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Aoki

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(54) **POWER CONTROL APPARATUS, IMAGE FORMING APPARATUS, POWER CONTROL METHOD, AND NON-TRANSITORY COMPUTER-EXECUTABLE MEDIUM**

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(30) **Foreign Application Priority Data**

Mar. 23, 2023 (JP) 2023-047118

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

(52) **U.S. Cl.**
CPC ***G03G 15/5004*** (2013.01); ***G03G 15/80*** (2013.01); *G03G 2215/00978* (2013.01); *G03G 2215/20* (2013.01)

(58) **Field of Classification Search**
USPC 399/88
See application file for complete search history.

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(57) **ABSTRACT**

A power control apparatus includes a power detection circuit to detect DC power converted from AC power supplied from a power supply and to be supplied to a control board of an image forming apparatus. The power control apparatus includes circuitry configured to, in response to a first printing operation performed by the image forming apparatus, calculate fluctuations in the DC power in each preset control period from a start of the first printing operation until stabilization of the DC power. The power control apparatus includes, in response to a printing operation subsequent to the first printing operation performed by the image forming apparatus, determine allocation of the AC power to a fixing device of the image forming apparatus in a next preset control period based on power obtained by adding, to the DC power, an average of the fluctuations in a plurality of preset control periods.

9 Claims, 15 Drawing Sheets

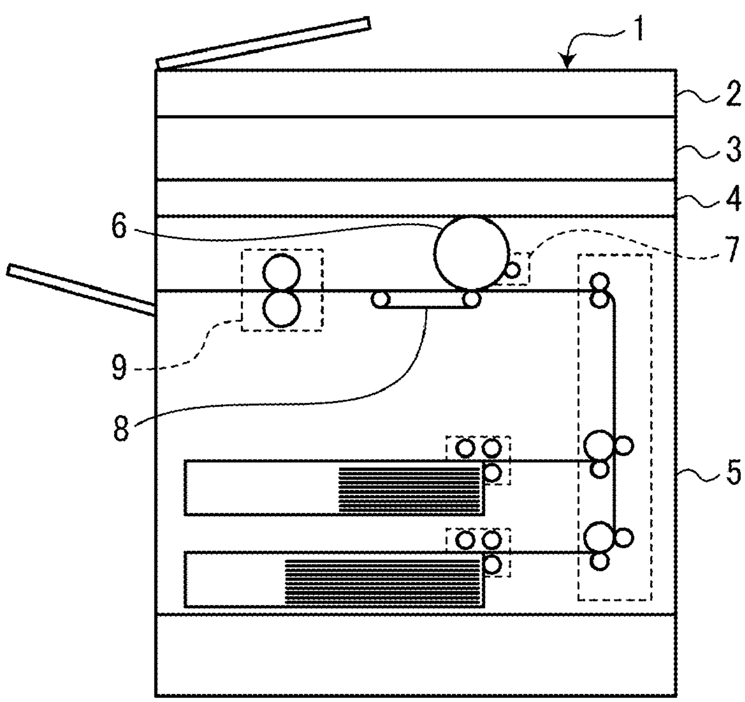


FIG. 1

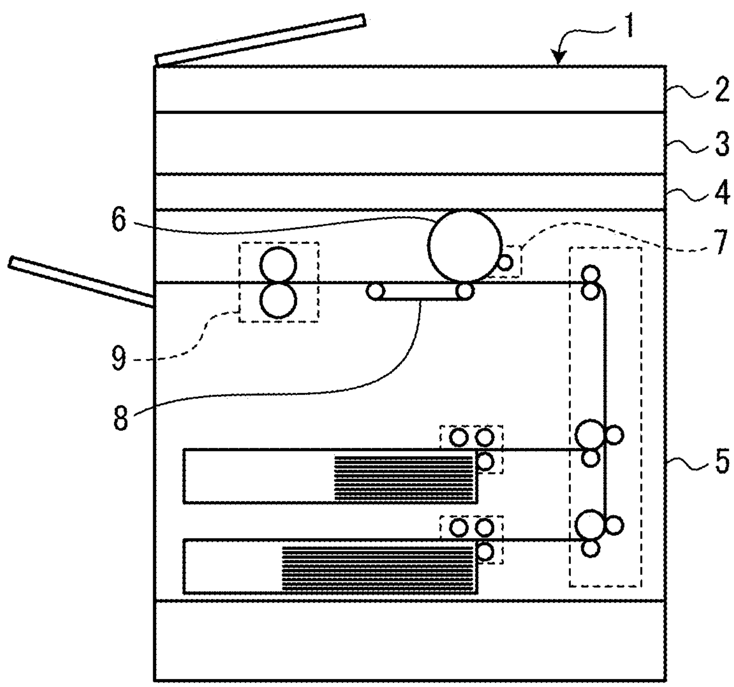


FIG. 2

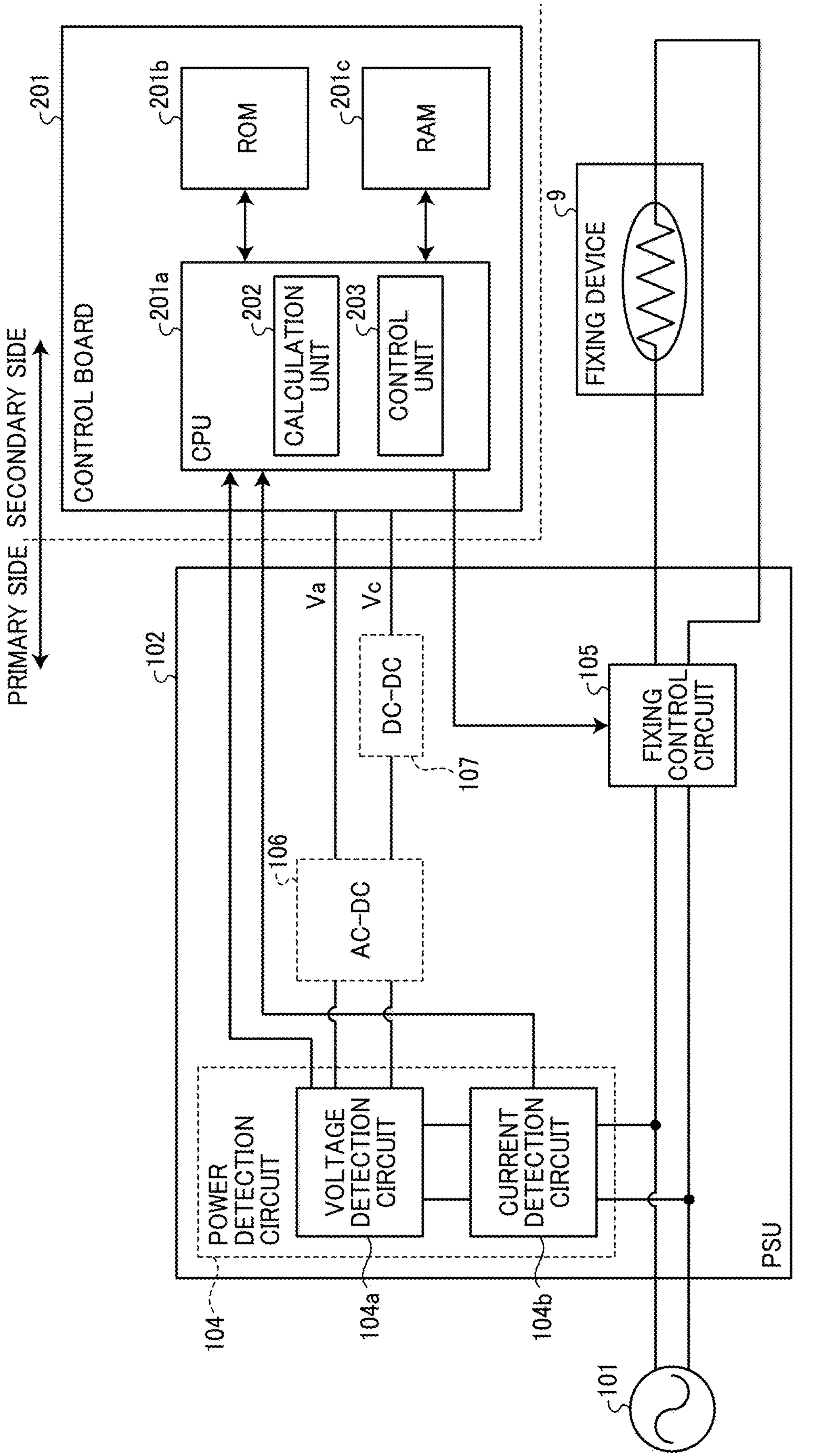

PRIMARY SIDE
SECONDARY SIDE
CONTROL BOARD
201
201a
CPU
202
CALCULATION UNIT
203
CONTROL UNIT
201b
ROM
201c
RAM
9
FIXING DEVICE
102
Va
Vc
DC-DC
107
AC-DC
106
105
FIXING CONTROL CIRCUIT
POWER DETECTION CIRCUIT
VOLTAGE DETECTION CIRCUIT
CURRENT DETECTION CIRCUIT
PSU
104
104a
104b
101

