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(54) **FIXING DEVICE AND IMAGE FORMING APPARATUS EACH CAPABLE OF PREVENTING FIXING MEMBER FROM BEING DAMAGED BY EXCESSIVE HEATING**

(71) Applicant: **KYOCERA Document Solutions Inc.**, Osaka (JP)

(72) Inventor: **Masatoshi Masuda**, Osaka (JP)

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(57) **ABSTRACT**

A fixing device includes a motor, a heater, a power supply stopping portion, and a threshold setting portion. The motor rotates a fixing member that fixes a toner image transferred to a sheet onto the sheet. The heater heats the fixing member upon being supplied with power. In a case where temperature of the fixing device exceeds a threshold, the power supply stopping portion stops supply of power to the heater. The threshold setting portion changes the threshold from a first temperature to a second temperature higher than the first temperature in an acceleration period in which rotation speed of the motor increases, and changes the threshold from the second temperature to the first temperature when a deceleration period in which the rotation speed of the motor decreases starts.

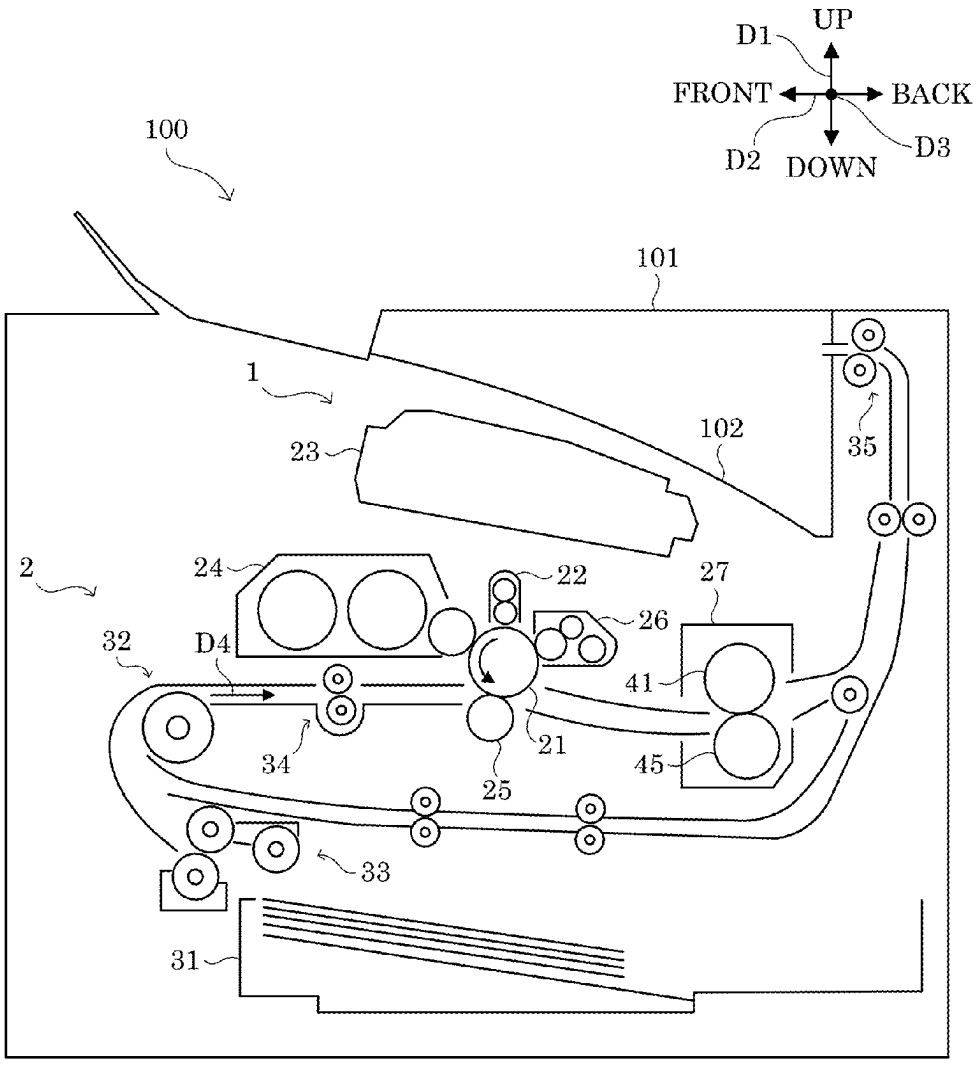


FIG.1

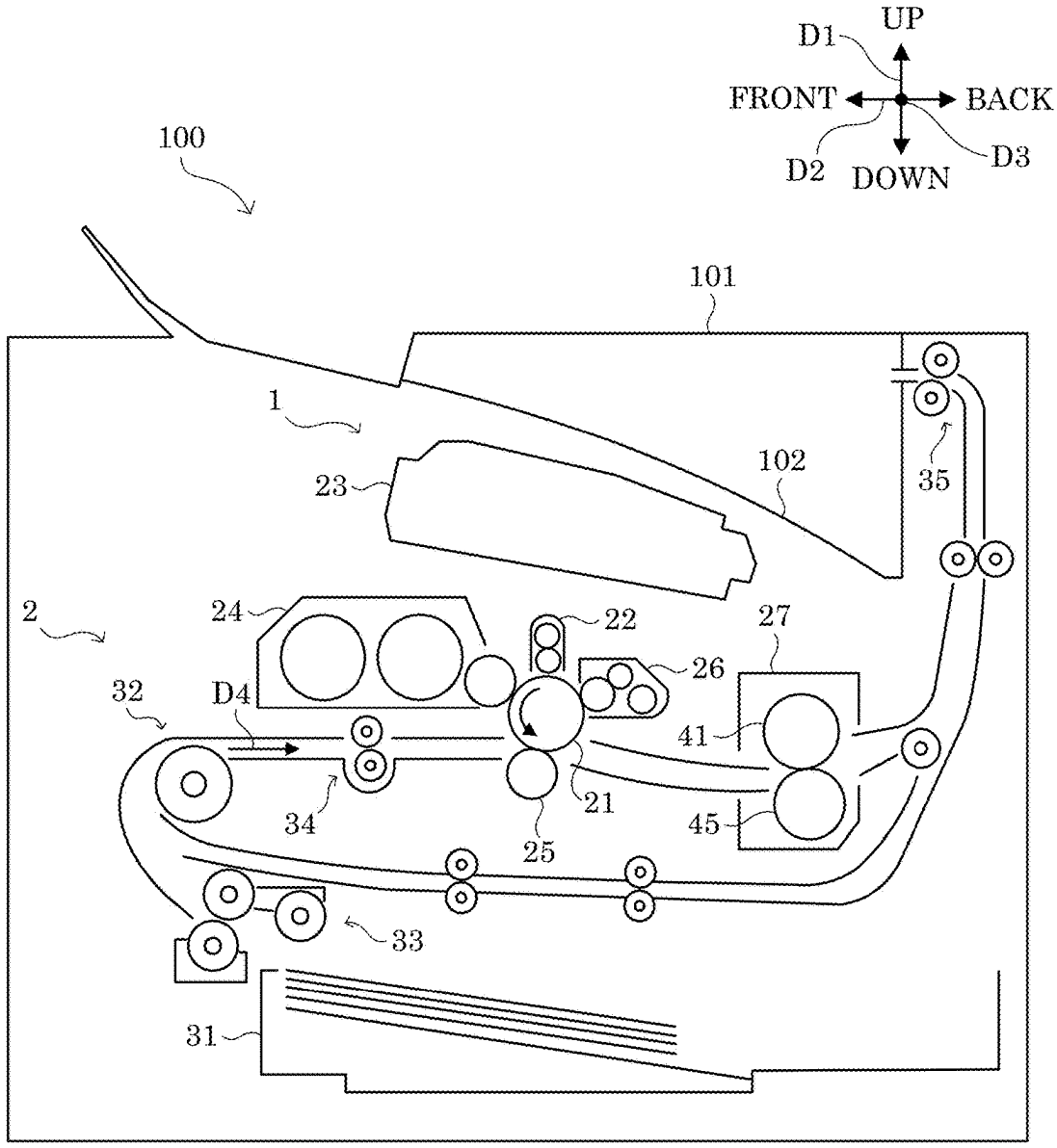

UP
D1
FRONT
BACK
D2
DOWN
D3
100
101
1
23
102
35
2
24
22
27
26
32
D4
41
34
21
45
25
33
31

FIG.2

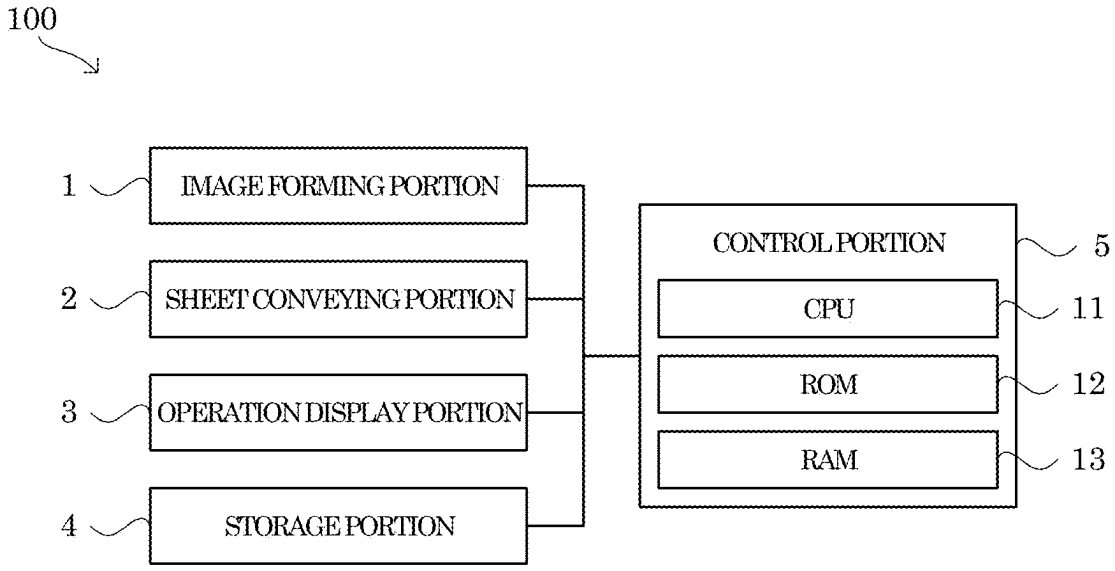

100
1
IMAGE FORMING PORTION
2
SHEET CONVEYING PORTION
3
OPERATION DISPLAY PORTION
4
STORAGE PORTION
CONTROL PORTION
5
CPU
11
ROM
12
RAM
13

