so that the AC power is not applied to the heater from when the zero crossing signal is output to the timing.

**6**. The apparatus of claim **1**, further comprising a zero crossing detection circuit which outputs a zero crossing signal each time a zero crossing point in voltage in the AC power is detected,
- wherein the controller controls the AC power so that the AC power is not applied to the heater, each time after the zero crossing signal is output and a peak of the AC power, while the AC power exceeds the threshold voltage.

**7**. The apparatus of claim **1**, further comprising a zero crossing detection circuit which outputs a zero crossing signal each time a zero crossing point in voltage in the AC power is detected,
- wherein the controller controls the AC power so that the AC power is not applied to the heater, each time after the zero crossing signal is output and a peak of the AC power, before the AC power becomes lower than the threshold voltage.

**8**. The apparatus of claim **1**, further comprising a zero crossing detection circuit which outputs a zero crossing signal each time a zero crossing point in voltage in the AC power is detected,
- wherein the controller determines a timing at which the AC power becomes lower than the threshold voltage after the zero crossing signal is output and the AC power becomes higher than the threshold voltage, and
- the controller controls the AC power so that the AC power is not applied to the heater each time from when the zero crossing signal is output to the timing.

**9**. The apparatus of claim **1**, wherein the heater is a planar heater having a heat- generating resistor.

**10**. A method of heater control performed by an image forming apparatus, the method comprising:
- generating heat, via a heater;

measuring, by a voltage detection circuit, a voltage of AC power input to the image forming apparatus;

determining a part of the measured voltage of AC power input exceeds a threshold voltage; and

periodically switching AC power to the heater between an ON state and an OFF state according to the determination, wherein AC power is periodically switched between the ON state and the OFF state so that the part of the measured voltage of AC power which exceeds the threshold voltage is not applied to the heater.

**11**. The method of claim **10**, further comprising:

outputting a zero crossing signal indicating that a zero crossing point in voltage in the AC power is detected,

wherein in the step of controlling the AC power to the heater, the AC power is not applied to the heater, after the zero crossing signal is output, while the AC power exceeds the threshold voltage.

**12**. The method of claim **10**, further comprising:

outputting a zero crossing signal indicating that a zero crossing point in voltage in the AC power is detected,

wherein in the step of controlling the AC power to the heater, the AC power is not applied to the heater, after the zero crossing signal is output and a peak of the AC power, while the AC power exceeds the threshold voltage.

**13**. The method of claim **10**, further comprising:

outputting a zero crossing signal indicating that a zero crossing point in voltage in the AC power is detected,

wherein in the step of controlling the AC power to the heater, the AC power is not applied to the heater, after the zero crossing signal is output and a peak of the AC power, before the AC power becomes lower than the threshold voltage.

**14**. The method of claim **10**, further comprising:

outputting a zero crossing signal indicating that a zero crossing point in voltage in the AC power is detected;

determining a timing at which the AC power becomes lower than the threshold voltage after the zero crossing signal is output and the AC power becomes higher than the threshold voltage,

wherein in the step of controlling the AC power to the heater, the AC power is not applied to the heater from when the zero crossing signal is output to the timing.

**15**. The method of claim **10**, further comprising:

outputting a zero crossing signal each time a zero crossing point in voltage in the AC power is detected,

wherein in the step of controlling the AC power to the heater, the AC power is not applied to the heater, each time after the zero crossing signal is output and a peak of the AC power, while the AC power exceeds the threshold voltage.

**16**. The method of claim **10**, further comprising:

outputting a zero crossing signal each time a zero crossing point in voltage in the AC power is detected,

wherein in the step of controlling the AC power to the heater, the AC power is not applied to the heater, each time after the zero crossing signal is output and a peak of the AC power, before the AC power becomes lower than the threshold voltage.

**17**. The method of claim **10**, further comprising:

outputting a zero crossing signal each time a zero crossing point in voltage in the AC power is detected; and

determining a timing at which the AC power becomes lower than the threshold voltage after the zero crossing signal is output and the AC power becomes higher than the threshold voltage,

wherein in the step of controlling the AC power to the heater, the AC power is not applied to the heater each time from when the zero crossing signal is output to the timing.

**18**. The method of claim **10**, wherein the heater is a planar heater having a heat- generating resistor.

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