FIG. 3A

FIG. 3

FIG. 3A
FIG. 3B

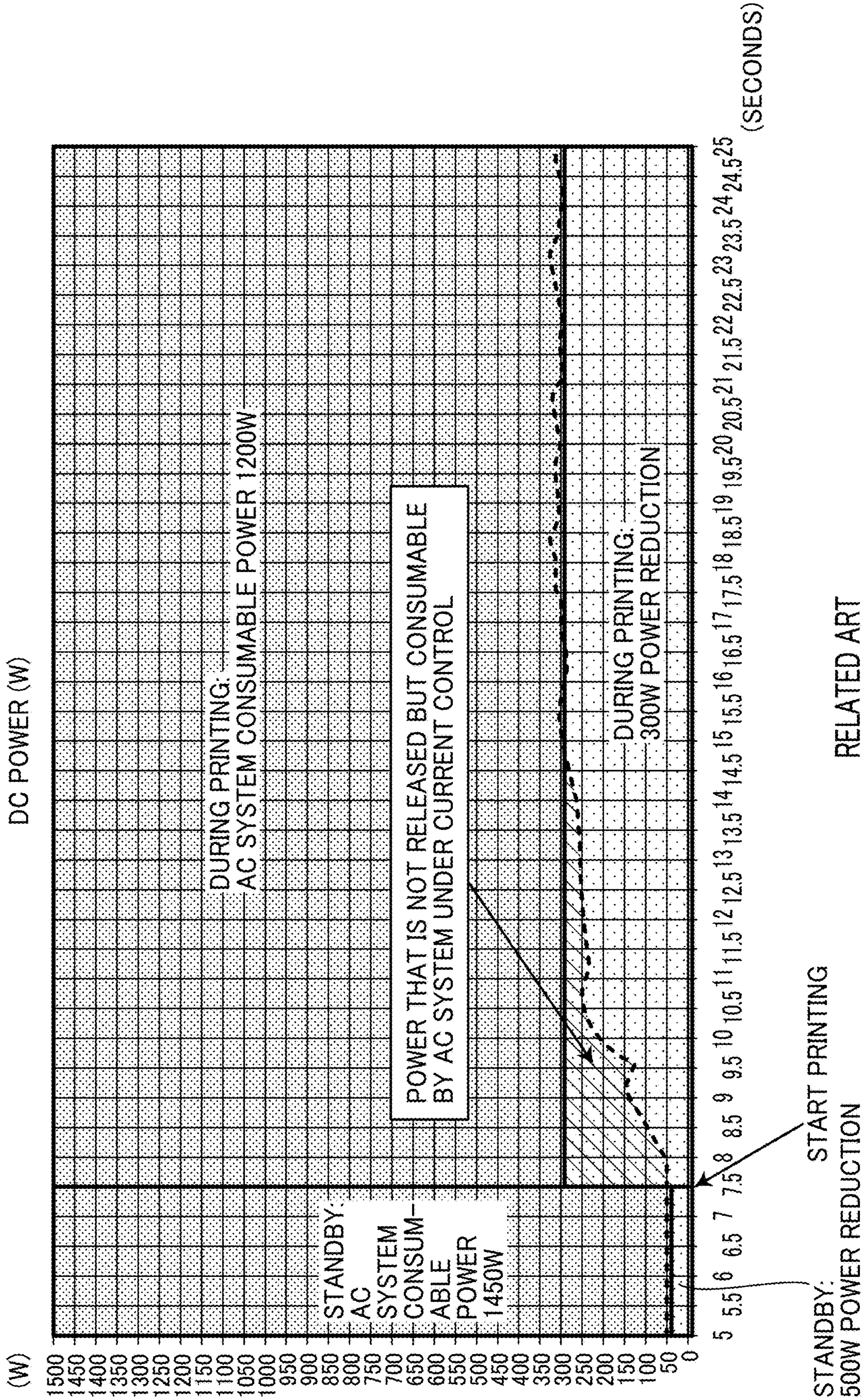
TABLE 1

PRINT SETTINGS		DF READING	SHEET EJECTION DESTINATION	STORAGE DESTINATION OF FLUCTUATION AMOUNT (Wfa), AND COUNT VALUE (K)
COLOR	ONE SIDED	NO READING	IN-BODY SHEET EJECTION	FC_S_001
			FIN SHEET EJECTION (NO POST-PROCESSING)	FC_S_002
			FIN SHEET EJECTION (WITH POST-PROCESSING)	FC_S_003
		EQUAL TO OR LESS THAN 300 dpi	IN-BODY SHEET EJECTION	FC_S_004
			FIN SHEET EJECTION (NO POST-PROCESSING)	FC_S_005
			FIN SHEET EJECTION (WITH POST-PROCESSING)	FC_S_006
		400dpi	IN-BODY SHEET EJECTION	FC_S_007
			FIN SHEET EJECTION (NO POST-PROCESSING)	FC_S_008
			FIN SHEET EJECTION (WITH POST-PROCESSING)	FC_S_009
		600dpi	IN-BODY SHEET EJECTION	FC_S_010
			FIN SHEET EJECTION (NO POST-PROCESSING)	FC_S_011
			FIN SHEET EJECTION (WITH POST-PROCESSING)	FC_S_012
	DU-PLEX	NO READING	IN-BODY SHEET EJECTION	FC_D_001
			FIN SHEET EJECTION (NO POST-PROCESSING)	FC_D_002
			FIN SHEET EJECTION (WITH POST-PROCESSING)	FC_D_003
		EQUAL TO OR LESS THAN 300 dpi	IN-BODY SHEET EJECTION	FC_D_004
			FIN SHEET EJECTION (NO POST-PROCESSING)	FC_D_005
			FIN SHEET EJECTION (WITH POST-PROCESSING)	FC_D_006
		400dpi	IN-BODY SHEET EJECTION	FC_D_007
			FIN SHEET EJECTION (NO POST-PROCESSING)	FC_D_008
			FIN SHEET EJECTION (WITH POST-PROCESSING)	FC_D_009
			IN-BODY SHEET EJECTION	FC_D_010

FIG. 3B

		600dpi	FIN SHEET EJECTION (NO POST-PROCESSING)	FC_D_011
			FIN SHEET EJECTION (WITH POST-PROCESSING)	FC_D_012
MONO-CHROME	ONE SIDED	NO READING	IN-BODY SHEET EJECTION	BK_S_001
			FIN SHEET EJECTION (NO POST-PROCESSING)	BK_S_002
			FIN SHEET EJECTION (WITH POST-PROCESSING)	BK_S_003
		EQUAL TO OR LESS THAN 300 dpi	IN-BODY SHEET EJECTION	BK_S_004
			FIN SHEET EJECTION (NO POST-PROCESSING)	BK_S_005
			FIN SHEET EJECTION (WITH POST-PROCESSING)	BK_S_006
		400dpi	IN-BODY SHEET EJECTION	BK_S_007
			FIN SHEET EJECTION (NO POST-PROCESSING)	BK_S_008
			FIN SHEET EJECTION (WITH POST-PROCESSING)	BK_S_009
		600dpi	IN-BODY SHEET EJECTION	BK_S_010
			FIN SHEET EJECTION (NO POST-PROCESSING)	BK_S_011
			FIN SHEET EJECTION (WITH POST-PROCESSING)	BK_S_012
	DU-PLEX	NO READING	IN-BODY SHEET EJECTION	BK_D_001
			FIN SHEET EJECTION (NO POST-PROCESSING)	BK_D_002
			FIN SHEET EJECTION (WITH POST-PROCESSING)	BK_D_003
		EQUAL TO OR LESS THAN 300 dpi	IN-BODY SHEET EJECTION	BK_D_004
			FIN SHEET EJECTION (NO POST-PROCESSING)	BK_D_005
			FIN SHEET EJECTION (WITH POST-PROCESSING)	BK_D_006
		400dpi	IN-BODY SHEET EJECTION	BK_D_007
			FIN SHEET EJECTION (NO POST-PROCESSING)	BK_D_008
			FIN SHEET EJECTION (WITH POST-PROCESSING)	BK_D_009
		600dpi	IN-BODY SHEET EJECTION	BK_D_010
			FIN SHEET EJECTION (NO POST-PROCESSING)	BK_D_011
			FIN SHEET EJECTION (WITH POST-PROCESSING)	BK_D_012

