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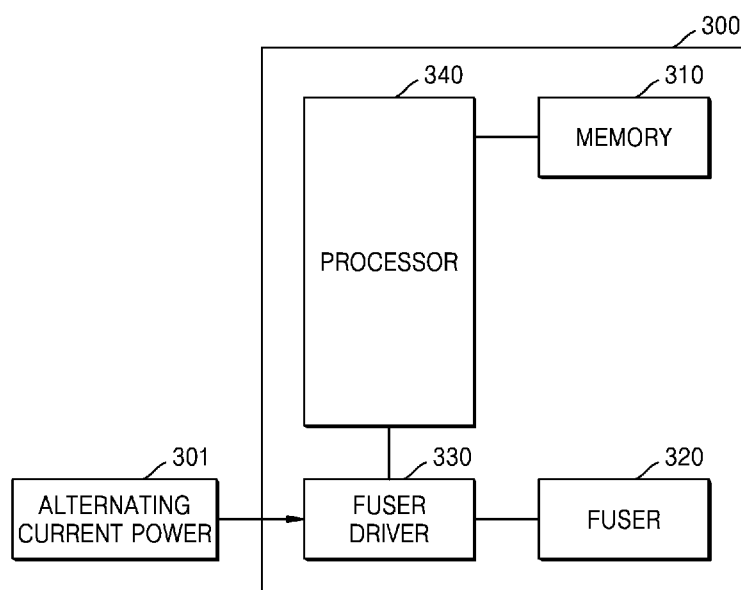
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(54) Title: CONTROLLING DRIVER TO SUPPLY POWER



(57) Abstract: An image forming apparatus and method for controlling a fuser driver that supplies power to a fuser are provided. The image forming apparatus performs wave number control and phase control with respect to input alternating current power, and supplies power to the fuser. In an example, the image forming apparatus controls the fuser driver so as to alternately perform the wave number control and the phase control.



Description

Title of Invention: CONTROLLING DRIVER TO SUPPLY POWER

Background Art

- [1] A process of forming an image on a print medium in an image forming apparatus is as follows. First, when an electrostatic latent image is formed by exposing a photoreceptor, and a toner is supplied thereto, toner particles charged on a surface of the photoreceptor are distributed according to a form of the electrostatic latent image. Next, the toner particles on the surface of the photoreceptor are transferred to a print medium, and the toner particles transferred to the print medium are heated and/or pressed and thus are fused to the print medium. Thus, an image may be formed on the print medium.
- [2] In order to perform such a process, an image forming apparatus includes a fuser for heating and/or pressing toner particles transferred to a print medium and fusing the toner particles.

Disclosure of Invention

Solution to Problem

- [3] An image forming apparatus and method for controlling a fuserdriver that supplies power to a fuser are provided. The image forming apparatus performs wave number control and phase control with respect to input alternating current power, and supplies power to the fuser. In an example, the image forming apparatus controls the fuserdriver so as to alternately perform the wave number control and the phase control.

Brief Description of Drawings

- [4] These and/or other aspects will become apparent and more readily appreciated from the following description of examples, taken in conjunction with the accompanying drawings in which:
- [5] FIG. 1 shows a structure of an image forming apparatus according to an example;
- [6] FIG. 2 shows a print unit according to an example;
- [7] FIG. 3 shows a structure of an image forming apparatus according to another example;
- [8] FIG. 4 shows a method of determining a control method according to a set duty, according to an example;
- [9] FIG. 5 shows a method of performing wave number control and phase control according to a set duty, according to an example;
- [10] FIG. 6 shows a fuser including two heaters according to an example;
- [11] FIG. 7 shows a duty table in an image forming apparatus including a fuser having

- two heaters according to an example;
- [12] FIG. 8 shows a method of performing wave number control and phase control according to a set duty in an image forming apparatus including a fuser having two heaters according to an example;
- [13] FIG. 9 shows a method of performing wave number control and phase control in a warm-up mode according to an example;
- [14] FIG. 10 shows a method of performing wave number control and phase control in a warm-up mode of an image forming apparatus including a fuser having two heaters according to an example; and
- [15] FIG. 11 is a flowchart of an operation method of an image forming apparatus according to an example.

Best Mode for Carrying out the Invention

- [16] An image forming apparatus comprises a fuser; a fuserdriver to perform at least one of wave number control or phrase control with respect to input alternating current power, and supply power to the fuser; a memory to store a program for controlling the fuserdriver; and a processor to control the fuserdriver so as to alternately perform the wave number control and the phrase control by executing the program stored in the memory.

Mode for the Invention

- [17] Various examples will now be described with reference to the accompanying drawings. The present examples may have different forms. A description of details widely known to those of ordinary skill in the art is omitted herein to more clearly explain features of the present examples. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. Expressions such as "at least one of," when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list.
- [18] It will be understood that, when an element is referred to as being "connected to" another element, the element can be directly connected to the other element or intervening elements may be present therebetween. When a portion "includes" an element, another element may be further included, rather than excluding the existence of the other element, unless otherwise described.
- [19] The term "image forming job" used herein may refer to image formation or various jobs (e.g., printing, scanning, or faxing) related to an image, for example, creation, storage, transmission, etc. of an image file. The term "job" may refer to not only an image forming job but also a series of processes required to perform the image forming job.
- [20] In addition, the term "image forming apparatus" may refer to all apparatuses, such as

a printer, a scanner, a fax machine, a multi-function printer (MFP), or a display, which are capable of performing an image forming job.

[21] In addition, the term "print data" may refer to data converted into a format able to be printed by a printer.

[22] In addition, the term "scan file" may refer to a file created by scanning an image in a scanner.

[23] In addition, the term "user" may refer to a person who performs manipulations related to an image forming job by using an image forming apparatus or a device connected to the image forming apparatus in a wired or wireless manner.

[24] FIG. 1 shows a structure of an image forming apparatus according to an example.

[25] Referring to FIG. 1, an image forming apparatus 100 may include an input/output (I/O) unit 110, a processor 120, a communicator 130, a memory 140, and an image forming job unit 150. Although not shown, the image forming apparatus 100 may further include other components such as a power supply for supplying power to each element of the image forming apparatus 100.

[26] The I/O unit 110 may include an input unit that receives, from a user, an input, etc. for performing an image forming job, and an output unit that displays a result of the image forming job, information regarding a state of the image forming apparatus 100, etc. For example, the I/O unit 110 may include an operation panel for receiving a user input, a display panel for showing a screen, etc.

[27] As an example, the input unit may include devices, such as, a keyboard, a physical button, a touch screen, a camera, a microphone, etc., which may receive various types of user inputs. Also, the output unit may include, for example, a display panel, a speaker, etc. However, the present disclosure is not limited thereto, and the I/O unit 110 may include a device that supports various inputs and outputs.

[28] The processor 120 may control operations of the image forming apparatus 100 and may include a processor such as a central processing unit (CPU). The processor 120 may control other elements included in the image forming apparatus 100 so as to perform operations corresponding to a user input received through the I/O unit 110.

[29] For example, the processor 120 may execute a program stored in the memory 140, read a file stored in the memory 140, store a new file in the memory 140, etc.

[30] The communicator 130 may perform wired/wireless communication with another device or a network. To this end, the communicator 130 may include a communication module that supports at least one of various wired/wireless communication methods. For example, the communication module may be a chipset, a sticker/a barcode (e.g., a sticker including a near field communication (NFC) tag), etc. including information required for communication.

[31] The wireless communication may include, for example, at least one of Wireless

Fidelity (Wi-Fi), Wi-Fi Direct, Bluetooth, Ultra Wide Band (UWB) and NFC. The wired communication may include, for example, at least one of a universal serial bus (USB) and a wired local area network (LAN) (Ethernet).