FIG.3

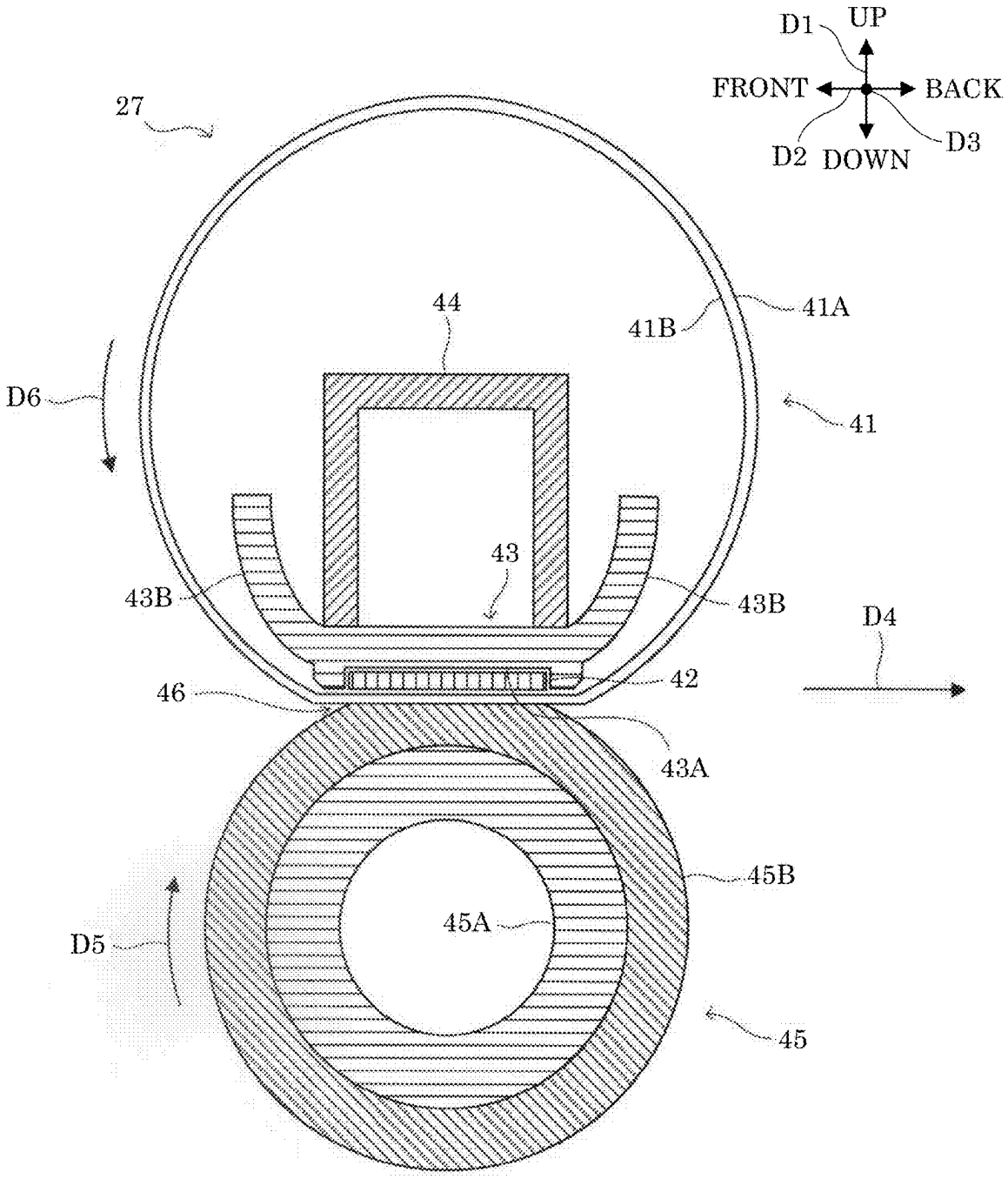

D1
UP
FRONT
BACK
D2
DOWN
D3
27
44
41B
41A
D6
41
43
43B
43B
D4
46
42
43A
45B
45A
D5
45