FIG. 4



RELATED ART

FIG. 5

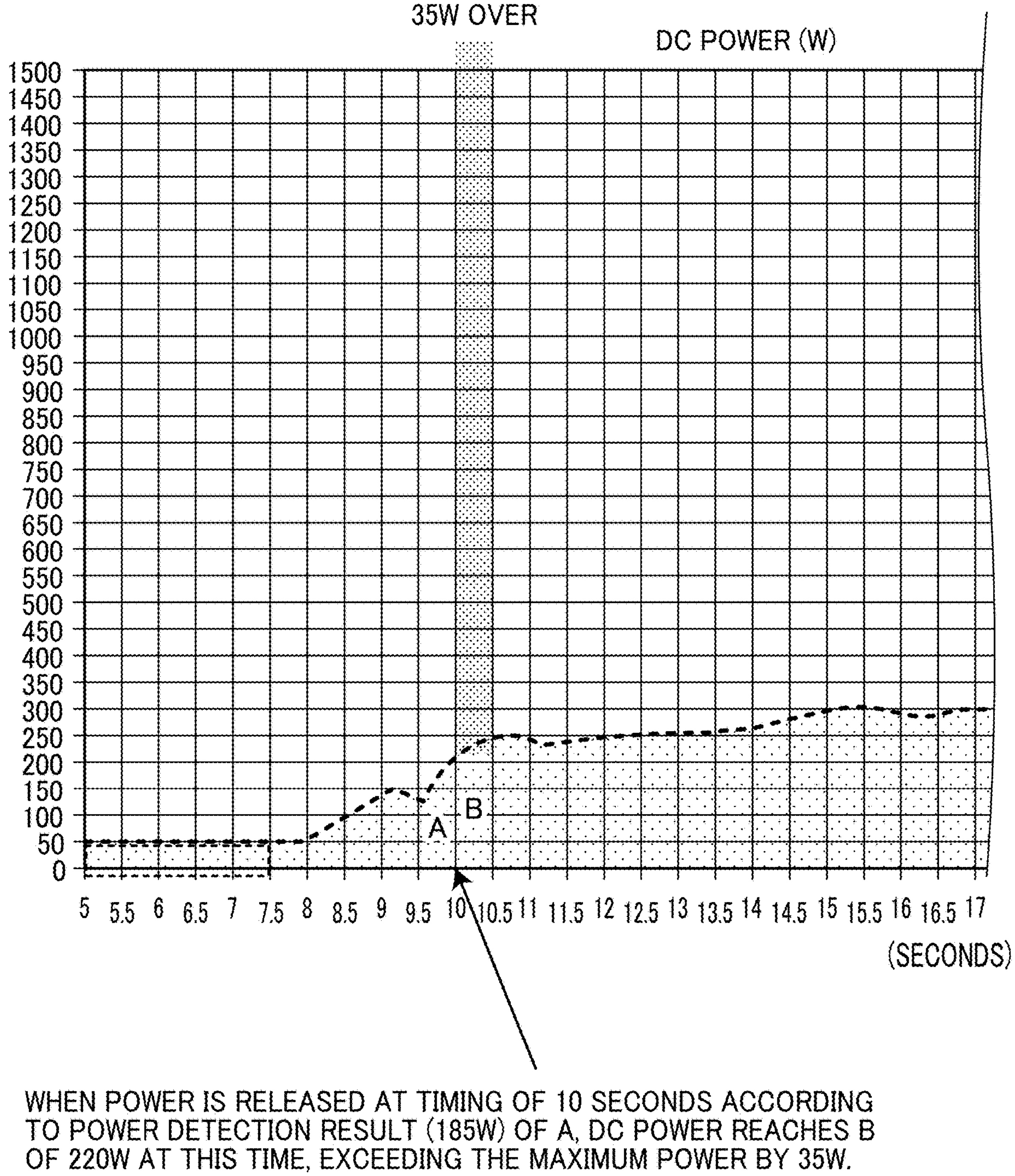
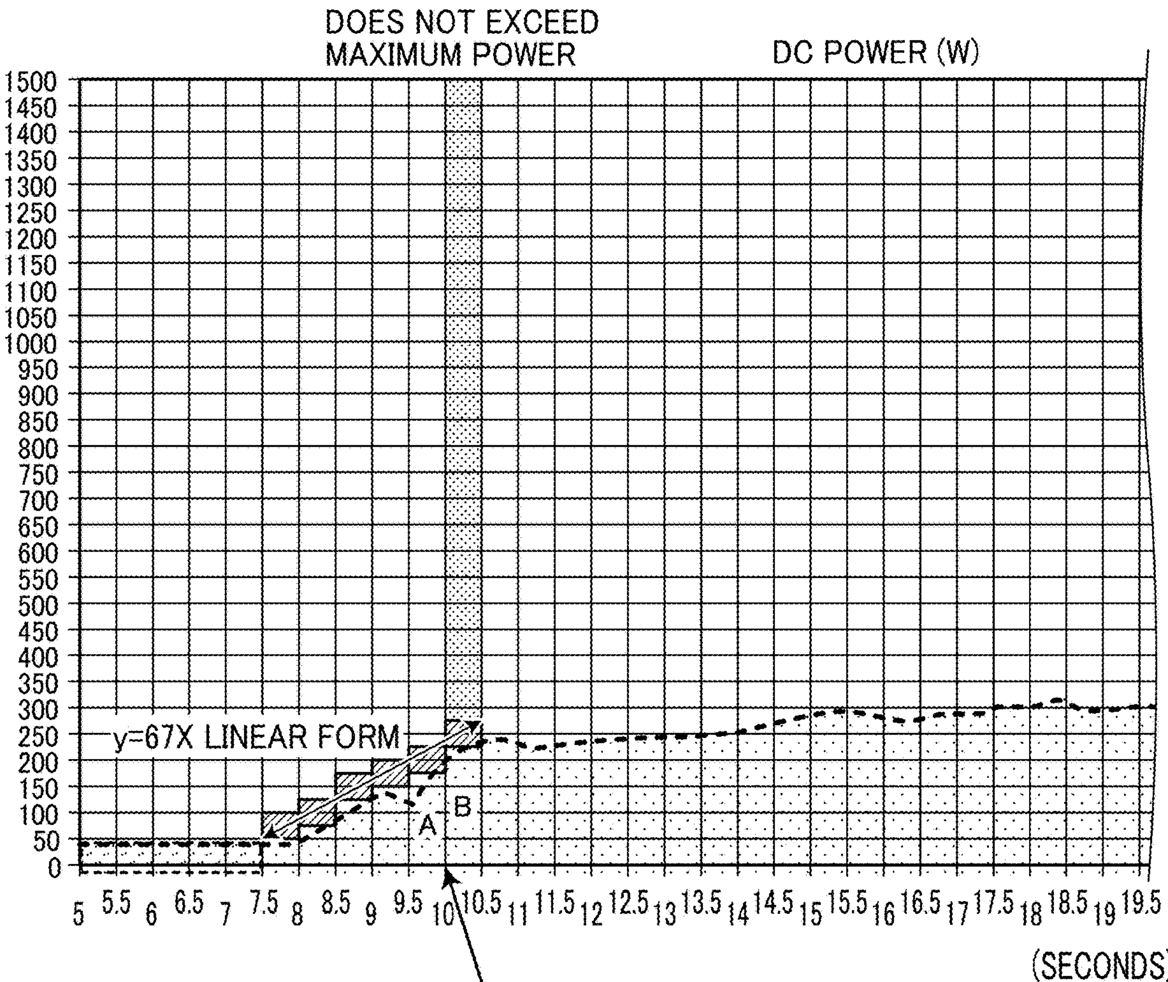

35W OVER
DC POWER (W)
1500
1450
1400
1350
1300
1250
1200
1150
1100
1050
1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
A
B
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
14
14.5
15
15.5
16
16.5
17
(SECONDS)
WHEN POWER IS RELEASED AT TIMING OF 10 SECONDS ACCORDING TO POWER DETECTION RESULT (185W) OF A, DC POWER REACHES B OF 220W AT THIS TIME, EXCEEDING THE MAXIMUM POWER BY 35W.

FIG. 6



DURING APPLICATION PERIOD OF LINEAR FORM, ADD 35W AS FLUCTUATION AMOUNT EVERY 0.5 SECONDS ACCORDING TO LINEAR FORM OBTAINED BASED ON POWER DETECTION RESULT.

↓

SINCE POWER IS RELEASED AT 220W, WHICH IS OBTAINED BY ADDING FLUCTUATION AMOUNT OF 35W TO DC POWER DETECTION RESULT OF A (185W) AT TIMING OF 10 SECONDS, EVEN WHEN DC POWER OF B IS 220W, AC POWER TO FIXING DEVICE DOES NOT EXCEED MAXIMUM POWER.

FIG. 7A

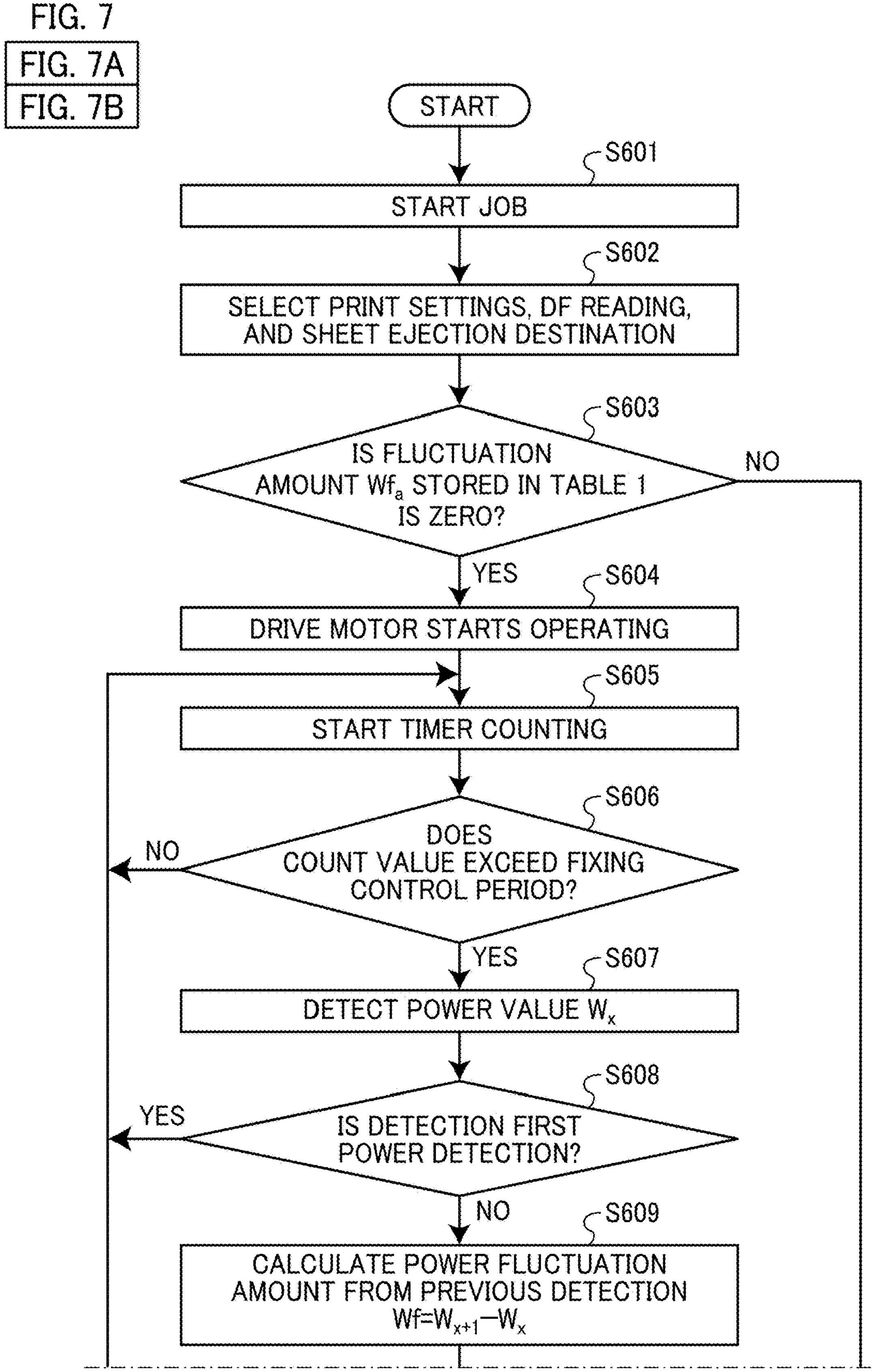


FIG. 7
FIG. 7A
FIG. 7B
START
S601
START JOB
S602
SELECT PRINT SETTINGS, DF READING, AND SHEET EJECTION DESTINATION
S603
IS FLUCTUATION AMOUNT Wfa STORED IN TABLE 1 IS ZERO?
NO
YES
S604
DRIVE MOTOR STARTS OPERATING
S605
START TIMER COUNTING
S606
DOES COUNT VALUE EXCEED FIXING CONTROL PERIOD?
NO
YES
S607
DETECT POWER VALUE Wx
S608
IS DETECTION FIRST POWER DETECTION?
YES
NO
S609
CALCULATE POWER FLUCTUATION AMOUNT FROM PREVIOUS DETECTION
Wf=Wx+1−Wx