- [32] The communicator 130 may be connected to an external device outside the image forming apparatus 100 and may receive/transmit signals or data from/to the external device. The communicator 130 may transmit signals or data received from the external device to the processor 120 or may transmit signals or data generated in the processor 120 to the external device. For example, when the communicator 130 receives a print command signal and print data from the external device, the processor 120 may output the received print data through a print unit 151.
- [33] Programs such as applications and data such as files may be installed and stored in the memory 140. The processor 120 may access and use the data stored in the memory 140 or may store new data in the memory 140. Also, the processor 120 may execute the programs installed in the memory 140 and may install, in the memory 140, applications externally received through the communicator 130.
- [34] The image forming job unit 150 may perform an image forming job such as printing, scanning, copying, or faxing.
- [35] Referring to FIG. 1, the image forming job unit 150 includes the print unit 151, a scan unit 152, and a fax unit 153. However, according to necessity, the image forming job unit 150 may include only some of the print unit 151, the scan unit 152, and the fax unit 153 or may further include an element that performs another image forming job.
- [36] The print unit 151 may form an image on a recording medium by using various printing methods such as an electrophotography method, an inkjet method, a thermal transfer method, and a thermosensitive method. In an example, the print unit 151 may print an image on the recording medium through a series of processes including an exposing process, a developing process, a transfer process, and a fusing process. The print unit 151 will be further described with reference to FIG. 2.
- [37] FIG. 2 shows a print unit according to an example.
- [38] Referring to FIG. 2, the print unit 151 may include a photoreceptor 1511, a charger 1512, an exposure device 1513, a developer 1514, a transfer device 1515, and a fuser 1516. The print unit 151 may further include a paper feeder (not shown) that provides a recording medium P. An electrostatic latent image is formed on the photoreceptor 1511. The photoreceptor may be referred to as a photoconductive drum, a photoconductive belt, or the like, according to its type. The charger 1512 charges a surface of the photoreceptor 1511 to a constant electric potential. The charger 1512 may be embodied as a corona charger, a charging roller, a charging brush, or the like. The exposure device 1513 changes an electric potential of the surface of the photoreceptor 1511 based on information regarding an image to be printed, thereby forming the elec-

trostatic latent image on the surface of the photoreceptor 1511. For example, the exposure device 1513 irradiates light that is modulated based on the information regarding the image to be printed onto the photoreceptor 1511 so as to form the electrostatic latent image. The exposure device 1513 may be referred to as an optical scanner, or the like. The developer 1514 includes a developing agent therein and provides the developing agent to the electrostatic latent image, thereby developing the electrostatic latent image into a visible image. The developer 1514 may include a developing roller 1517 that provides the developing agent to the electrostatic latent image. For example, the developing agent may be provided from the developing roller 1517 to the electrostatic latent image formed on the photoreceptor 1511 due to a developing electric field between the developing roller 1517 and the photoreceptor 1511. The visible image formed on the photoreceptor 1511 is transferred to the recording medium P by the transfer device 1515. The transfer device 1515 may transfer the visible image to the recording medium P by using, for example, an electrostatic transfer method. The visible image is fixed to the recording medium P by electrostatic attraction. The fuser 1516 fixes the visible image to the recording medium P by applying heat and/or pressure to the visible image on the recording medium P. A printing job is processed through the above-described. In addition, although not illustrated in FIG. 2, the print unit 151 may include a fuser driver for driving the fuser 1516.

- [39] Referring again to FIG. 1, the scan unit 152 may irradiate light onto a document and may read an image recorded on the document by receiving light reflected from the document. A charge coupled device (CCD), a contact type image sensor (CIS), or the like may be used as an image sensor that reads the image from the document. The scan unit 152 may have a flatbed structure, in which a document is fixed at a certain location and an image is read from the document by a moving image sensor, a document-feed structure, in which an image sensor is fixed at a certain location and a document is moved relative thereto, or a combination thereof.
- [40] The fax unit 153 may share an element for scanning an image with the scan unit 152 and may share an element for printing a received file with the print unit 151. The fax unit 153 may transmit a scanned file to a destination or may externally receive a file.
- [41] FIG. 3 shows a structure of an image forming apparatus according to another example.
- [42] Referring to FIG. 3, an image forming apparatus 300 may include a memory 310, a fuser 320, a fuser driver 330, and a processor 340. The image forming apparatus 300 of FIG. 3 may be the same apparatus as the image forming apparatus 100 of FIG. 1, and the memory 310 and the processor 340 may also be the same elements as the memory 140 and the processor 120 of FIG. 1. Also, the fuser 320 may be the same element as

the fuser 1516 of FIG. 2. Accordingly, repeated descriptions thereof will be briefly provided below.

- [43] Programs such as applications and data such as files may be installed and stored in the memory 310. In an example, the memory 310 may store a program for controlling the fuser driver 330. In this regard, the program for controlling the fuser driver 330 may be installed in the memory 310. The processor 340 may execute the program for controlling the fuser driver 330, which is stored in the memory 310.
- [44] The fuser 320 applies heat and/or pressure to an image transferred to a recording medium and thus fixes the image to the recording medium. In an example, the fuser 320 may receive power supply from the fuser driver 330.
- [45] The fuser driver 330 may supply power to the fuser 320 in order to drive the fuser 320. In an example, the fuser driver 330 may perform wave number control and phase control with respect to input of alternating current power and thus may supply power to the fuser 320. In an example, the alternating current power may be supplied by an external power source 301.
- [46] The wave number control is a method by which a control cycle is set to be an integer multiple of a half cycle of alternating current power, which is supplied to the fuser 320, and a supply of the alternating current power (i.e., an on and off of the alternating current power) is controlled based on the half cycle of the alternating current power. The phase control is a method by which a phase angle of alternating current power, which is supplied to the fuser 320, is adjusted to control a supply of the alternating current power (i.e., an on and off of the alternating current power). In an example, the fuser driver 330 may alternately perform the wave number control and the phase control based on the half cycle of the alternating current power according to control by the processor 340.
- [47] The processor 340 controls operations of the image forming apparatus 300 and may control the fuser driver 330 by executing a program, which is stored in the memory 310, for controlling the fuser driver 330. In an example, the processor 340 may control the fuser driver 330 so as to alternately perform the wave number control and the phase control. In this regard, the processor 340 may control the fuser driver 330 so as to alternately perform the wave number control and the phase control based on the half cycle of the alternating current power.
- [48] The processor 340 may set a control cycle and a duty and may control the fuser driver 330 so as to perform the wave number control and the phase control according to the set control cycle and duty. In an example, the processor 340 may set the control cycle to be an even multiple of the half cycle of the alternating current power. In other words, the control cycle may be an integer multiple of one cycle of the alternating current power. According to an example, when the processor 340 sets the control cycle

to be an even multiple of the half cycle of the alternating current power and thus alternately performs the wave number control and the phase control based on the half cycle of the alternating current power, the wave number control and the phase control may be performed the same number of times.

- [49] Although not illustrated in FIG. 3, the image forming apparatus 300 may further include a temperature sensor for measuring a temperature of the fuser 320. The temperature sensor may measure a temperature of a fusing member included in the fuser 320. In an example, the processor 340 may set a target temperature of the fuser 320 according to the temperature of the fuser 320 measured by the temperature sensor and may set a control cycle and a duty according to the set target temperature.
- [50] In addition, although not illustrated in FIG. 3, the image forming apparatus 300 may further include a zero cross detector for detecting a zero cross point at which a voltage of the alternating current power is 0 V. In an example, the processor 340 may control the fuser driver 330 based on the zero cross point detected by the zero cross detector. That is, the processor 340 may determine a half cycle of input alternating current power based on the zero cross point.
- [51] The processor 340 may control the fuser driver 330 based on the zero cross point detected by the zero cross detector so as to perform the wave number control with respect to one preceding or following half cycle of the alternating current power and perform the phase control with respect to the other following or preceding half cycle where the wave number control is not performed. That is, the processor 340 may control the fuser driver 330 so as to alternately perform the wave number control and the phase control based on the zero cross point.
- [52] The processor 340 may determine a control method according to the set duty. In an example, the processor 340 may control the fuser driver 330 so as to perform the phase control when the set duty is greater than 0% and less than 50%, perform the wave number control when the set duty is 50%, and alternately perform the wave number control and the phase control when the set duty is greater than 50% and less than or equal to 100%. This will be described below with reference to FIGS. 4 and 5.
- [53] FIG. 4 shows a method of determining a control method according to a set duty, according to an example.
- [54] Referring to FIG. 4, the processor 340 may set a target temperature of the fuser 320 according to a measured temperature of the fuser 320, may set a control cycle for controlling the fuser 320 according to the set temperature, and may store the control cycle in a control cycle register 410. In an example, the processor 340 may set the control cycle to be an even multiple of a half cycle of alternating current power. In FIG. 4, two times of the half cycle of the alternating current power, that is, one cycle of the alternating current power, has been set as the control cycle by setting 2 as the control

cycle. Although FIG. 4 shows the control cycle stored in a register, the control cycle may be stored in the memory 310.