FIG.4

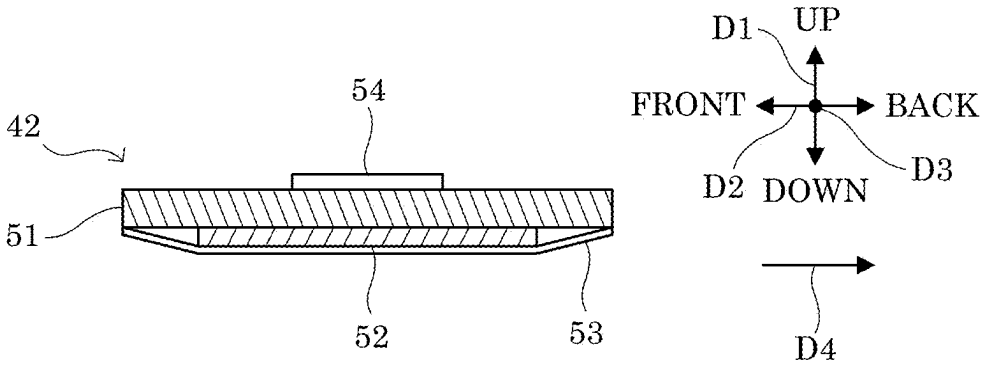


FIG.5

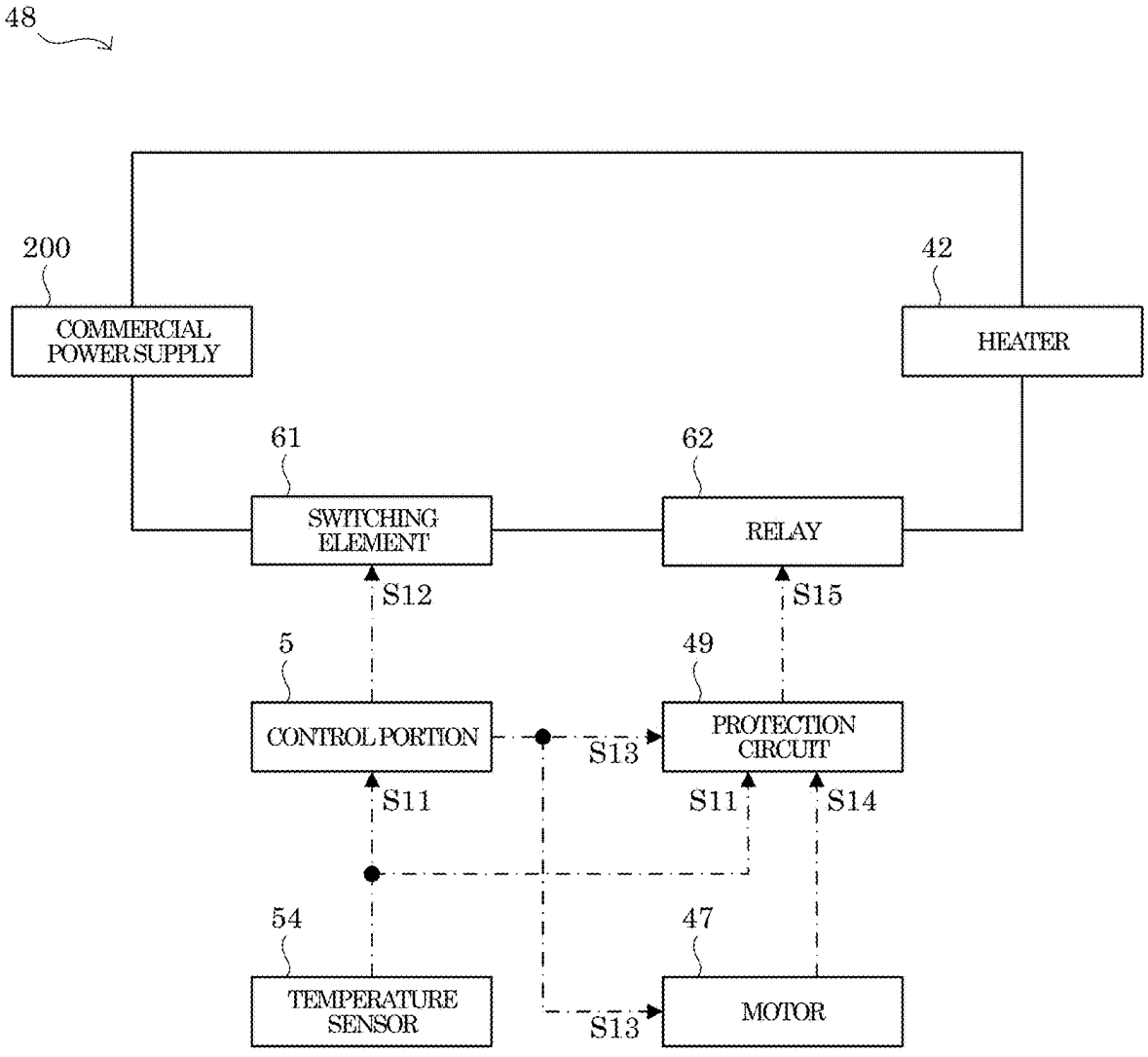
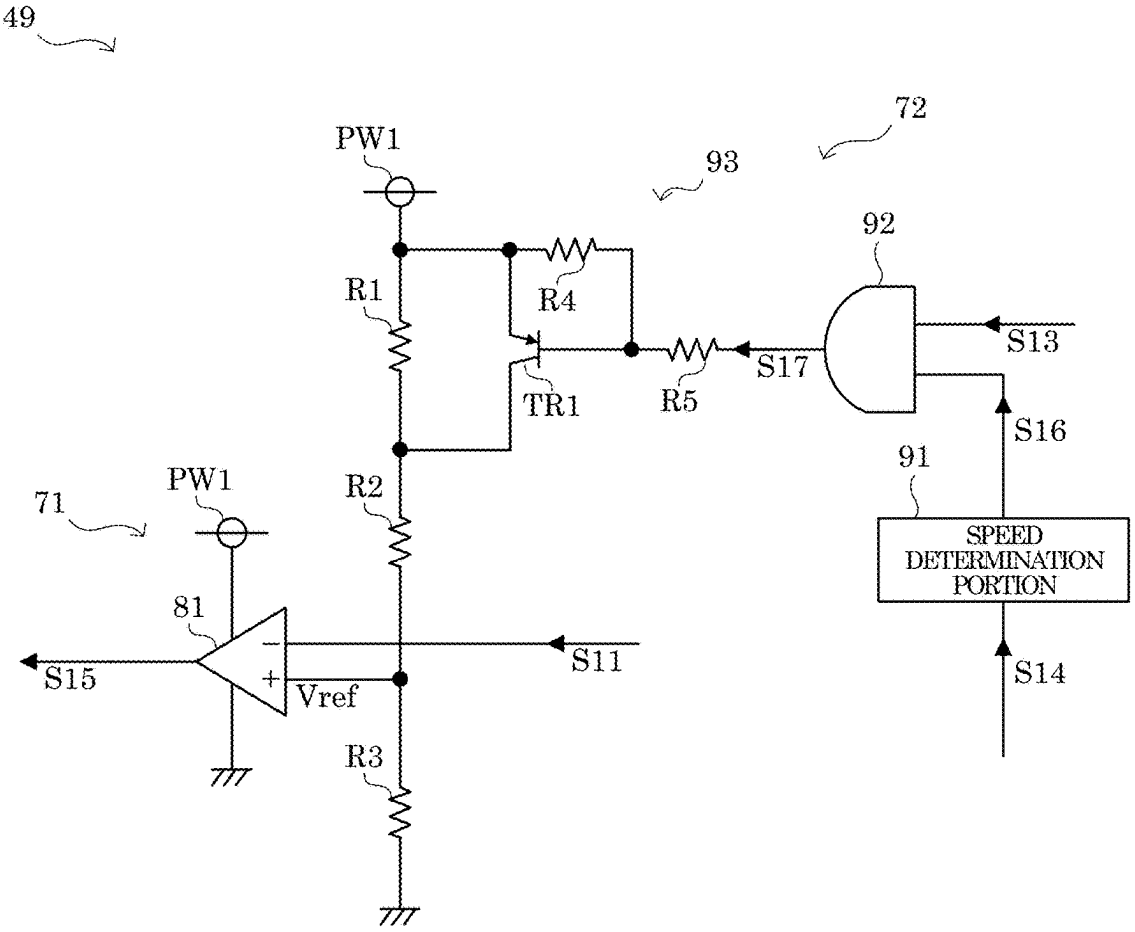