FIG. 7B

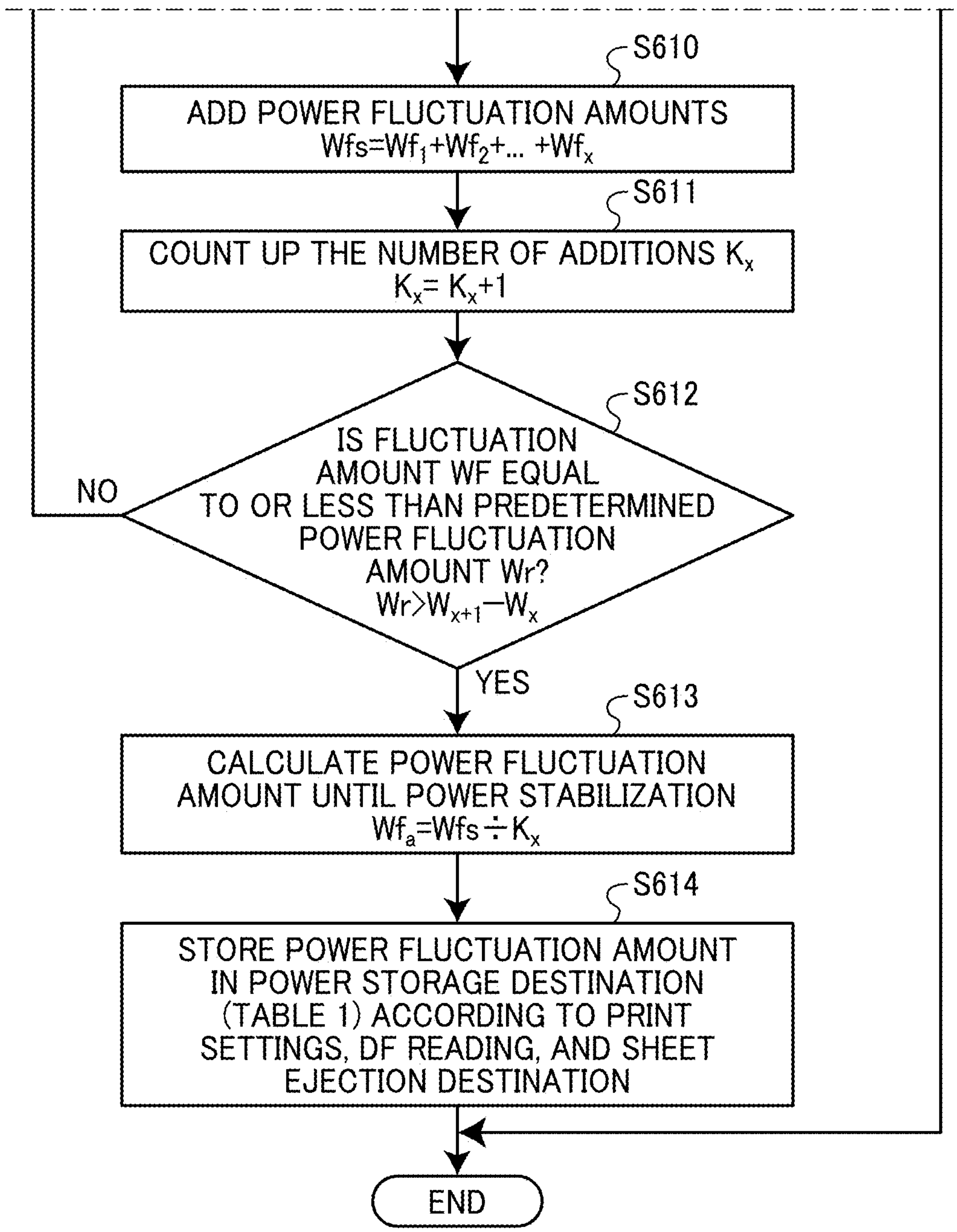

S610
ADD POWER FLUCTUATION AMOUNTS
$Wfs=Wf_1+Wf_2+... +Wf_x$
S611
COUNT UP THE NUMBER OF ADDITIONS K_x
$K_x= K_x+1$
S612
IS FLUCTUATION AMOUNT WF EQUAL TO OR LESS THAN PREDETERMINED POWER FLUCTUATION AMOUNT Wr?
$Wr>W_{x+1}-W_x$
NO
YES
S613
CALCULATE POWER FLUCTUATION AMOUNT UNTIL POWER STABILIZATION
$Wf_a=Wfs\div K_x$
S614
STORE POWER FLUCTUATION AMOUNT IN POWER STORAGE DESTINATION (TABLE 1) ACCORDING TO PRINT SETTINGS, DF READING, AND SHEET EJECTION DESTINATION
END

FIG. 8A

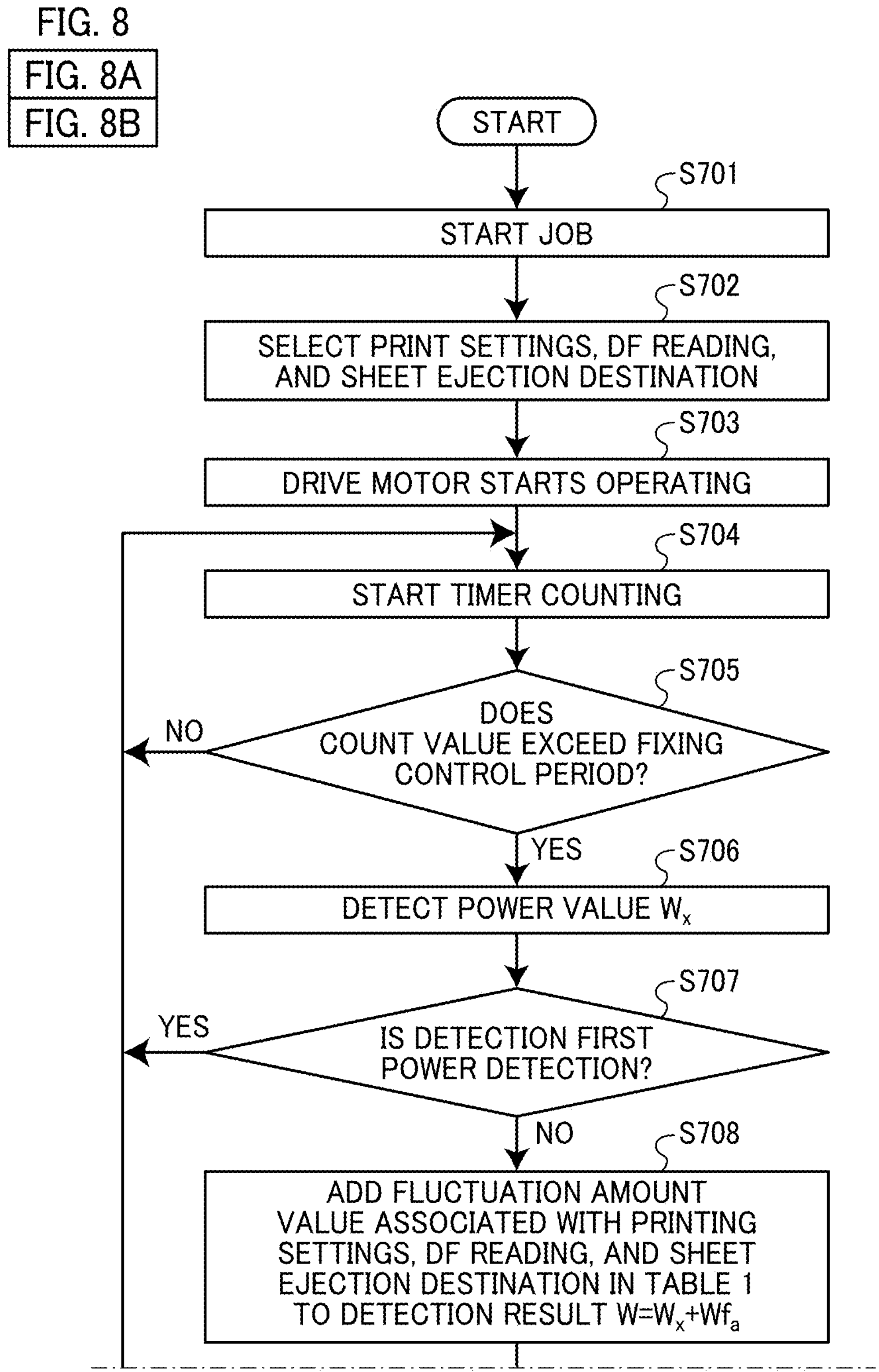


FIG. 8
FIG. 8A
FIG. 8B
START
S701
START JOB
S702
SELECT PRINT SETTINGS, DF READING, AND SHEET EJECTION DESTINATION
S703
DRIVE MOTOR STARTS OPERATING
S704
START TIMER COUNTING
S705
DOES COUNT VALUE EXCEED FIXING CONTROL PERIOD?
NO
YES
S706
DETECT POWER VALUE W_x
S707
IS DETECTION FIRST POWER DETECTION?
YES
NO
S708
ADD FLUCTUATION AMOUNT VALUE ASSOCIATED WITH PRINTING SETTINGS, DF READING, AND SHEET EJECTION DESTINATION IN TABLE 1 TO DETECTION RESULT $W=W_x+Wf_a$