[55] The processor 340 may set a control cycle and generate a duty table 420 according to the set control cycle. As an example, the processor 340 generates the duty table 420 corresponding to a number of control cycles. In the example of FIG. 4, 2 is set as the control cycle, and thus, the duty table 420 is generated to input data regarding two half cycles. The processor 340 inputs a set duty to the duty table 420. Referring to FIG. 4, the processor 340 generates the duty table 420 to control the fuser driver 330 so as to perform phase control at a first phase 421 and control the fuser driver 330 so as to perform wave number control at a second phase 422. This is merely an example, and the fuser driver 330 may be controlled so as to perform the wave number control and then perform the phase control.

[56] In this regard, 100% may be set as a duty for the second phase 422 at which the wave number control is performed, and a duty (A) may be set within a range of 0~100% for the first phase 421 at which the phase control is performed. According to an example, the processor 340 may perform the phase control and/or the wave number control based on a half cycle. Accordingly, even though 100% is set as a duty for the second phase 422 at which the wave number control is performed, the wave number control is on during only the half cycle, and thus, 50% is set as a duty based on the entire control cycle. Likewise, even in a case of the phase control, although the duty (A) is set for the first phase 421 at which the phase control is performed, a half of the duty (A) is set as a duty based on the entire control cycle.

[57] The processor 340 may set the phase control duty (A) as shown below.

[58] 1) When a duty is 0 ~ 50% based on the entire control cycle: phase control duty (A) = set duty x 2

[59] 2) When a duty is 50% based on the entire control cycle: phase control duty (A) = 0 (no phase control)

[60] 3) When a duty is 50 ~ 100% based on the entire control cycle: phase control duty (A) = (set duty - 50) x 2

[61] Referring to FIG. 4, when a duty is greater than 0% and less than 50% based on the entire control cycle, the processor 340 allows the first phase 421 to be on and allows the second phase 422 to be off. That is, the processor 340 controls the fuser driver 330 so as to perform only the phase control. When the duty is 50% based on the entire control cycle, the processor 340 allows the first phase 421 to be off and allows the second phase 422 to be on. That is, the processor 340 controls the fuser driver 330 so as to perform only the wave number control. When the duty is greater than 50% and less than or equal to 100% based on the entire control cycle, the processor 340 allows both of the first phase 421 and the second phase 422 to be on. That is, the processor

340 controls the fuser driver 330 so as to alternately perform the wave number control and the phase control.

[62] The processor 340 stores phase control and wave number control settings according to a range of duty set by controlling the fuser driver 330 in a duty register 430.

[63] FIG. 5 shows a method of performing wave number control and phase control according to a set duty, according to an example.

[64] Referring to FIG. 5, the processor 340 controls the fuser driver 330 so as to perform phase control during a preceding half cycle of input alternating current power and perform wave number control during the following half cycle. However, this is merely an example, and the fuser driver 330 may be controlled so as to perform the wave number control during a preceding half cycle and perform the phase control during the following half cycle.

[65] Referring to FIG. 5, when a duty is greater than 0% and less than 50% based on the entire control cycle (510), the processor 340 controls the fuser driver 330 so as to perform only the phase control during a preceding half cycle. When the duty is 50% based on the entire control cycle (520), the processor 340 controls the fuser driver 330 so as to perform the wave number control during the following half cycle. When the duty is greater than 50% and less than or equal to 100% based on the entire control cycle (530), the processor 340 controls the fuser driver 330 so as to alternately perform the phase control and the wave number control by performing the wave number control during a preceding half cycle and performing the phase control during the following half cycle.

[66] When there is no suspension command of the processor 340, the fuser driver 330 may repeat performing operations according to the control cycle.

[67] According to an example, a change in current according to a lapse of time may be minimized by alternately performing the phase control and the wave number control, and thus, flicker characteristics may improve.

[68] FIG. 6 shows a fuser including two heaters according to an example.

[69] Referring to FIG. 6, the fuser 320 may be the same element as the fuser 320 of FIG. 3. A heater is an element for generating heat required to apply heat and/or pressure to an image transferred to a recording medium and thereby fix the image to the recording medium. In an example, the fuser 320 may include a plurality of heaters for heating different areas of a fusing member.

[70] Referring to FIG. 6, the fuser 320 may include a first heater 610 for heating a first area of the fusing member and a second heater 620 for heating a second area of the fusing member. In an example, the processor 340 may control the fuser driver 330 so as to alternately perform wave number control and phase control with respect to the first heater 610 and alternately perform the phase control and the wave number control

in an opposite order from the first heater 610 with respect to the second heater 620. For example, the processor 340 may control the fuser driver 330 so as to supply power with a phase difference of 180° to the first heater 610 and the second heater 620.

[71] FIG. 7 shows a duty table in an image forming apparatus including a fuser having two heaters according to an example.

[72] Referring to FIG. 7, an example is illustrated in which 2 is set as a control cycle and a duty table, similar to duty table 420, is generated to input data regarding two half cycles. FIG. 7 shows an example of performing wave number control and phase control during a plurality of control cycles.

[73] Referring to a duty table 710, the first heater 610 performs wave number control at a first phase and performs phase control at a second phase, whereas the second heater 620 performs the phase control at the first phase and performs the wave number control at the second phase. Accordingly, the first heater 610 and the second heater 620 may not use the same control method at the same control timing. Referring to a duty table 720, the first heater 610 performs the phase control at the first phase and performs the wave number control at the second phase, whereas the second heater 620 performs the wave number control at the first phase and performs the phase control at the second phase.

[74] That is, the first heater 610 and the second heater 620 may perform different control methods from each other at the same phase and may not use a certain control method at a certain phase.

[75] FIG. 8 shows a method of performing wave number control and phase control according to a set duty in an image forming apparatus including a fuser having two heaters according to an example.

[76] Referring to FIG. 8, the processor 340 controls the fuser driver 330 so as to perform phase control during a preceding half cycle of input alternating current power and perform wave number control during the following half cycle with respect to the first heater 610. Also, the processor 340 controls the fuser driver 330 so as to perform the wave number control during a preceding half cycle of input alternating current power and perform the phase control during the following half cycle with respect to the second heater 620. As described above with reference to FIG. 7, this is merely an example, and the fuser driver 330 may be controlled so as to perform the wave number control during a preceding half cycle and perform the phase control during the following half cycle with respect to the first heater 610 and perform control in the opposite order with respect to the second heater 620.

[77] Referring to FIG. 8, when a duty is greater than 0% and less than 50% based on the entire control cycle (810), the processor 340 controls the fuser driver 330 so that the first heater 610 and the second heater 620 may perform only the phase control. When

the duty is 50% based on the entire control cycle (820), the processor 340 controls the fuser driver 330 so that the first heater 610 and the second heater 620 may perform only the wave number control. When the duty is greater than 50% and less than or equal to 100% based on the entire control cycle (830), the processor 340 controls the fuser driver 330 so that the first heater 610 and the second heater 620 may alternately perform the phase control and the wave number control.