48
200
COMMERCIAL POWER SUPPLY
42
HEATER
61
SWITCHING ELEMENT
62
RELAY
S12
S15
5
CONTROL PORTION
49
PROTECTION CIRCUIT
S13
S11
S11
S14
54
TEMPERATURE SENSOR
47
MOTOR
S13

FIG.6


49
72
PW1
93
92
R1
R4
S13
S17
TR1
R5
S16
91
PW1
71
R2
SPEED DETERMINATION PORTION
81
S15
S11
Vref
S14
R3

FIXING DEVICE AND IMAGE FORMING APPARATUS EACH CAPABLE OF PREVENTING FIXING MEMBER FROM BEING DAMAGED BY EXCESSIVE HEATING

INCORPORATION BY REFERENCE

[0001] This application is based upon and claims the benefit of priority from the corresponding Japanese Patent Application No. 2024-021599 filed on Feb. 16, 2024, the entire contents of which are incorporated herein by reference.

BACKGROUND

[0002] This disclosure relates to a fixing device and an image forming apparatus.

[0003] An electrophotographic image forming apparatus includes a fixing device. For example, the fixing device includes a fixing member, a motor, a heater, a temperature sensor, and a power supply stopping portion. The fixing member fixes a toner image transferred to a sheet onto the sheet. The motor rotates the fixing member. The heater heats the fixing member upon being supplied with power. The temperature sensor senses the temperature of the fixing device. The power supply stopping portion stops the supply of power to the heater in a case where the temperature sensed by the temperature sensor exceeds a preset threshold.

[0004] In addition, a fixing device capable of changing the threshold from a first temperature to a second temperature higher than the first temperature in a case where the rotation speed of the motor increases beyond a predefined reference speed, and changing the threshold from the second temperature to the first temperature in a case where the rotation speed of the motor decreases beyond the reference speed has been known as the related art.

SUMMARY

[0005] A fixing device according to an aspect of this disclosure includes a fixing member, a motor, a heater, a temperature sensor, a power supply stopping portion, a threshold setting portion. The fixing member fixes a toner image transferred to a sheet onto the sheet. The motor rotates the fixing member. The heater heats the fixing member upon being supplied with power. The temperature sensor senses the temperature of the fixing device. The power supply stopping portion stops supply of power to the heater in a case where the temperature sensed by the temperature sensor exceeds a preset threshold. The threshold setting portion changes the threshold from a predefined first temperature to a second temperature higher than the first temperature in an acceleration period in which rotation speed of the motor increases, and changes the threshold from the second temperature to the first temperature when a deceleration period in which the rotation speed of the motor decreases starts.

[0006] An image forming apparatus according to another aspect of this disclosure includes an image forming portion. The image forming portion includes the fixing device and forms an image on the sheet.

[0007] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description with reference where appropriate to the accompanying drawings. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter. Furthermore, the claimed subject matter is not limited to implementations that solve any or all disadvantages noted in any part of this disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a diagram showing a configuration of an image forming apparatus according to an embodiment of this disclosure.

[0009] FIG. **2** is a diagram showing a system configuration of the image forming apparatus according to the embodiment of this disclosure.

[0010] FIG. **3** is a diagram showing a configuration of a fixing device of the image forming apparatus according to the embodiment of this disclosure.

[0011] FIG. **4** is a diagram showing a configuration of a heater of the image forming apparatus according to the embodiment of this disclosure.

[0012] FIG. **5** is a diagram showing a configuration of a heater drive circuit of the image forming apparatus according to the embodiment of this disclosure.

[0013] FIG. **6** is a diagram showing a configuration of a protection circuit of the image forming apparatus according to the embodiment of this disclosure.

DETAILED DESCRIPTION

[0014] Hereinafter, an embodiment of this disclosure will be described with reference to the accompanying drawings. It is to be noted that the following embodiment is a specific example of this disclosure and does not limit the technical scope of this disclosure.

Configuration of Image Forming Apparatus **100**

[0015] First, the configuration of an image forming apparatus **100** according to an embodiment of this disclosure will be described with reference to FIGS. **1** and **2**. Here, FIG. **1** is a cross-sectional view of the configuration of the image forming apparatus **100**.

[0016] It is to be noted that the perpendicular direction with the image forming apparatus **100** placed in an installation state (state shown in FIG. **1**) that allows for use is defined as an up-down direction D**1** for convenience of description. In addition, a front-back direction D**2** is defined by using the left surface of the image forming apparatus **100** shown in FIG. **1** as a front (front surface). Furthermore, a left-right direction D**3** is defined on the basis of the front of the image forming apparatus **100** in the installation state.

[0017] The image forming apparatus **100** is a printer having a print function of forming an image on the basis of image data. It is to be noted that this disclosure is applicable to a facsimile apparatus, a copier, a multifunction peripheral, and the like that each form an image by electrophotography.