FIG. 8B

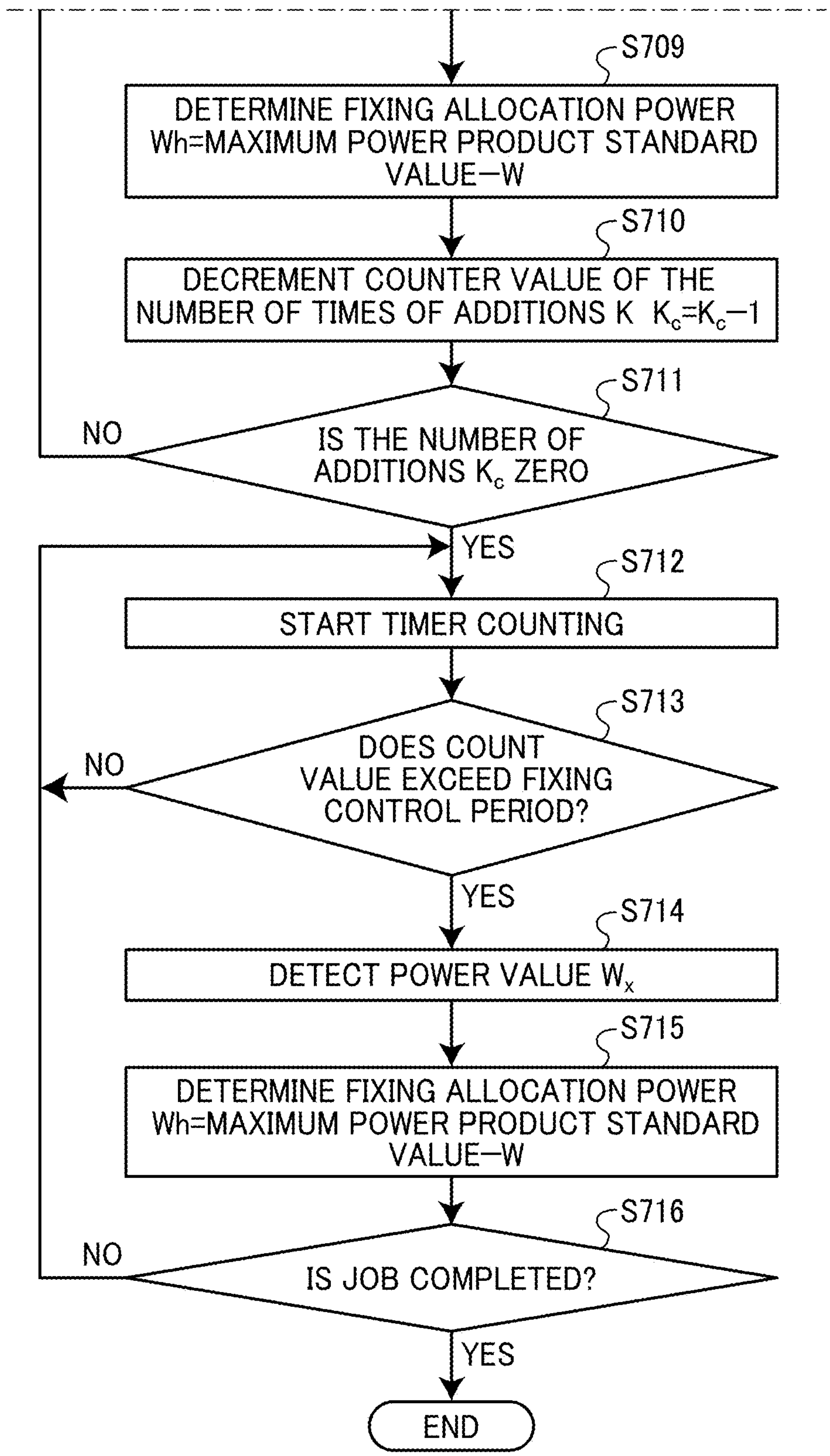

S709
DETERMINE FIXING ALLOCATION POWER Wh=MAXIMUM POWER PRODUCT STANDARD VALUE−W
S710
DECREMENT COUNTER VALUE OF THE NUMBER OF TIMES OF ADDITIONS K $K_c=K_c-1$
S711
IS THE NUMBER OF ADDITIONS K_c ZERO
NO
YES
S712
START TIMER COUNTING
S713
DOES COUNT VALUE EXCEED FIXING CONTROL PERIOD?
NO
YES
S714
DETECT POWER VALUE W_x
S715
DETERMINE FIXING ALLOCATION POWER Wh=MAXIMUM POWER PRODUCT STANDARD VALUE−W
S716
IS JOB COMPLETED?
NO
YES
END

FIG. 9A

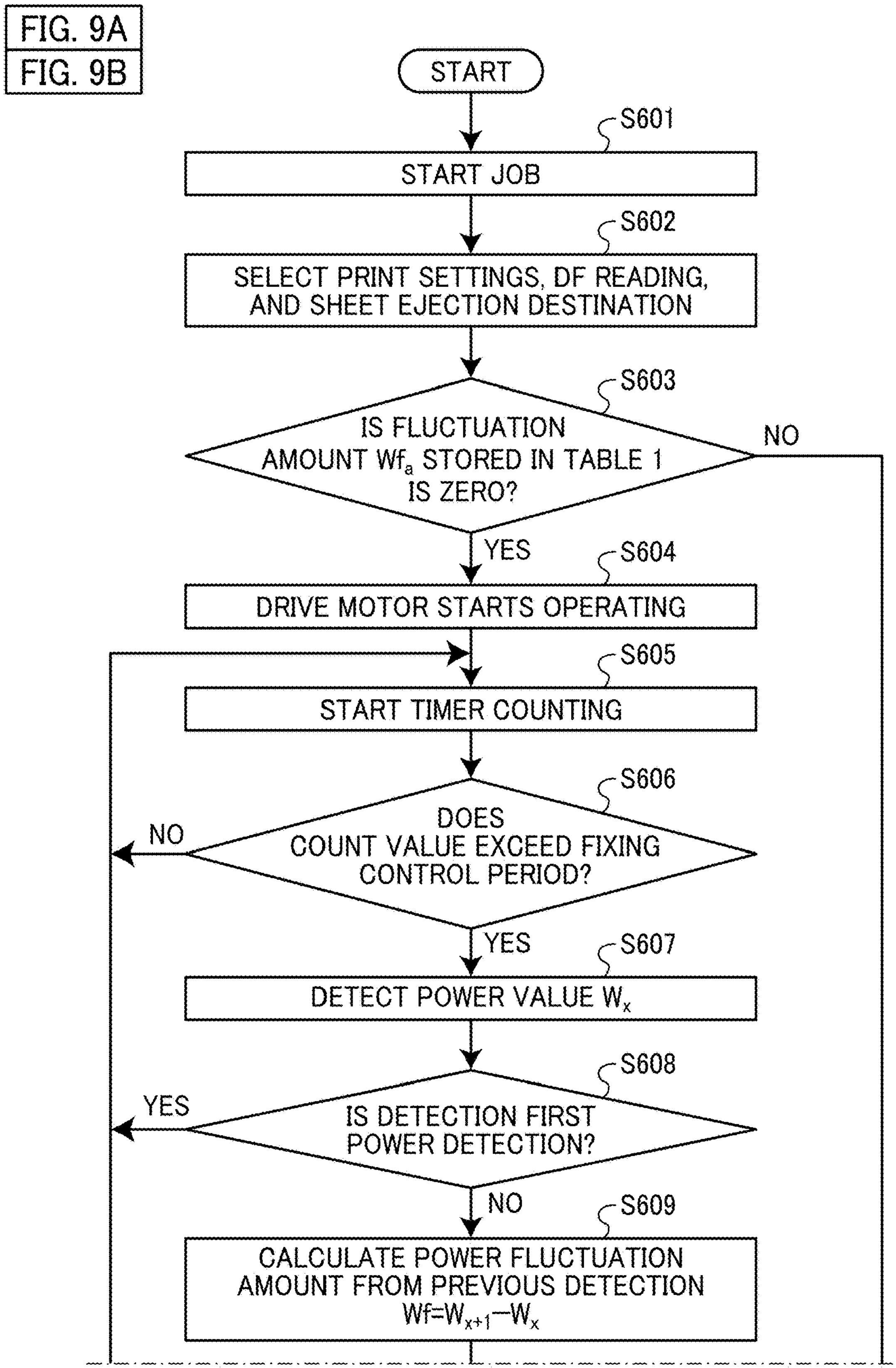


FIG. 9
FIG. 9A
FIG. 9B
START
S601
START JOB
S602
SELECT PRINT SETTINGS, DF READING, AND SHEET EJECTION DESTINATION
S603
IS FLUCTUATION AMOUNT Wf_a STORED IN TABLE 1 IS ZERO?
NO
YES
S604
DRIVE MOTOR STARTS OPERATING
S605
START TIMER COUNTING
S606
DOES COUNT VALUE EXCEED FIXING CONTROL PERIOD?
NO
YES
S607
DETECT POWER VALUE W_x
S608
IS DETECTION FIRST POWER DETECTION?
YES
NO
S609
CALCULATE POWER FLUCTUATION AMOUNT FROM PREVIOUS DETECTION
$Wf=W_{x+1}-W_x$