[78] According to an example, a wave of a total of alternating currents input to two heaters, that is, a total alternating current input to the fuser 320, shows a certain form according to a change in time, and it means that there is no change in an input current value. Accordingly, a change in current according to a lapse of time may be minimized, and thus, flicker characteristics may improve.

[79] FIG. 9 shows a method of performing wave number control and phase control in a warm-up mode according to an example.

[80] When there is no user input for a certain period of time, the image forming apparatus 300 may enter a waiting mode. When receiving a user input in the waiting mode, the image forming apparatus 300 returns to an active mode. In this regard, in order to prevent a sudden operation, the image forming apparatus 300 performs a warm-up mode for preparing an operation. In an example, in the warm-up mode, the processor 340 may set a control cycle to be longer than a control cycle for a print period.

[81] In the warm-up mode, the processor 340 may control the fuser driver 330 so as to sequentially perform phase control and wave number control or wave number control and phase control and alternately perform the wave number control and the phase control.

[82] Referring to FIG. 9, the image forming apparatus 300 receives a user input in a waiting mode 910. When the image forming apparatus 300 receives the user input, the processor 340 may control the fuser driver 330 so as to perform phase control 920 or wave number control 930. Although FIG. 9 shows first performing the phase control 920, this is merely an example. In another example, the wave number control 930 may be performed first. As part of the warm-up mode, the processor 340 may control the fuser driver 330 so as to alternately perform wave number control and phase control 940.

[83] According to an example, in the warm-up mode, a change in current according to a lapse of time may be minimized, and thus, flicker characteristics may improve.

[84] FIG. 10 shows a method of performing wave number control and phase control in a warm-up mode of an image forming apparatus including a fuser having two heaters according to an example.

[85] Referring to FIG. 10, the image forming apparatus 300 receives a user input in a waiting mode 1010. When the image forming apparatus 300 receives the user input,

the processor 340 may control the fuser driver 330 so as to perform wave number control with respect to one of the first heater 610 and the second heater 620 (1020).

[86] The processor 340 may control the fuser driver 330 so as to perform the wave number control with respect to the other heater (1030). Sequentially supplying power instead of simultaneously supplying power to two heaters may decrease a change in current, thereby improving flicker characteristics. Further, the processor 340 may perform phase control with respect to one of the first heater 610 and the second heater 620 (1040) and then may also perform the phase control with respect to the other heater (1050).

[87] In this regard, the processor 340 may control the fuser driver 330 so as to perform different control methods at the same phase with respect to the first heater 610 and the second heater 620.

[88] Although FIG. 10 shows the processor 340 controlling the fuser driver 330 so as to perform wave number control first with respect to each heater, this is merely an example, and the fuser driver 330 may be controlled so as to perform phase control first. Similarly, although FIG. 10 shows the processor 340 controlling the first heater 610 before controlling the second heater 620, this is merely an example, and the second heater 620 may be controlled before the first heater 610.

[89] Elements of an image forming apparatus according to an example have been described above. An example of an operation method of an image forming apparatus will now be described. In this regard, a repeated description thereof will be briefly provided below.

[90] FIG. 11 is a flowchart of an operation method of an image forming apparatus according to an example.

[91] Referring to FIG. 11, the image forming apparatus 300 receives alternating current power in operation 1110.

[92] In operation 1120, the image forming apparatus 300 may alternately perform wave number control and phase control with respect to the received alternating current power and thus may supply power to a fuser. In an example, the image forming apparatus 300 may set a control cycle and a duty and may perform the wave number control and the phase control according to the set control cycle and duty. The image forming apparatus 300 may set the control cycle to be an even multiple of a half cycle of the alternating current power and may alternately perform the wave number control and the phase control based on the half cycle of the alternating current power. In addition, the image forming apparatus 300 may measure a temperature of the fuser, set a target temperature of the fuser according to the measured temperature of the fuser, and set the control cycle and the duty according to the target temperature. Further, the image forming apparatus 300 may detect a zero cross point at which a voltage of the

alternating current power is 0 V, and may perform the wave number control and the phase control based on the detected zero cross point. In this regard, based on the zero cross point, the image forming apparatus 300 may perform the wave number control with respect to one preceding or following half cycle of the alternating current power and may perform the phase control with respect to the other following or preceding half cycle where the wave number control is not performed.

- [93] When the set duty is greater than 0% and less than 50%, the image forming apparatus 300 may perform the phase control. When the set duty is 50%, the image forming apparatus 300 may perform the wave number control. When the set duty is greater than 50% and less than or equal to 100%, the image forming apparatus 300 may alternately perform the wave number control and the phase control.
- [94] The image forming apparatus 300 may include the first heater 610 and the second heater 620, may alternately perform the wave number control and the phase control with respect to the first heater 610, and may alternately perform the phase control and the wave number control in an opposite order from the first heater 610 with respect to the second heater 620. Also, the image forming apparatus 300 may perform a warm-up mode in which the phase control and the wave number control or the wave number control and the phase control are sequentially performed and the wave number control and the phase control are alternately performed. In this regard, in the warm-up mode, the image forming apparatus 300 may set a control cycle to be longer than a control cycle for a print period.
- [95] The examples described herein may be embodied in the form of a computer-readable recording medium for storing a command and data executable by a computer. At least one of the command and the data may be stored in the form of program code, and when executed by a processor, may generate a predetermined program module to perform a predetermined operation.
- [96] The computer-readable recording medium may refer to, for example, a magnetic storage medium such as a hard disk, an optical reading medium such as compact disc (CD) or digital versatile disc (DVD), etc., or may refer to a memory included in a server accessible through a network. For example, the computer-readable recording medium may be at least one of the memory 140 of the image forming apparatus 100 or a memory of the input/output unit 110, or may be a memory included in an external device connected to the image forming apparatus 100 through a network.
- [97] While one or more examples have been described with reference to the figures, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the inventive concept as defined by the following claims. It should be understood that examples described herein should be considered in a descriptive sense only and not for

purposes of limitation.

Claims

- [Claim 1] An image forming apparatus comprising:
a fuser;
a fuser driver to perform at least one of wave number control or phrase control with respect to input alternating current power, and supply power to the fuser;
a memory to store a program for controlling the fuser driver; and
a processor to control the fuser driver so as to alternately perform the wave number control and the phrase control by executing the program stored in the memory.
- [Claim 2] The image forming apparatus of claim 1, wherein the processor sets a control cycle and a duty and controls the fuser driver so as to perform the wave number control and the phase control according to the set control cycle and the set duty.
- [Claim 3] The image forming apparatus of claim 2, wherein the processor controls the fuser driver so as to perform the phase control when the set duty is greater than 0% and less than 50%, perform the wave number control when the set duty is 50%, and alternately perform the wave number control and the phase control when the set duty is greater than 50% and less than or equal to 100%.
- [Claim 4] The image forming apparatus of claim 2, wherein the processor sets the control cycle to be an even multiple of a half cycle of the alternating current power and control the fuser driver so as to alternately perform the wave number control and the phase control based on the half cycle of the alternating current power.
- [Claim 5] The image forming apparatus of claim 2, further comprising a temperature sensor to measure a temperature of the fuser,
wherein the processor sets a target temperature of the fuser according to the temperature of the fuser measured by the temperature sensor and sets the control cycle and the duty according to the target temperature.
- [Claim 6] The image forming apparatus of claim 1, further comprising a zero cross detector to detect a zero cross point at which a voltage of the alternating current power is 0 V,
wherein the processor controls the fuser driver based on the zero cross point detected by the zero cross detector.
- [Claim 7] The image forming apparatus of claim 6, wherein the processor controls the fuser driver so as to perform the wave number control with