[0018] As shown in FIGS. **1** and **2**, the image forming apparatus **100** includes an image forming portion **1**, a sheet conveying portion **2**, an operation display portion **3**, a storage portion **4**, and a control portion **5**. The image forming portion **1**, the sheet conveying portion **2**, the storage portion **4**, and the control portion **5** are housed in a housing **101** (see FIG. **1**) of the image forming apparatus **100**. The housing **101** is formed to have a substantially rectangular-cuboid shape. The operation display portion **3** and a sheet receiving portion **102** (see FIG. **1**) to which a sheet on which

an image has been formed by the image forming apparatus **100** is discharged are formed in the upper portion of the housing **101**.

[0019] The operation display portion **3** is a user interface of the image forming apparatus **100**. The operation display portion **3** includes a display portion such as a liquid-crystal display that displays various kinds of information in response to a control instruction from the control portion **5** and an operation portion such as an operation key or a touch panel that inputs various kinds of information to the control portion **5** in response to an operation of a user.

[0020] The storage portion **4** is a non-volatile storage device. For example, the storage portion **4** is a non-volatile memory such as a flash memory.

[0021] The control portion **5** integrally controls the image forming apparatus **100**. As shown in FIG. **2**, the control portion **5** includes a CPU **11**, a ROM **12**, and a RAM **13**. The CPU **11** is a processor that executes various calculation processes. The ROM **12** is a non-volatile storage device in which information about a control program or the like for causing the CPU **11** to execute various processes is stored in advance. The RAM **13** is a volatile or non-volatile storage device that is used as a temporary storage memory (work area) for various processes which are executed by the CPU **11**. In the control portion **5**, the CPU **11** executes various control programs stored in advance in the ROM **12**. This causes the control portion **5** to integrally control the image forming apparatus **100**. It is to be noted that the control portion **5** may include an electronic circuit such as an integrated circuit (ASIC). In addition, the control portion **5** may be a control portion provided separately from a main control portion which integrally controls the image forming apparatus **100**.

[0022] The image forming portion **1** is capable of forming an image on a sheet by electrophotography on the basis of image data received from an information processing apparatus such as an external personal computer. As shown in FIG. **1**, the image forming portion **1** includes a photoconductor drum **21**, a charging device **22**, a laser scanning unit **23**, a developing device **24**, a transfer roller **25**, a cleaning device **26**, and a fixing device **27**.

[0023] The photoconductor drum **21** is supported by the housing **101** so as to be rotatable. The photoconductor drum **21** receives rotational driving force transmitted from an unillustrated motor and rotates in an arrow direction shown in FIG. **1**.

[0024] The charging device **22** charges a surface of the photoconductor drum **21**.

[0025] The laser scanning unit **23** irradiates the surface of the photoconductor drum **21** charged by the charging device **22** with light based on image data. The laser scanning unit **23** forms an electrostatic latent image on the surface of the photoconductor drum **21**.

[0026] The developing device **24** uses a developer including toner to develop the electrostatic latent image formed on the surface of the photoconductor drum **21**. The developing device **24** forms a toner image on the surface of the photoconductor drum **21**.

[0027] The transfer roller **25** transfers the toner image formed on the surface of the photoconductor drum **21** to a sheet to be conveyed to the fixing device **27** by the sheet conveying portion **2**.

[0028] The cleaning device **26** cleans the surface of the photoconductor drum **21** after the toner image is transferred by the transfer roller **25**.

[0029] The fixing device **27** heats the sheet having the toner image transferred thereto and fixes the toner image onto the sheet.

[0030] The sheet conveying portion **2** conveys a sheet on which an image is formed by the image forming portion **1**. As shown in FIG. **1**, the sheet conveying portion **2** includes a sheet feed cassette **31**, a sheet conveyance path **32**, a sheet feed unit **33**, a registration roller pair **34**, and a sheet discharge roller pair **35**.

[0031] The sheet feed cassette **31** stores a sheet on which an image is formed by the image forming portion **1**. As shown in FIG. **1**, the sheet feed cassette **31** is provided on the bottom of the housing **101**. For example, sheet members such as paper, coated paper, postcard paper, envelopes, and OHP sheets are stored in the sheet feed cassette **31**. The sheet feed cassette **31** includes a lift plate that lifts up a plurality of sheets stored therein.

[0032] The sheet conveyance path **32** is a sheet movement path that reaches the sheet receiving portion **102** from the sheet feed cassette **31** through the transfer roller **25** and the fixing device **27**. The sheet conveyance path **32** is provided with a plurality of roller pairs including the registration roller pair **34** and the sheet discharge roller pair **35**. In the sheet conveyance path **32**, a sheet conveyed from the sheet feed cassette **31** is conveyed by the plurality of roller pairs in a conveyance direction D**4** (see FIG. **1**) toward the sheet receiving portion **102**. The sheet conveyance path **32** is formed by a pair of conveyance guide members provided in the housing **101**.

[0033] The sheet feed unit **33** sends sheets stored in the sheet feed cassette **31** to the sheet conveyance path **32** one by one. The sheet feed unit **33** includes a pickup roller, a sheet feed roller, and a retard roller. The pickup roller comes into contact with the upper surface of the uppermost sheet of the plurality of sheets lifted up by the lift plate of the sheet feed cassette **31** and rotates to send the sheet to the sheet feed roller. The sheet feed roller comes into contact with the upper surface of the sheet sent by the pickup roller and rotates to send the sheet to the sheet conveyance path **32**. The retard roller is provided below the sheet feed roller to be biased to the sheet feed roller. In a case where the pickup roller sends a plurality of stacked sheets, the retard roller separates the sheets other than the uppermost sheet from the plurality of stacked sheets.

[0034] The registration roller pair **34** conveys a sheet to a transfer position by the transfer roller **25** in synchronization with the timing at which a toner image formed on the surface of the photoconductor drum **21** is conveyed to the transfer position by the rotation of the photoconductor drum **21**.

[0035] The sheet discharge roller pair **35** discharges a sheet onto which a toner image has been fixed by the fixing device **27** to the sheet receiving portion **102**.

Configuration of Fixing Device **27**

[0036] Next, the configuration of the fixing device **27** will be described with reference to FIGS. **3** to **6**. Here, FIG. **3** is a cross-sectional view of the configuration of the fixing device **27**. In addition, FIG. **4** is a cross-sectional view of the configuration of a heater **42**. In addition, FIG. **5** is a diagram showing the configuration of a heater drive circuit **48**. In addition, FIG. **6** is a diagram showing the configuration of

a protection circuit **49**. It is to be noted that FIG. **5** shows an analog signal S**11**, a pulse signal S**12**, a digital signal S**13**, a pulse signal S**14**, and a digital signal S**15** by arrowed one-dot chain lines.

[0037] As shown in FIG. **3**, the fixing device **27** includes a fixing belt **41**, the heater **42**, a support portion **43**, a pressing member **44**, and a pressure roller **45**. In addition, the fixing device **27** includes a motor **47**, the heater drive circuit **48**, and the protection circuit **49** shown in FIG. **5**.