FIG. 9B

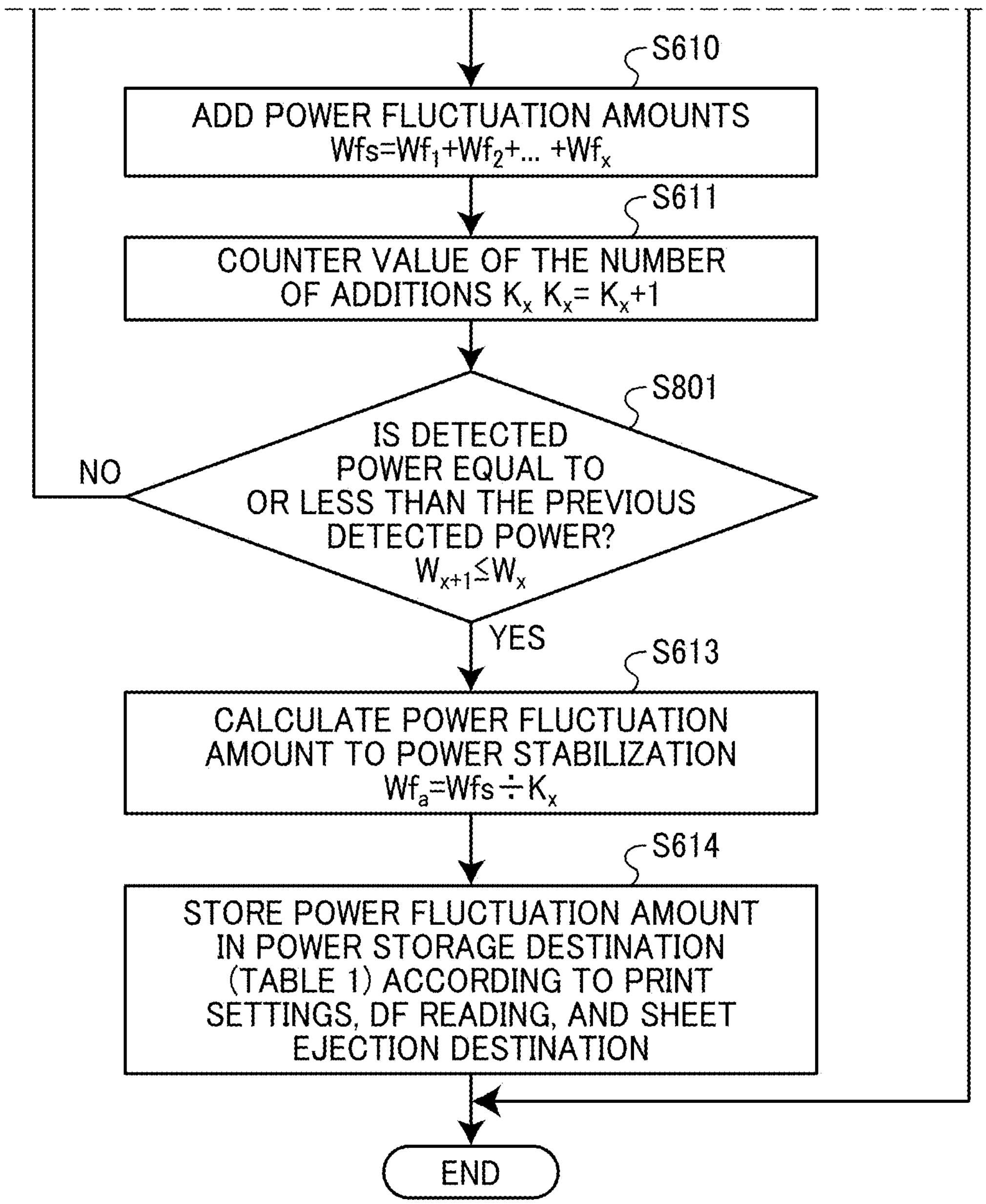

S610
ADD POWER FLUCTUATION AMOUNTS
$Wfs=Wf_1+Wf_2+\ldots +Wf_x$
S611
COUNTER VALUE OF THE NUMBER OF ADDITIONS K_x $K_x= K_x+1$
S801
IS DETECTED POWER EQUAL TO OR LESS THAN THE PREVIOUS DETECTED POWER?
$W_{x+1}\leq W_x$
NO
YES
S613
CALCULATE POWER FLUCTUATION AMOUNT TO POWER STABILIZATION
$Wf_a=Wfs \div K_x$
S614
STORE POWER FLUCTUATION AMOUNT IN POWER STORAGE DESTINATION (TABLE 1) ACCORDING TO PRINT SETTINGS, DF READING, AND SHEET EJECTION DESTINATION
END

FIG. 10A

FIG. 10

FIG. 10A
FIG. 10B

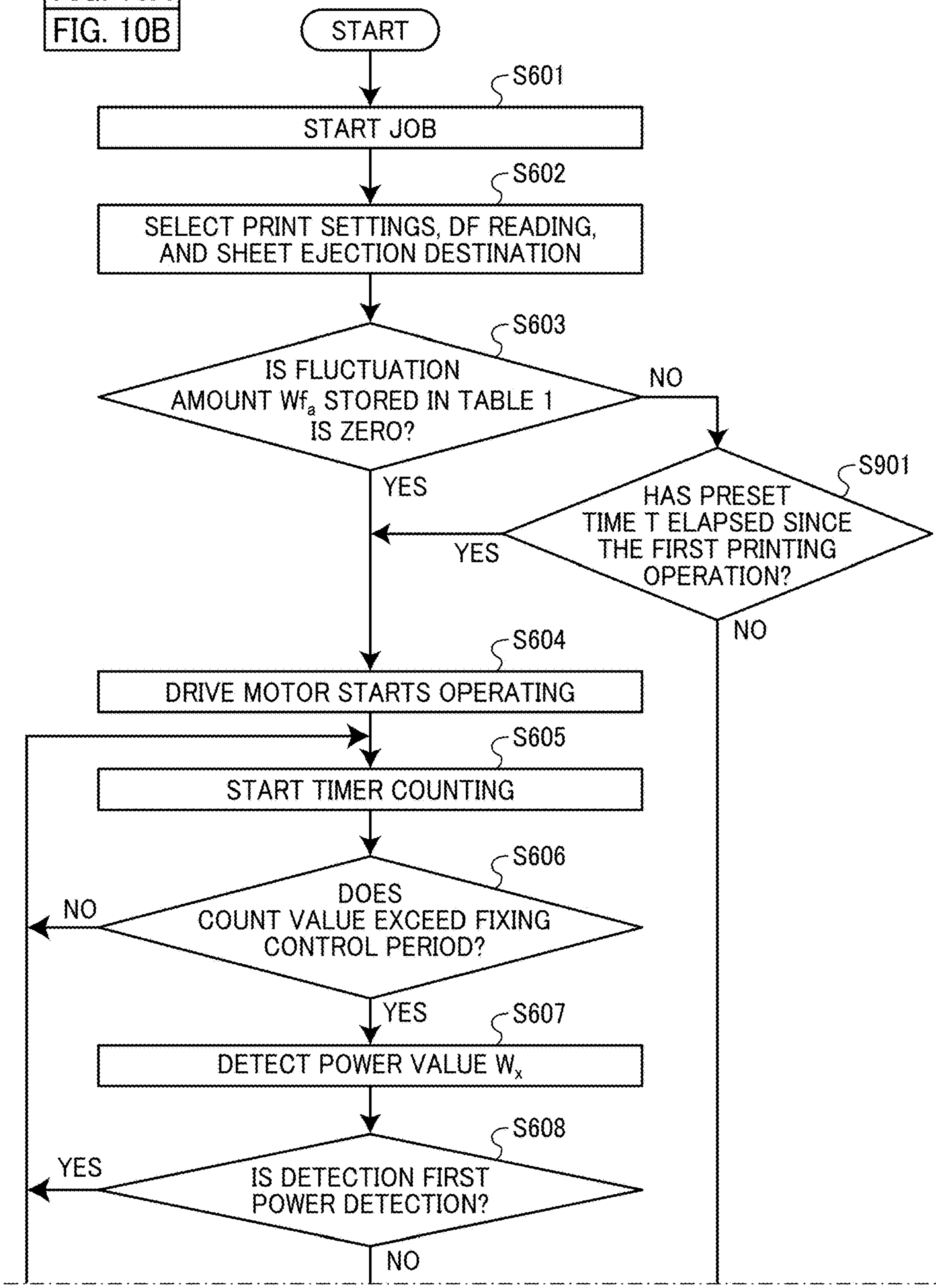
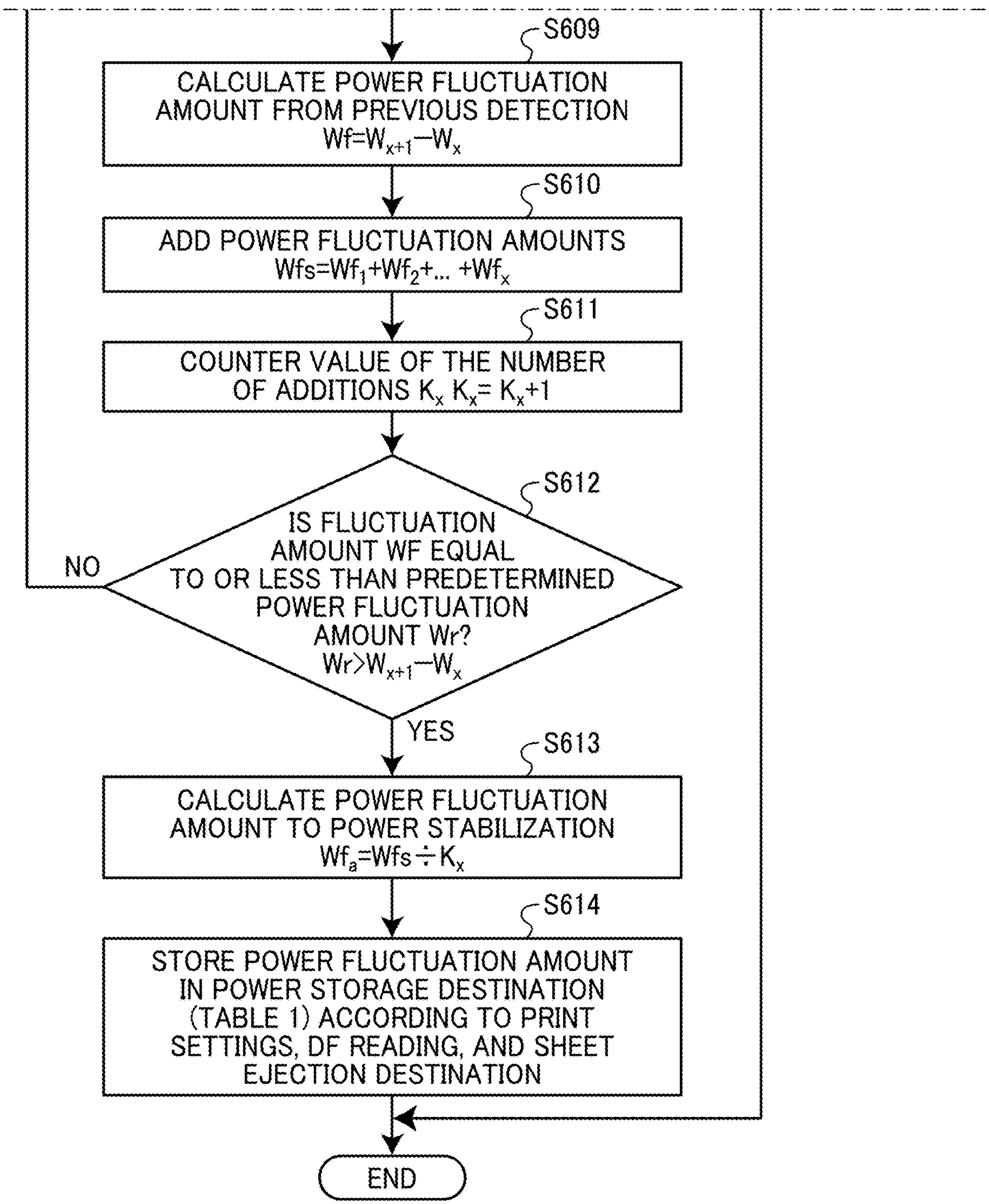