- respect to one of a preceding half cycle and a following half cycle of the alternating current power based on the zero cross point and perform the phase control with respect to the other of the following and preceding half cycles where the wave number control is not performed.
- [Claim 8] The image forming apparatus of claim 1, wherein the fuser comprises a first heater and a second heater, and wherein the processor controls the fuser driver so as to alternately perform the wave number control and the phase control with respect to the first heater, and alternately perform the phase control and the wave number control with respect to the second heater in an opposite order to that performed with respect to the first heater.
- [Claim 9] The image forming apparatus of claim 1, wherein the processor controls the fuser driver, in a warm-up mode, so as to perform the phase control followed by the wave number control, or perform the wave number control followed by the phase control, and thereafter alternately perform the wave number control and the phase control.
- [Claim 10] The image forming apparatus of claim 1, wherein the processor sets, in a warm-up mode, a control cycle so as to be longer than a control cycle for a print period.
- [Claim 11] A method of operating an image forming apparatus, the method comprising:
receiving alternating current power;
alternately performing wave number control and phrase control with respect to the received alternating current power; and
supplying power to a fuser.
- [Claim 12] The method of claim 11, further comprising setting a control cycle and a duty,
wherein the alternately performing of the wave number control and the phrase control with respect to the received alternating current power and the supplying of the power to the fuser comprises performing the wave number control and the phrase control according to the set control cycle and the set duty.
- [Claim 13] The method of claim 12, wherein the alternately performing of the wave number control and the phrase control with respect to the received alternating current power and the supplying of the power to the fuser comprises:
performing the phase control when the set duty is greater than 0% and less than 50%;

performing the wave number control when the set duty is 50%; and alternately performing the wave number control and the phase control when the set duty is greater than 50% and less than or equal to 100%.

[Claim 14]

The method of claim 12,

wherein the setting of the control cycle and the duty comprises setting the control cycle to be an even multiple of a half cycle of the alternating current power, and

wherein the alternately performing of the wave number control and the phase control with respect to the received alternating current power and the supplying of the power to the fuser comprises alternately performing the wave number control and the phase control based on the half cycle of the alternating current power.

[Claim 15]

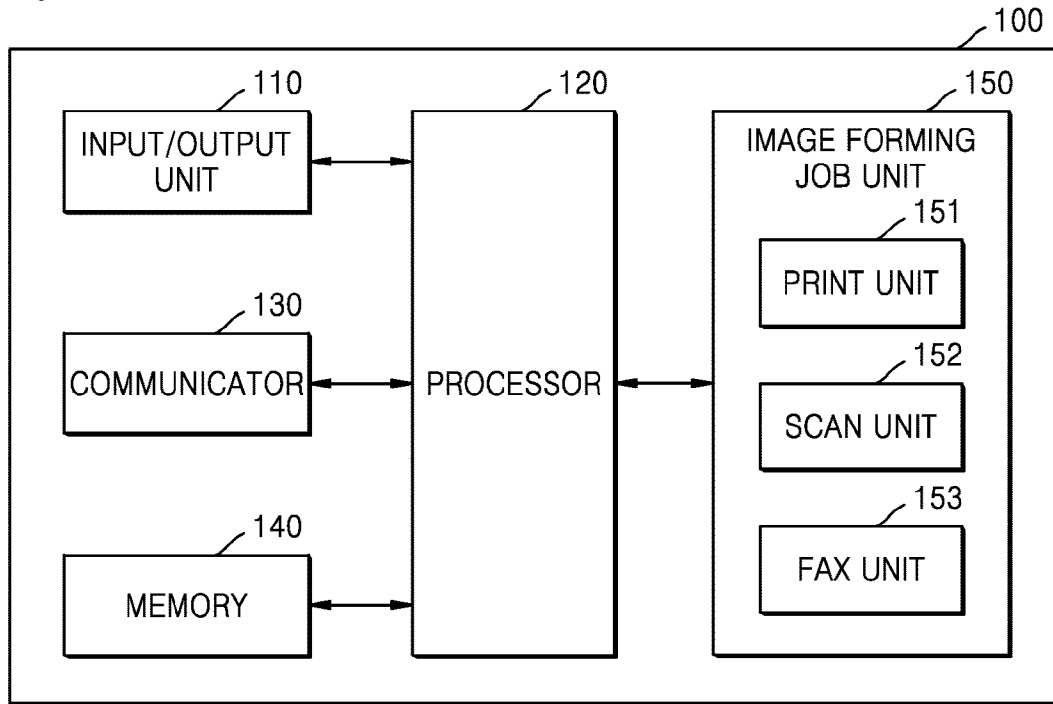
The method of claim 12, further comprising measuring a temperature of the fuser,

wherein the setting of the control cycle and the duty comprises:

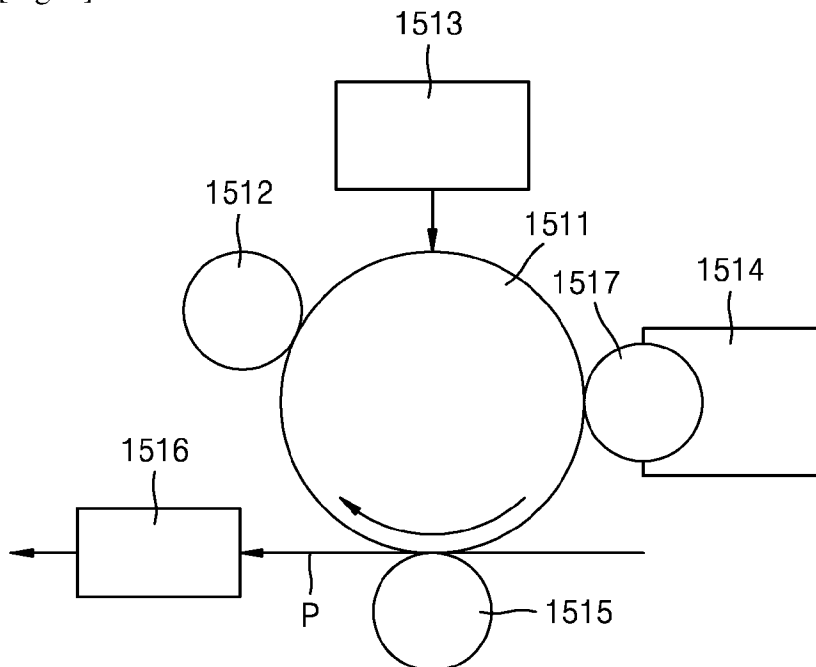
setting a target temperature of the fuser according to the measured temperature of the fuser; and

setting the control cycle and the duty according to the target temperature.

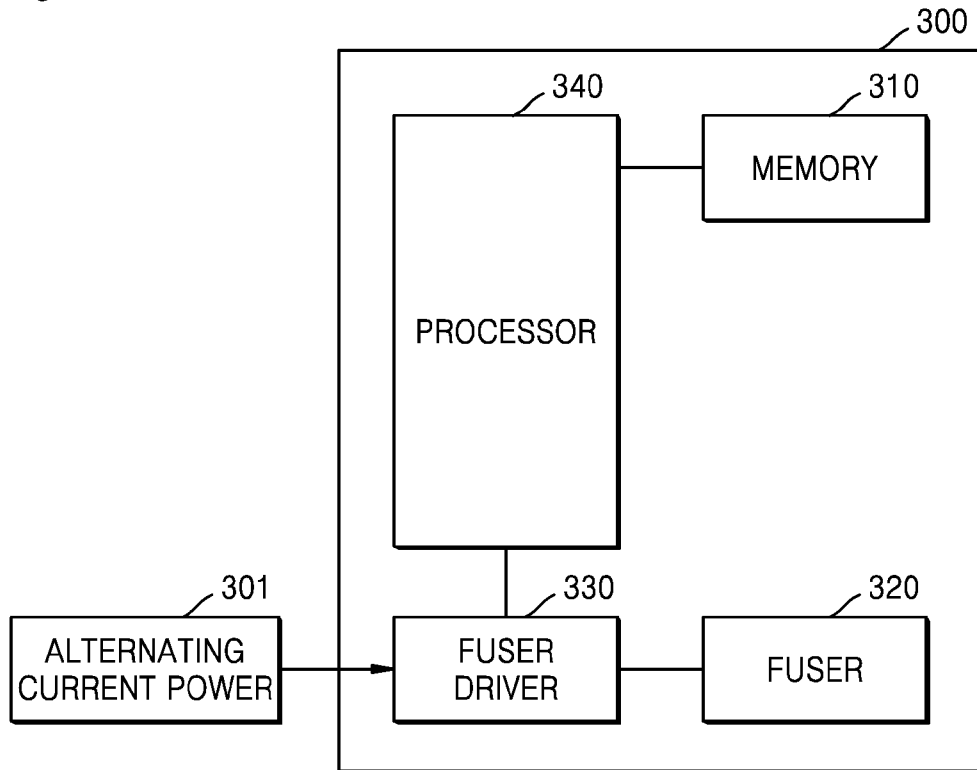
[Fig. 1]