[0038] The fixing belt **41** is heated by the heater **42** to a predefined fixing temperature of 180 degrees Celsius or the like. The heated fixing belt **41** comes into contact with a sheet to fix a toner image transferred to the sheet onto the sheet. As shown in FIG. **3**, the fixing belt **41** is endless. In addition, the fixing belt **41** has flexibility. The fixing belt **41** includes a base material layer, an elastic layer provided on the outer peripheral surface of the base material layer, and a release layer provided on the outer peripheral surface of the elastic layer. The base material layer is formed by using a metal material such as stainless steel and nickel alloy. The elastic layer is formed by using a material such as silicon rubber. The release layer is formed by using a fluorine-based resin material such as PFA (tetrafluoroethylene perfluoroalkoxy ethylene copolymer resin). The fixing belt **41** is long along the left-right direction D**3**. The size of the fixing belt **41** in the left-right direction D**3** is determined depending on the maximum size of a sheet on which the image forming apparatus **100** is capable of forming an image. The fixing belt **41** is an example of a fixing member according to this disclosure. It is to be noted that the fixing member according to this disclosure is not limited to a belt-shaped member and may be a roller-shaped member or the like.

[0039] The pressure roller **45** is provided at a position that allows the pressure roller **45** to come into contact with an outer peripheral surface **41**A (see FIG. **3**) of the fixing belt **41**. Specifically, as shown in FIG. **3**, the pressure roller **45** is provided below the fixing belt **41**. The pressure roller **45** is long along the left-right direction D**3**. The pressure roller **45** includes a shaft **45**A and an elastic layer **45**B. The shaft **45**A is formed by using a metal material to have a cylindrical shape. The elastic layer **45**B is formed on the outer periphery of the shaft **45**A by using a material having elasticity. The shaft **45**A is supported by a pair of side plates so as to be rotatable. The pair of side plates is provided inside the housing **101**. The pressure roller **45** receives rotational driving force supplied from the motor **47** to rotate in a rotation direction D**5** (see FIG. **3**).

[0040] The heater **42** heats the fixing belt **41** upon being supplied with power. As shown in FIG. **3**, the heater **42** is provided at a position opposed to the pressure roller **45** across the fixing belt **41** inside the fixing belt **41**. The heater **42** is long in the left-right direction D**3** and extends over both outer sides of the fixing belt **41** in the left-right direction D**3**.

[0041] As shown in FIG. **4**, the heater **42** includes a substrate **51**, a heating resistor **52**, a protective layer **53**, and a temperature sensor **54**.

[0042] The substrate **51** is a member shaped like a flat plate that is long in the left-right direction D**3**. The substrate **51** is formed by using a material that is excellent in heat resistance, electrical insulation, and low-heat capacity. For example, the substrate **51** is formed by using ceramic such as alumina. The substrate **51** is larger in size in the left-right direction D**3** than the fixing belt **41**. The substrate **51** is disposed to extend on both outer sides of the fixing belt **41** in the left-right direction D**3**. Both ends of the substrate **51** in the left-right direction D**3** therefore protrude from the fixing belt **41** outward in the left-right direction D**3**.

[0043] As shown in FIGS. **3** and **4**, the lower surface of the substrate **51** is opposed to an inner peripheral surface **41**B (see FIG. **3**) of the fixing belt **41**. As shown in FIG. **4**, the heating resistor **52** is disposed on the lower surface of the substrate **51**. In addition, the opposed region on the lower surface of the substrate **51** to the inner peripheral surface **41**B of the fixing belt **41** is covered with the protective layer **53** (see FIG. **4**). The protective layer **53** is formed by using a material such as glass having electrical insulation.

[0044] As shown in FIGS. **3** and **4**, the upper surface of the substrate **51** is opposed to the bottom surface of a recessed portion **43**A of the support portion **43**. As shown in FIG. **4**, the temperature sensor **54** is disposed on the upper surface of the substrate **51**. The temperature sensor **54** senses the temperature of the fixing device **27**. Specifically, the temperature sensor **54** senses the temperature of the heater **42** and outputs the analog signal S**11** (see FIG. **5**) of a voltage corresponding to the sensed temperature. For example, the voltage of the analog signal S**11** grows lower as the temperature sensor **54** senses higher temperature. The analog signal S**11** output from the temperature sensor **54** is input to the control portion **5** and the protection circuit **49**.

[0045] The heating resistor **52** generates heat upon being supplied with power from a commercial power supply **200** (see FIG. **5**). The heating resistor **52** is formed to have the shape of a strip that is long in the left-right direction D**3** and has a predetermined thickness in the direction orthogonal to the lower surface of the substrate **51**. For example, the heating resistor **52** is formed by using a material such as silver palladium (Ag/Pd). The heating resistor **52** is smaller in size in the left-right direction D**3** than the fixing belt **41**. The heating resistor **52** is disposed inside the opposed region on the lower surface of the substrate **51**.

[0046] The support portion **43** supports the heater **42**. As shown in FIG. **3**, the support portion **43** is provided inside the fixing belt **41**. The support portion **43** is long in the left-right direction D**3** and extends over both outer sides of the fixing belt **41** in the left-right direction D**3**. The recessed portion **43**A corresponding to the shape of the heater **42** is formed on the bottom of the support portion **43**. The heater **42** is fitted into the recessed portion **43**A.

[0047] The pressing member **44** presses the support portion **43** toward the pressure roller **45**. As shown in FIG. **3**, the pressing member **44** is provided at a position opposed to the pressure roller **45** across the support portion **43** inside the fixing belt **41**. The pressing member **44** is long in the left-right direction D**3** and extends over both outer sides of the fixing belt **41** in the left-right direction D**3**. Both ends of the pressing member **44** in the left-right direction D**3** are biased toward the pressure roller **45** by an unillustrated biasing member. This causes the pressing member **44** to press the support portion **43** toward the pressure roller **45**. The support portion **43** is pressed toward the pressure roller **45** to press the heater **42** supported by the support portion **43** toward the pressure roller **45**.

[0048] The heater **42** is pressed toward the pressure roller **45** by the pressing member **44** to be pressure-welded to the inner peripheral surface **41**B of the fixing belt **41**. This forms a fixing nip portion **46** between the fixing belt **41** and the pressure roller **45**. The fixing nip portion **46** fixes a toner

image transferred to a sheet onto the sheet. A region in which the fixing belt **41** and the pressure roller **45** come into contact is herein defined as the fixing nip portion **46**. It is to be noted that a lubricant such as fluorine grease is applied between the heater **42** and the inner peripheral surface **41**B of the fixing belt **41**.

[0049] The fixing belt **41** is sandwiched by the heater **42** and the pressure roller **45**. When the pressure roller **45** rotates in the rotation direction D**5**, the fixing belt **41** rotates along a belt rotation direction D**6** (see FIG. **3**) following the rotation of the pressure roller **45**.

[0050] The support portion **43** includes a pair of guide portions **43**B that comes into contact with the inner peripheral surface **41**B of the fixing belt **41** and guides the movement of the fixing belt **41**. The pair of guide portions **43**B is provided at both ends of the support portion **43** in the front-back direction D**2**. The fixing belt **41** is guided by the pair of guide portions **43**B to move along a predefined movement path.

[0051] It is to be noted that the pressure roller **45** may be biased toward the heater **42**. In this case, the pressing member **44** does not have to be biased by the biasing member.