FIG. 10B


S609
CALCULATE POWER FLUCTUATION AMOUNT FROM PREVIOUS DETECTION
$Wf=W_{x+1}-W_x$
S610
ADD POWER FLUCTUATION AMOUNTS
$Wfs=Wf_1+Wf_2+\ldots+Wf_x$
S611
COUNTER VALUE OF THE NUMBER OF ADDITIONS K_x $K_x=K_x+1$
S612
IS FLUCTUATION AMOUNT WF EQUAL TO OR LESS THAN PREDETERMINED POWER FLUCTUATION AMOUNT Wr?
$Wr>W_{x+1}-W_x$
NO
YES
S613
CALCULATE POWER FLUCTUATION AMOUNT TO POWER STABILIZATION
$Wf_a=Wfs\div K_x$
S614
STORE POWER FLUCTUATION AMOUNT IN POWER STORAGE DESTINATION (TABLE 1) ACCORDING TO PRINT SETTINGS, DF READING, AND SHEET EJECTION DESTINATION
END

POWER CONTROL APPARATUS, IMAGE FORMING APPARATUS, POWER CONTROL METHOD, AND NON-TRANSITORY COMPUTER-EXECUTABLE MEDIUM

CROSS-REFERENCE TO RELATED APPLICATION

This patent application is based on and claims priority pursuant to 35 U.S.C. § 119(a) to Japanese Patent Application No. 2023-047118, filed on Mar. 23, 2023, in the Japan Patent Office, the entire disclosure of which is hereby incorporated by reference herein.

BACKGROUND

Technical Field

Embodiments of the present disclosure relate to a power control apparatus, an image forming apparatus, a power control method, and a non-transitory computer-executable medium.

Related Art

In image forming apparatuses, a technology for controlling power is known. According to such a technology, secondary-side direct current (DC) power is detected during an apparatus operation time such as a printing operation time to reduce alternating current (AC) power in an AC system (primary side) such as power allocated to fixing. Thus, the AC current is prevented from exceeding a rated current on the facility side, a rated current or rated power of the apparatus. However, according to such a power control technology, since the apparatus operation is detected and then power allocated for fixing is reduced, DC power for each apparatus operation status stored in advance is used. For this reason, power is not reduced in accordance with the fluctuation of the DC power in the apparatus operation status. This leads to excessive reduction of the power allocated for fixing.

In view of the above-described drawback, a technology is known according to which secondary-side DC power is detected and power allocated for fixing is determined on the basis of the detection result in order to efficiently supply power to the fixing side.

SUMMARY

According to an embodiment of the present disclosure, a power control apparatus includes a power detection circuit and circuitry. The power detection circuit detects direct current (DC) power converted from alternating current (AC) power supplied from a power supply and to be supplied to a control board of an image forming apparatus. The circuitry, in response to a first printing operation performed by the image forming apparatus, calculates fluctuations in the DC power in each preset control period from a start of the first printing operation until stabilization of the DC power. The circuitry, in response to a printing operation subsequent to the first printing operation performed by the image forming apparatus, determines allocation of the AC power to a fixing device of the image forming apparatus in a next preset control period based on power obtained by adding, to the DC power, an average of the fluctuations in a plurality of preset control periods.

According to an embodiment of the present disclosure, an image forming apparatus includes the above-described power control apparatus.

According to an embodiment of the present disclosure, a power control method performed by a power control apparatus includes detecting DC power converted from AC power supplied from a power supply and to be supplied to a control board of an image forming apparatus. The power control method includes, in response to a first printing operation performed by the image forming apparatus, calculating fluctuations in the DC power in each preset control period from a start of the first printing operation until stabilization of the DC power. The power control method includes, in response to a printing operation subsequent to the first printing operation performed by the image forming apparatus, determining allocation of the AC power to a fixing device of the image forming apparatus in a next preset control period based on power obtained by adding, to the DC power, an average of the fluctuations in a plurality of preset control periods.

According to an embodiment of the present disclosure, a non-transitory computer-executable medium stores a plurality of instructions which, when executed by one or more processors, cause the one or more processors to perform a power control method. The power control method includes acquiring a result of detecting DC power converted from AC power supplied from a power supply and to be supplied to a control board of an image forming apparatus. The power control method includes, in response to a first printing operation performed by the image forming apparatus, calculating fluctuations in the DC power in each preset control period from a start of the first printing operation until stabilization of the DC power. The power control method includes, in response to a printing operation subsequent to the first printing operation performed by the image forming apparatus, determining allocation of the AC power to a fixing device of the image forming apparatus in a next preset control period based on power obtained by adding, to the DC power, an average of the fluctuations in a plurality of preset control periods.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of embodiments of the present disclosure and many of the attendant advantages and features thereof can be readily obtained and understood from the following detailed description with reference to the accompanying drawings, wherein:

FIG. **1** is a diagram illustrating a configuration of an image forming apparatus according to Embodiment 1 of the present disclosure;

FIG. **2** is a diagram illustrating a circuit configuration of the image forming apparatus, according to Embodiment 1 of the present disclosure;

FIGS. **3**A and **3**B (FIG. **3**) are a table stored in a storage unit in which calculated amounts of fluctuation or a storage destination in which the calculated amounts of fluctuation are stored are associated with print modes, according to an embodiment of the present disclosure;

FIG. **4** is a diagram for describing an example of a process of determining power allocated to fixing in the image forming apparatus, according to Embodiment 1 of the present disclosure;

FIG. **5** is a diagram for describing an example of a process of determining power allocated to fixing in the image forming apparatus, according to Embodiment 1 of the present disclosure;

FIG. **6** is a diagram for describing an example of a process of determining power allocated to fixing in the image forming apparatus, according to Embodiment 1 of the present disclosure;

FIGS. **7**A and **7**B (FIG. **7**) are a flowchart of an example of a flow of a process of calculating an amount of fluctuation in DC power in the image forming apparatus, according to Embodiment 1 of the present disclosure;

FIGS. **8**A and **8**B (FIG. **8**) are a flowchart of an example of a flow of a process of determining power allocated to fixing in the image forming apparatus, according to Embodiment 1 of the present disclosure;

FIGS. **9**A and **9**B (FIG. **9**) are a flowchart of an example of a flow of a process of calculating an amount of fluctuation in DC power in the image forming apparatus, according to Embodiment 2 of the present disclosure; and

FIGS. **10**A and **10**B (FIG. **10**) are a flowchart of an example of a flow of a process of calculating an amount of fluctuation in DC power in the image forming apparatus, according to Embodiment 3 of the present disclosure.

The accompanying drawings are intended to depict embodiments of the present disclosure and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted. Also, identical or similar reference numerals designate identical or similar components throughout the several views.

DETAILED DESCRIPTION

In describing embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that have a similar function, operate in a similar manner, and achieve a similar result.

Referring now to the drawings, embodiments of the present disclosure are described below. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

A description is now given in detail of embodiments of a power control apparatus, an image forming apparatus, a power control method, and a program with reference to the accompanying drawings.