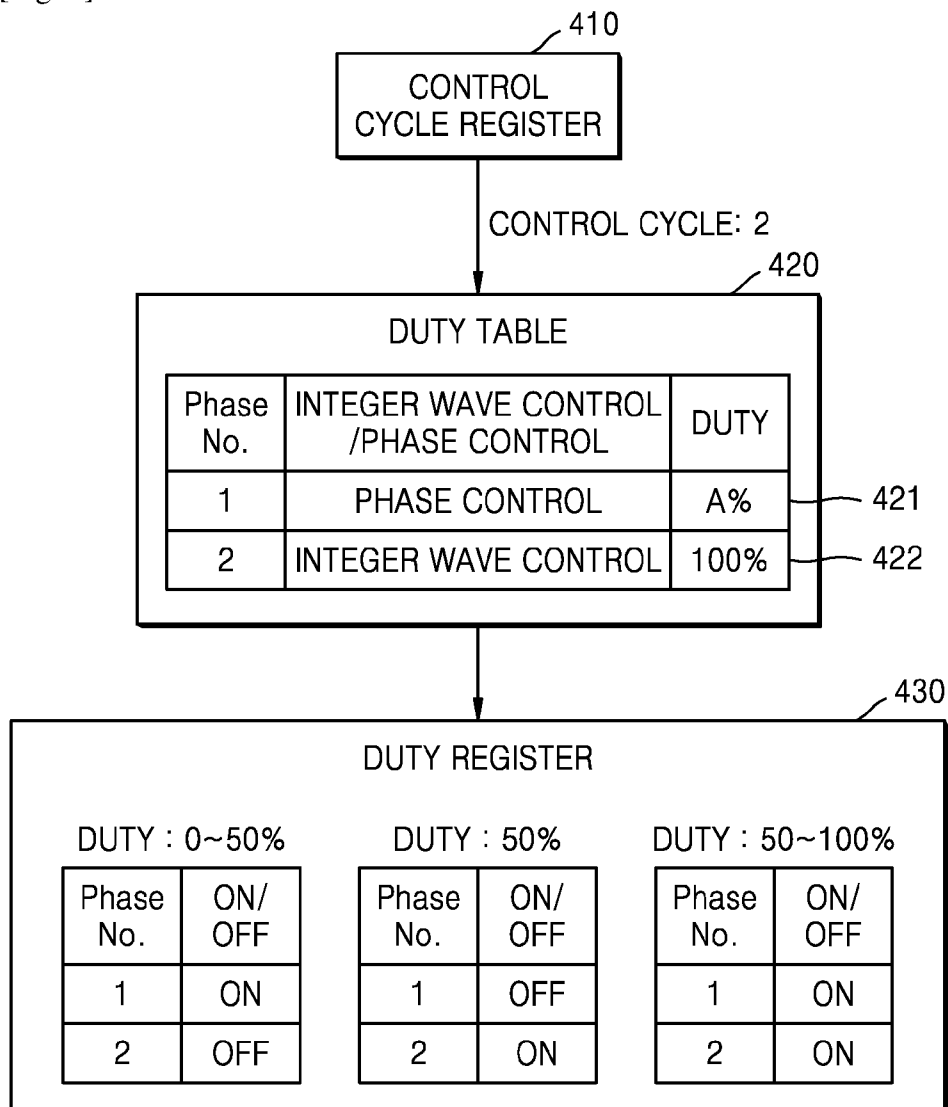
[Fig. 2]



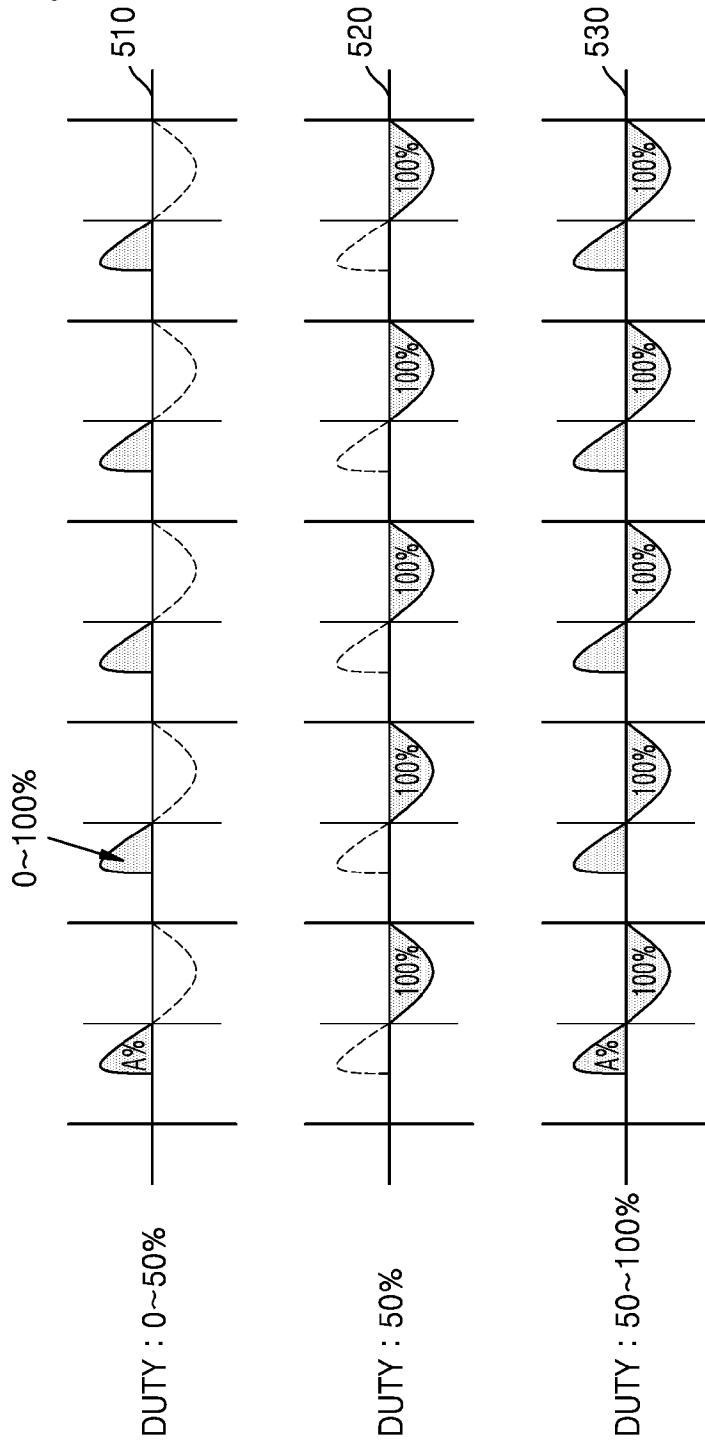
[Fig. 3]



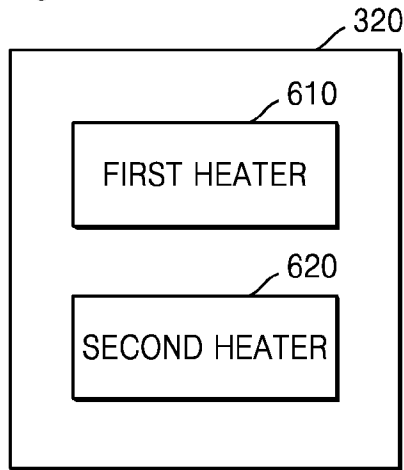
[Fig. 4]