[0052] The motor **47** rotates the fixing belt **41**. Specifically, the motor **47** supplies rotational driving force to the pressure roller **45** to rotate the pressure roller **45**, thereby rotating the fixing belt **41** following the rotation of the pressure roller **45**. In a case where the signal level of the digital signal S**13** (see FIG. **5**) received from the control portion **5** is switched from a low level to a high level, the motor **47** transitions to a drive state from a stop state. In the drive state, the supply of power from an unillustrated power supply to the motor **47** is controlled such that the rotation speed of the motor **47** reaches a predefined specific speed. In addition, in a case where the signal level of the digital signal S**13** received from the control portion **5** is switched from the high level to the low level, the motor **47** transitions to the stop state from the drive state. While rotating, the motor **47** outputs the pulse signal S**14** (see FIG. **5**) having a frequency corresponding to the rotation speed. The pulse signal S**14** output from the motor **47** is input to the protection circuit **49**.

[0053] The heater drive circuit **48** drives the heater **42**. As shown in FIG. **5**, the heater drive circuit **48** includes a switching element **61** and a relay **62**.

[0054] As shown in FIG. **5**, the switching element **61** is provided in an electrical conduction path between the commercial power supply **200** and the heater **42**. The switching element **61** is a semiconductor switch capable of switching the connection and disconnection of the electrical conduction path between the commercial power supply **200** and the heater **42** upon receiving the pulse signal S**12** (see FIG. **5**) at a preset duty ratio that is output from the control portion **5**. For example, the switching element **61** is a triac.

[0055] The control portion **5** controls the driving of the heater **42** on the basis of the temperature sensed by the temperature sensor **54**. Specifically, the control portion **5** sets the duty ratio of the pulse signal S**12** on the basis of the analog signal S**11** received from the temperature sensor **54** such that the temperature of the fixing belt **41** reaches the fixing temperature.

[0056] As shown in FIG. **5**, the relay **62** is provided in the electrical conduction path between the commercial power supply **200** and the heater **42**. The relay **62** disconnects the electrical conduction path between the commercial power supply **200** and the heater **42** upon receiving the digital signal S**15** (see FIG. **5**) output from the protection circuit **49**. For example, in a case where the signal level of the digital signal S**15** output from the protection circuit **49** is the low level, the relay **62** enables the electrical conduction path between the commercial power supply **200** and the heater **42**. In addition, in a case where the signal level of the digital signal S**15** output from the protection circuit **49** is the high level, the relay **62** disconnects the electrical conduction path between the commercial power supply **200** and the heater **42**. It is to be noted that the heater drive circuit **48** may include a switching element (different from the switching element **61**) instead of the relay **62**.

[0057] In the fixing device **27**, the motor **47** transitions to the drive state from the stop state after the supply of power to the heater **42** is started. This heats the lubricant and decreases the sliding resistance between the heater **42** and the fixing belt **41** before the motor **47** starts to be driven. It is thus possible to reduce the load on the motor **47**. In addition, in the fixing device **27**, the motor **47** transitions to the stop state from the drive state after the supply of power to the heater **42** is stopped. This stops the supply of thermal energy from the heater **42** before the rotation speed of the fixing belt **41** decreases. It is thus possible to prevent the fixing belt **41** from reaching excessively high temperature at the time and after the deceleration of the rotation speed of the fixing belt **41**.

[0058] The protection circuit **49** uses the relay **62** to stop the supply of power to the heater **42**.

[0059] Specifically, the protection circuit **49** includes a power supply stopping portion **71** and a threshold setting portion **72** shown in FIG. **6**.

[0060] The power supply stopping portion **71** stops the supply of power to the heater **42** in a case where the temperature sensed by the temperature sensor **54** exceeds the preset threshold.

[0061] As shown in FIG. **6**, the power supply stopping portion **71** includes a comparator **81**. The comparator **81** outputs the digital signal S**15** (see FIG. **6**) corresponding to a result of a comparison between the voltage of the analog signal S**11** (see FIG. **6**) output from the temperature sensor **54** and a reference voltage Vref (see FIG. **6**) corresponding to the threshold. Specifically, in a case where the voltage of the analog signal S**11** output from the temperature sensor **54** is higher than the reference voltage Vref, the comparator **81** outputs the digital signal S**15** at the low level. In addition, in a case where the voltage of the analog signal S**11** output from the temperature sensor **54** is lower than the reference voltage Vref, the comparator **81** outputs the digital signal S**15** at the high level.

[0062] Here, a fixing device capable of changing the threshold from a first temperature to a second temperature higher than the first temperature in a case where the rotation speed of the motor **47** increases beyond a predefined reference speed, and changing the threshold from the second temperature to the first temperature in a case where the rotation speed of the motor **47** decreases beyond the reference speed has been known as the related art.

[0063] However, in the fixing device according to the related art described above, in a case where the supply of power to the heater **42** continues even after the motor **47** starts to decelerate because of the runaway or the like of the CPU **11** of the control portion **5**, the fixing belt **41** may be

excessively heated and the fixing belt **41** may be damaged before the rotation speed of the motor **47** decreases beyond the reference speed.

[0064] In contrast, the image forming apparatus **100** according to the embodiment of this disclosure is capable of preventing the fixing belt **41** from being damaged by excessive heating as described below.

[0065] The threshold setting portion **72** changes the threshold from the first temperature to the second temperature higher than the first temperature in an acceleration period in which the rotation speed of the motor **47** increases, and changes the threshold from the second temperature to the first temperature when a deceleration period in which the rotation speed of the motor **47** decreases starts.

[0066] For example, in a case where the rotation speed of the motor **47** increases beyond the reference speed, the threshold setting portion **72** changes the threshold from the first temperature to the second temperature. In addition, in a case where the motor **47** transitions to the stop state from the drive state, the threshold setting portion **72** changes the threshold from the second temperature to the first temperature.

[0067] For example, the first temperature is 100 degrees Celsius. In addition, the second temperature is 230 degrees Celsius. It is to be noted that the first temperature and the second temperature may be temperatures set to any degrees Celsius.

[0068] As shown in FIG. **6**, the threshold setting portion **72** includes a speed determination portion **91**, an AND circuit **92**, and a reference voltage switching circuit **93**. The speed determination portion **91** determines whether or not the rotation speed of the motor **47** exceeds the reference speed. The reference speed is speed lower than the specific speed.

[0069] Specifically, the speed determination portion **91** is an electronic circuit that outputs a digital signal S**16** (see FIG. **6**) at the low level in a case where the frequency of the pulse signal S**14** received from the motor **47** is lower than or equal to the frequency corresponding to the reference speed, and outputs the digital signal S**16** at the high level in a case where the frequency of the pulse signal S**14** received from the motor **47** exceeds the frequency corresponding to the reference speed.

[0070] The AND circuit **92** receives the digital signal S**13** (see FIG. **5**) output from the control portion **5** and the digital signal S**16** (see FIG. **6**) output from the speed determination portion **91**. The AND circuit **92** outputs a digital signal S**17** (see FIG. **6**) at the high level only in a case where the received digital signal S**13** and digital signal S**16** are both at the high level.