[Fig. 5]



[Fig. 6]

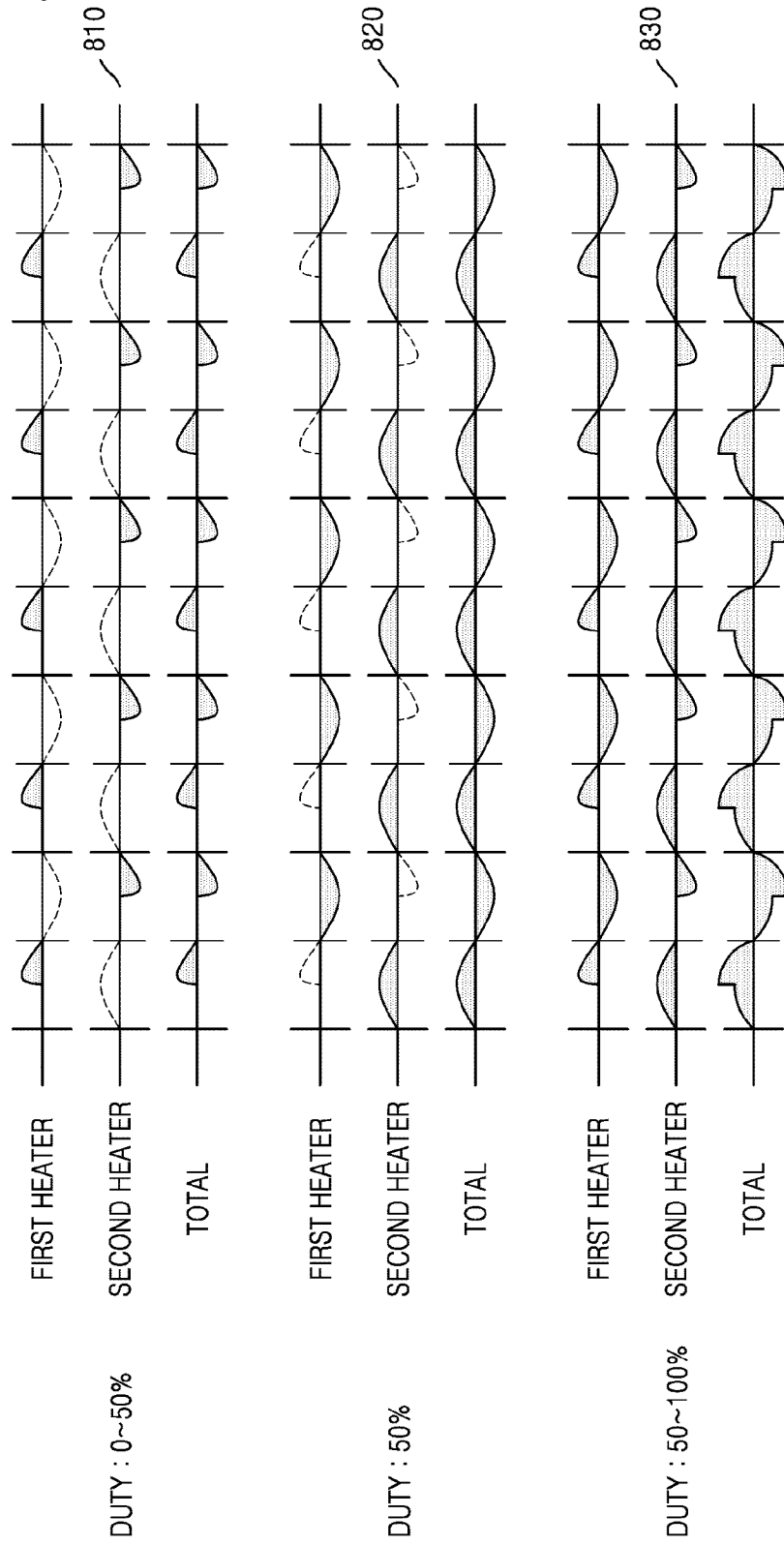


[Fig. 7]

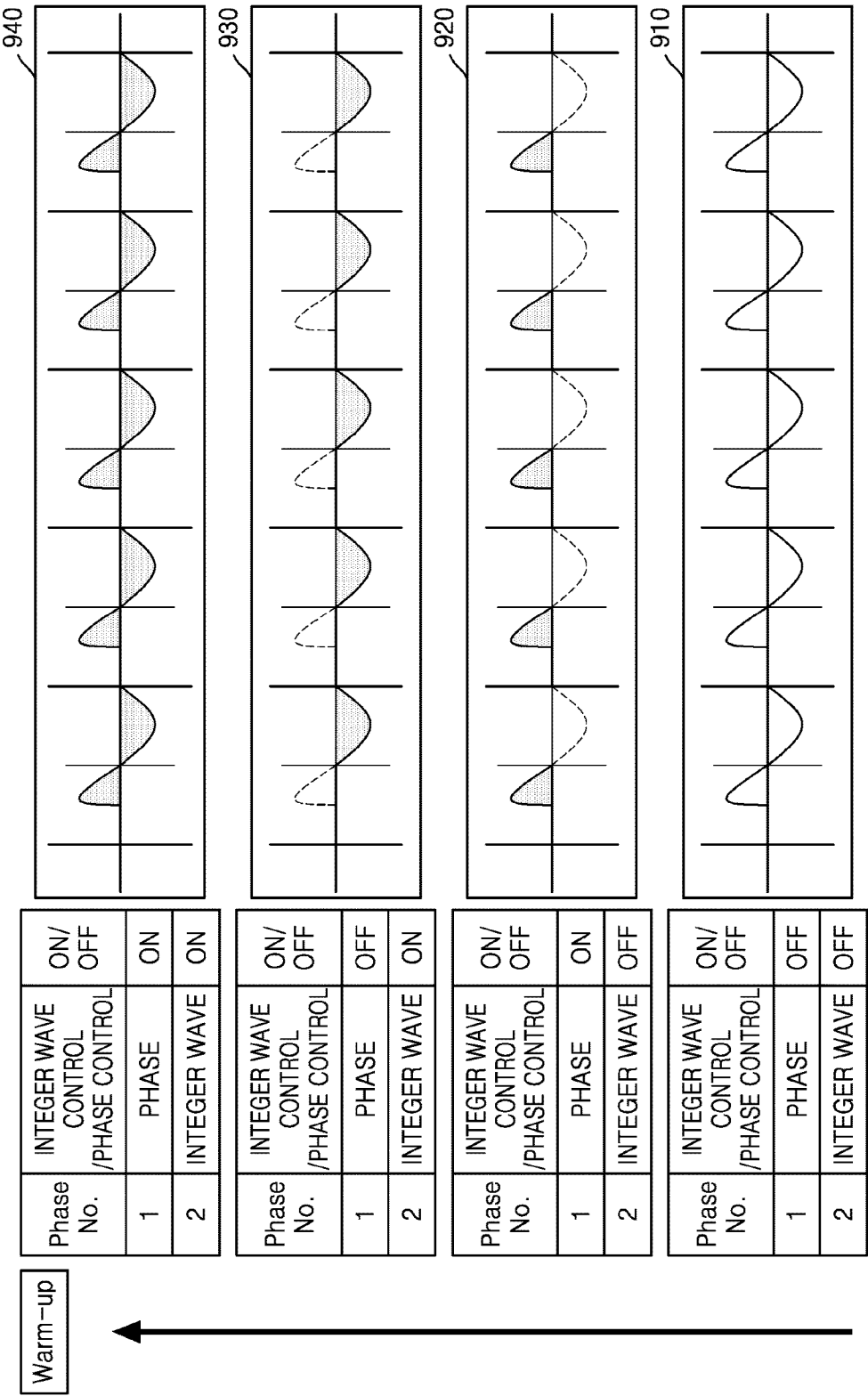
CONTROL CYCLE = 2		CONTROL CYCLE 1		CONTROL CYCLE 2		CONTROL CYCLE 3		...	
CONTROL METHOD	FIRST PHASE	SECOND PHASE	FIRST PHASE	SECOND PHASE	FIRST PHASE	SECOND PHASE	FIRST PHASE	SECOND PHASE	
FIRST HEATER	INTEGER WAVE	PHASE	INTEGER WAVE	PHASE	INTEGER WAVE	PHASE	INTEGER WAVE	PHASE	
SECOND HEATER	PHASE	INTEGER WAVE	PHASE	INTEGER WAVE	PHASE	INTEGER WAVE	PHASE	INTEGER WAVE	