[0071] In other words, the AND circuit **92** outputs the digital signal S**17** at the high level in a case where the motor **47** is in the drive state and the rotation speed of the motor **47** exceeds the reference speed. In addition, the AND circuit **92** outputs the digital signal S**17** at the low level in a case where the motor **47** is in the stop state or the rotation speed of the motor **47** is less than or equal to the reference speed.

[0072] That is, the digital signal S**17** output from the AND circuit **92** is switched from the low level to the high level in an acceleration period in which the rotation speed of the motor **47** increases. In addition, the digital signal S**17** output from the AND circuit **92** is switched from the high level to the low level when a deceleration period in which the rotation speed of the motor **47** decreases starts (when the state of the motor **47** is switched from the drive state to the stop state).

[0073] The reference voltage switching circuit **93** switches the reference voltage Vref between a first voltage corresponding to the first temperature and a second voltage corresponding to the second temperature in response to a change in the signal level of the digital signal S**17** output from the AND circuit **92**.

[0074] As shown in FIG. **6**, the reference voltage switching circuit **93** includes resistors R**1** to R**5** and a transistor TR**1**.

[0075] The transistor TR**1** is a PNP-type transistor.

[0076] As shown in FIG. **6**, the base terminal of the transistor TR**1** is connected to the output terminal of the AND circuit **92** through the resistor R**5**. In addition, the base terminal of the transistor TR**1** is connected to the emitter terminal of the transistor TR**1** through the resistor R**4**.

[0077] As shown in FIG. **6**, the collector terminal of the transistor TR**1** is connected to a power supply PW**1** through the resistor R**1**. In addition, the collector terminal of the transistor TR**1** is connected to the noninverting input terminal of the comparator **81** through the resistor R**2**. In addition, the collector terminal of the transistor TR**1** is connected to ground through the resistor R**2** and the resistor R**3**.

[0078] As shown in FIG. **6**, the emitter terminal of the transistor TR**1** is connected to the power supply PW**1**.

[0079] In the reference voltage switching circuit **93**, the transistor TR**1** is on in a case where the signal level of the digital signal S**17** output from the AND circuit **92** is the low level. In a case where the transistor TR**1** is on, a voltage output from the power supply PW**1** is divided into the first voltage by the resistor R**2** and the resistor R**3** and input to the noninverting input terminal of the comparator **81**.

[0080] In addition, in the reference voltage switching circuit **93**, the transistor TR**1** is off in a case where the signal level of the digital signal S**17** output from the AND circuit **92** is the high level. In a case where the transistor TR**1** is off, a voltage output from the power supply PW**1** is divided into the second voltage lower than the first voltage by the resistor R**1**, the resistor R**2**, and the resistor R**3** and input to the noninverting input terminal of the comparator **81**.

[0081] In this way, in the image forming apparatus **100**, the threshold is changed from the first temperature to the second temperature in the acceleration period in which the rotation speed of the motor **47** increases. This makes it possible to prevent the fixing belt **41** from being excessively heated when the motor **47** is stopped or while the motor **47** is rotating at low speed in comparison with the configuration in which the threshold is constantly the second temperature.

[0082] In addition, in the image forming apparatus **100**, the threshold is changed from the second temperature to the first temperature when the deceleration period in which the rotation speed of the motor **47** decreases starts. This makes it possible to forcibly stop the supply of power to the heater **42** when the deceleration period starts even in a case where the CPU **11** exhibits runaway. It is thus possible to prevent the fixing belt **41** from being excessively heated before the rotation speed of the motor **47** decreases beyond the reference speed in comparison with the configuration in which the threshold is changed from the second temperature to the first temperature in a case where the rotation speed of the

motor **47** decreases beyond the reference speed. This makes it possible to prevent the fixing belt **41** from being damaged by excessive heating.

[0083] Additionally, in a case where a predetermined time passes after the motor **47** transitions to the drive state from the stop state, the threshold setting portion **72** may change the threshold from the first temperature to the second temperature. For example, the threshold setting portion **72** may include a delay circuit that outputs the received digital signal S**13** with a predetermined time delay instead of the speed determination portion **91**.

[0084] In addition, the threshold setting portion **72** may change the threshold step by step from the first temperature to the second temperature in the acceleration period. For example, in a case where the rotation speed of the motor **47** increases beyond a first speed lower than the reference speed, the threshold setting portion **72** may change the threshold from the first temperature to a third temperature between the first temperature and the second temperature. In a case where the rotation speed of the motor **47** increases beyond a second speed higher than the reference speed and lower than the specific speed, the threshold setting portion **72** may change the threshold from the third temperature to the second temperature.

[0085] In addition, the heater **42** may include the plurality of temperature sensors **54** disposed to be spaced apart from each other in the left-right direction D**3**. In this case, it is sufficient if the protection circuit **49** includes the power supply stopping portions **71** corresponding to the respective temperature sensors **54**.

[0086] In addition, the temperature sensor **54** may sense the temperature of a component member different from the heater **42** in the fixing device **27**. For example, the temperature sensor **54** may sense the temperature of the fixing belt **41**.

Supplementary Notes of Invention

[0087] The gist of the invention extracted from the embodiment described above will be supplementarily noted below. It is to be noted that the respective configurations and the respective processing functions described in the following supplementary notes can be sorted out and used in any combination.

Supplementary Note 1

[0088] A fixing device including:

[0089] a fixing member configured to fix a toner image transferred to a sheet onto the sheet;

[0090] a motor configured to rotate the fixing member;

[0091] a heater configured to heat the fixing member upon being supplied with power;

[0092] a temperature sensor configured to sense temperature of the fixing device;

[0093] a power supply stopping portion configured to stop supply of power to the heater in a case where the temperature sensed by the temperature sensor exceeds a preset threshold; and

[0094] a threshold setting portion configured to change the threshold from a predefined first temperature to a second temperature higher than the first temperature in an acceleration period in which rotation speed of the motor increases, and change the threshold from the second temperature to the first temperature when a deceleration period in which the rotation speed of the motor decreases starts.

Supplementary Note 2

[0095] An image forming apparatus including

[0096] an image forming portion including the fixing device according to Supplementary Note 1, the image forming portion being configured to form an image on the sheet.

[0097] It is to be understood that the embodiments herein are illustrative and not restrictive, since the scope of the disclosure is defined by the appended claims rather than by the description preceding them, and all changes that fall within metes and bounds of the claims, or equivalence of such metes and bounds thereof are therefore intended to be embraced by the claims.

1. A fixing device comprising:

a fixing member configured to fix a toner image transferred to a sheet onto the sheet;

a motor configured to rotate the fixing member;

a heater configured to heat the fixing member upon being supplied with power;

a temperature sensor configured to sense temperature of the fixing device;

a power supply stopping portion configured to stop supply of power to the heater in a case where the temperature sensed by the temperature sensor exceeds a preset threshold; and

a threshold setting portion configured to change the threshold from a predefined first temperature to a second temperature higher than the first temperature in an acceleration period in which rotation speed of the motor increases, and change the threshold from the second temperature to the first temperature when a deceleration period in which the rotation speed of the motor decreases starts.

2. An image forming apparatus comprising

an image forming portion including the fixing device according to claim **1**, the image forming portion being configured to form an image on the sheet.

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