CONTROL CYCLE = 2		CONTROL CYCLE 1		CONTROL CYCLE 2		CONTROL CYCLE 3		...	
CONTROL METHOD	FIRST PHASE	SECOND PHASE	FIRST PHASE	SECOND PHASE	FIRST PHASE	SECOND PHASE	FIRST PHASE	SECOND PHASE	
FIRST HEATER	PHASE	INTEGER WAVE	PHASE	INTEGER WAVE	PHASE	INTEGER WAVE	PHASE	INTEGER WAVE	
SECOND HEATER	INTEGER WAVE	PHASE	INTEGER WAVE	PHASE	INTEGER WAVE	PHASE	INTEGER WAVE	PHASE	

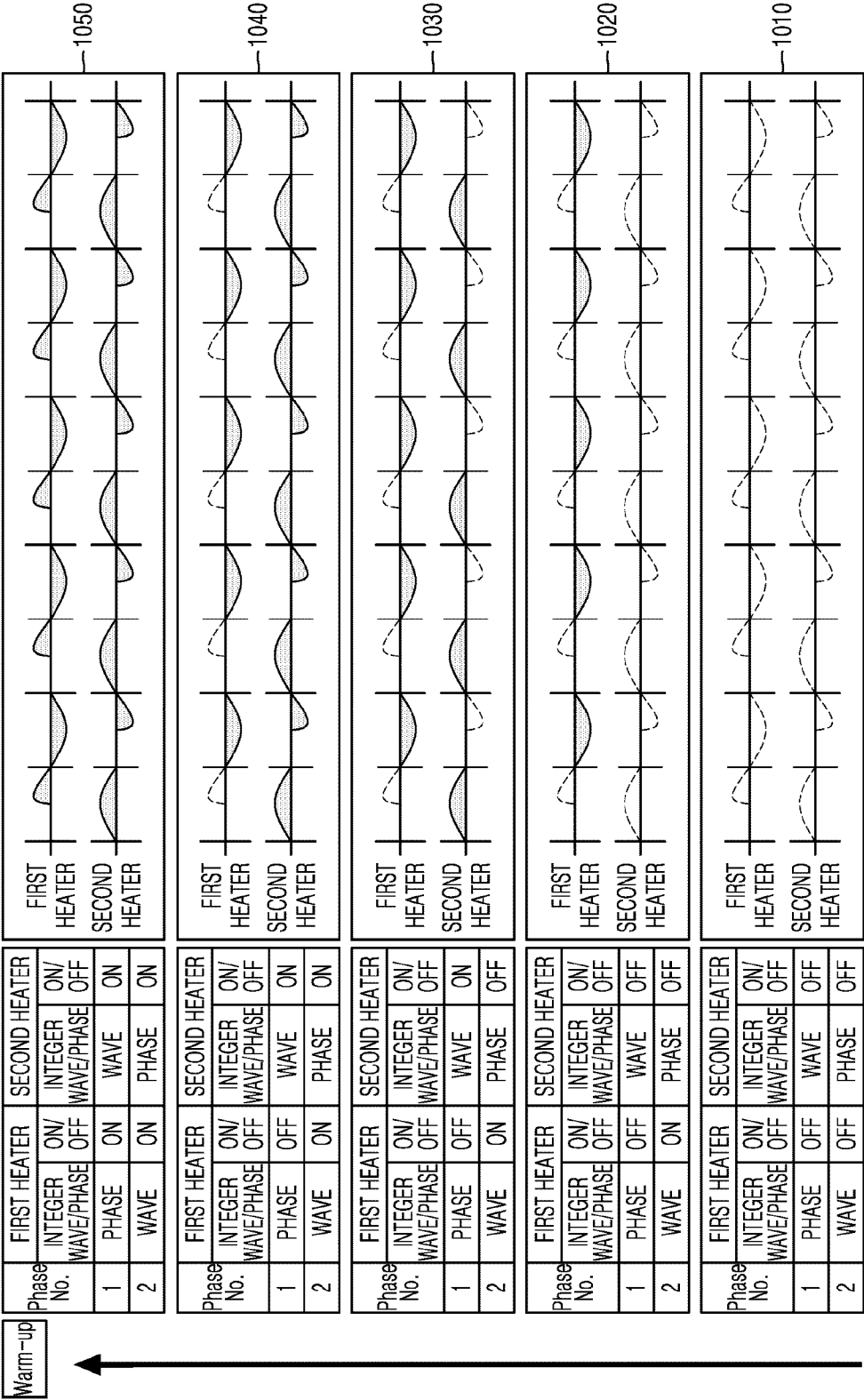
[Fig. 8]



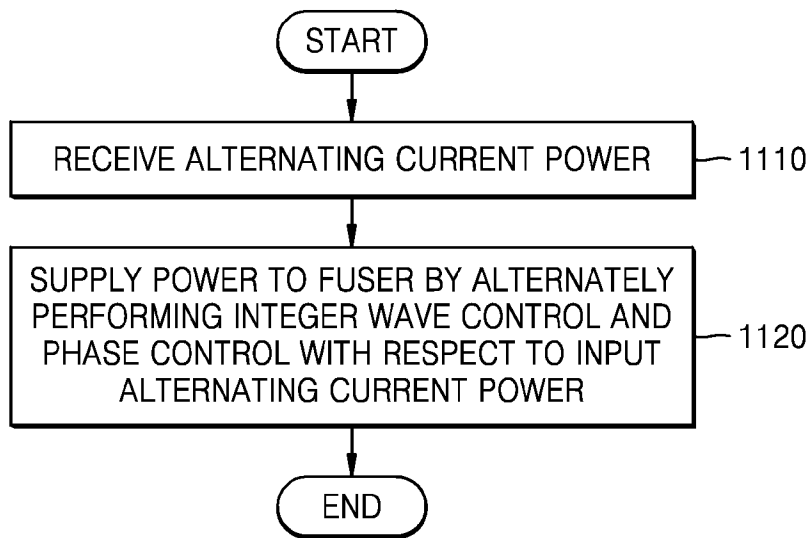
[Fig. 9]



[Fig. 10]



[Fig. 11]



A. CLASSIFICATION OF SUBJECT MATTER**G03G 15/20(2006.01)i, G03G 15/00(2006.01)i, G03G 21/18(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G03G 15/20; H02M 1/08; B60H 1/00; G03G 15/00; G03G 21/18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: fuser, wave number, phase, alternating current power, cycle, duty, heater, temperature, zero cross point, warm-up

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 8953964 B2 (AN-SIK JEONG et al.) 10 February 2015 See column 7, lines 27-45; and claims 1, 3.	1-15
Y	US 2017-0108806 A1 (SAMSUNG ELECTRONICS CO., LTD.) 20 April 2017 See paragraphs [0074], [0111], [0152]-[0153]; claim 6; and figure 2.	1-15
Y	JP 3826094 B2 (CANON K. K.) 27 September 2006 See paragraph [0021]; and claims 1-2.	2-5, 7, 12-15
Y	US 2008-0131160 A1 (MITSUOKA TETSUNORI et al.) 05 June 2008 See claims 1, 4.	10
A	US 2010-0247131 A1 (KEI SATO et al.) 30 September 2010 See paragraphs [0063]-[0064]; claim 1; and figure 10.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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Date of mailing of the international search report

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Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2018/002807

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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