Embodiment 1

FIG. **1** is a diagram illustrating an example of a configuration of an image forming apparatus according to Embodiment 1. As illustrated in FIG. **1**, an image forming apparatus **1** according to the present embodiment is, for example, a digital multifunction peripheral, and has functions such as a copier function, a printer function, and a facsimile function. The image forming apparatus **1** according to the present embodiment includes a control panel including an application (or mode) switch key that receives an operation for sequentially switching and selecting the copier function, the printer function, and the facsimile function. The image forming apparatus **1** operates in a copy mode when the copier function is selected, operates in a printer mode when the printer function is selected, and operates in a facsimile mode when the facsimile function is selected.

With reference to FIG. **1**, a brief description is given of a flow of image formation by the image forming apparatus **1** according to the present embodiment, taking the copy mode as an example. In the copy mode, an automatic document feeder (ADF) **2** feeds documents of a document bundle one by one to an image reading device **3**, and the image reading device **3** reads image information. A writing unit **4** as a writing means converts the read image information into optical information via an image processing means. A photoconductor drum **6** is uniformly charged by a charger, and then exposed to the optical information from the writing unit **4**. Thus, an electrostatic latent image is formed. The electrostatic latent image on the photoconductor drum **6** is developed by a developing device **7** into a toner image. The toner image is transferred from a conveyance belt **8** to a transfer sheet that is fed from a sheet feeder unit to the conveyance belt **8**. The photoconductor drum **6**, the developing device **7**, and the conveyance belt **8** serve as an image forming device to form an image. After this operation, the toner image is fixed on the transfer paper by a fixing device **9**, and the transfer paper is ejected.

FIG. **2** is a diagram illustrating an example of a circuit configuration of the image forming apparatus **1** according to Embodiment 1. As illustrated in FIG. **2**, the circuit configuration of the image forming apparatus **1** according to the present embodiment is divided into a primary-side circuit and a secondary-side circuit. A power supply **101**, a power supply unit (PSU) **102**, and the fixing device **9** are provided on the primary-side circuit. A control board **201** is provided on the secondary-side circuit.

A power detection circuit **104**, a fixing control circuit **105**, an alternating current (AC)-direct current (DC) conversion unit **106**, and a DC-DC conversion unit **107**, are mounted on the PSU **102**. A central processing unit (CPU) **201***a*, a read-only memory (ROM) **201***b*, and a random-access memory (RAM) **201***c* are mounted on the control board **201**.

The AC-DC conversion unit **106** converts AC power supplied from the power supply **101** into DC power and supplies the DC power to the control board **201**. The DC-DC conversion unit **107** converts the voltage of the DC power converted from the AC power by the AC-DC conversion unit **106** and supplies the DC power to the control board **201**. The fixing control circuit **105** is mounted on, for example, the PSU **102**, and switches between the energized mode and the de-energized mode of the fixing device **9** in accordance with a signal from the CPU **201***a* of the control board **201**.

The power detection circuit **104** is an example of a power detection unit to detect the DC power supplied to the control board **201**. In the present embodiment, the power detection circuit **104** includes a current detection circuit **104***b* and a voltage detection circuit **104***a*, and is mounted on the PSU **102**. The current detection circuit **104***b* detects current consumption during operation of the image forming apparatus **1**. The voltage detection circuit **104***a* detects power supply voltages Va and Vc of a power supply environment (i.e., the power supply **101**). The power detection circuit **104** detects power consumption (DC power) during operation of the image forming apparatus **1**.

The detected power supply voltages Va and Vc, current consumption, and power consumption are subjected to analog/digital (A/D) conversion by the CPU **201***a* on the control board **201**, and stored in, for example, the ROM **201***b* or the RAM **201***c*. The ROM **201***b* and the RAM **201***c* further stores, for example, power consumption detected at the time of the first printing operation by the image forming apparatus **1**, power supply voltages Va and Vc, a detected current, power information provided in advance.

The CPU **201***a* controls an ON/OFF signal to be sent to the fixing control circuit **105** on the basis of the power consumption at the time of the first printing operation by the image forming apparatus **1** stored in the ROM **201***b* and the RAM **201***c* in accordance with a time when the control of the fixing device **9** is started to change the pattern of the energization to the fixing device **9**.

Specifically, the CPU **201***a* includes a calculation unit **202** and a control unit **203**. The calculation unit **202** acquires the detection result of DC power detected by the power detection circuit **104**. Further, the calculation unit **202** calculates fluctuations in the DC power from the start of the printing operation to the stabilization of the DC power respectively for multiple preset control periods (i.e., fixing control periods) when the first printing operation is performed in the image forming apparatus **1**. The calculation unit **202** serves as a calculation unit according to an embodiment of the present disclosure. Furthermore, the calculation unit **202** stores the amounts of fluctuation calculated respectively for the fixing control periods in a storage unit such as the RAM **201***c*. In the present embodiment, the calculation unit **202** may determine that the DC power gets stable from the start of the printing operation when the amount of fluctuation in the DC power is within a preset amount of fluctuation in power. The preset amount of fluctuation in power serves as a predetermined amount of fluctuation in power according to an embodiment of the present disclosure.

Further, in the present embodiment, the calculation unit **202** may calculate the amounts of fluctuation respectively for multiple print modes having different power consumption patterns at the start of the printing operation. Such a configuration can calculate multiple amounts of fluctuation in accordance with the power consumption patterns at the start of the printing operation, which vary depending on the print mode and the configuration of the image forming apparatus **1** and record the calculated amounts of fluctuation. Thus, power allocated for fixing can be controlled in accordance with the power consumption pattern. In the present embodiment, the print mode may be, for example, a combination of print settings, a document feeder (DF) reading, and a sheet ejection destination. Further, the calculation unit **202** may store the calculated amounts of fluctuation or the storage destination in which the calculated amounts of fluctuation are stored in a storage unit such as the RAM **201***c* in association with the print modes as illustrated in Table 1 of FIGS. **3**A and **3**B (FIG. **3**).

When a printing operation subsequent to the first printing operation is performed in the image forming apparatus **1**, the control unit **203** determines the allocation of AC power of the next fixing control period to the fixing device **9** on the basis of power obtained by adding the average of the amounts of fluctuation of the fixing control periods to the DC power. The control unit **203** serves as a control unit according to an embodiment of the present disclosure. Thus, AC power to the fixing device **9** (i.e., power allocated to fixing) is determined by correcting the fluctuation, which increases over time, in the DC power at the start of printing with a linear form obtained from the detection result of the DC power at the time of the first printing operation. This prevents the total of the primary-side AC power and the secondary-side DC power from exceeding the maximum power in the actual printing operation.

FIG. **4** to FIG. **6** are diagrams for describing an example of a process of determining the power allocated to fixing in the image forming apparatus **1** according to Embodiment 1. In FIG. **4** to FIG. **6**, the vertical axis represents power, and the horizontal axis represents elapsed time from the start of the printing operation.

As illustrated in FIG. **4**, in image forming apparatuses, a power control technology is known in the art according to which the secondary-side DC power during an apparatus operation such as a printing operation is detected and AC power consumed in an AC system (primary side) is reduced so that the AC power does not exceed a rated current on the facility side, a rated current of the apparatus, or rated power.

However, in the power control technology according to the related art, DC power (e.g., 300 W) for each apparatus operation status such as during a printing operation stored in advance is used. Since the power cannot be reduced in accordance with the fluctuation of the DC power in the apparatus operating status, the power allocated to fixing (e.g., 1200 W) is excessively reduced.

In view of such a drawback, as illustrated in FIG. **5**, a technology has been developed that, in order to efficiently supply AC power to the fixing device, detects the secondary-side DC power and determines power allocated to fixing on the basis of the detection result. This technology brings about no issue in a time period when the secondary-side DC power is stable. However, this technology does not take into consideration a time lag from detection at the start of printing to determination of the power allocated to fixing. At the start of printing, the secondary-side DC power fluctuates. For example, the secondary-side DC power increases over time. Accordingly, if the power allocated to fixing is determined on the basis of the detection result of the DC power, the total of the primary-side AC power and the secondary-side DC power may exceed the maximum power at some times in the actual operation.

By contrast, in the image forming apparatus **1** according to the present embodiment, the control unit **203** adds the average of the amounts of fluctuation for multiple fixing control periods obtained in advance from the detection result of the DC power to the DC power in a time period during which the DC power linearly increases (i.e., a time period from the start of the printing operation until the stabilization of the DC power). For example, as illustrated in FIG. **6**, the control unit **203** releases the AC power to the fixing device **9** on the basis of 220 W obtained by adding 35 W which is the amount of fluctuation to the detection result (e.g., 185 W) of the DC power in a fixing control period A, at the timing of a fixing control period B which is 10 seconds after the fixing control period A. Accordingly, even when the DC power is 220 W in the fixing control period B, the total of the primary-side AC power and the secondary-side DC power is prevented from exceeding the maximum power.

FIGS. **7**A and **7**B (FIG. **7**) are a flowchart of an example of a flow of a process of calculating the amount of fluctuation in DC power in the image forming apparatus **1**, according to Embodiment 1. When a job (printing operation) in the image forming apparatus **1** is started (step S**601**), the calculation unit **202** selects a print mode including, for example, print settings, a DF reading, and a sheet ejection destination (step S**602**).

Subsequently, the calculation unit **202** determines whether the amount of fluctuation of DC power Wf_a in the selected print mode is stored (step S**603**). In other words, the calculation unit **202** determines whether $Wf_a=0$. When the calculation unit **202** determines that the amount of fluctuation Wf_a in the selected print mode is stored (step S**603**: No), the process of calculating the amount of fluctuation ends.

When the calculation unit **202** determines that the amount of fluctuation Wf_a in the selected print mode is not stored (step S**603**: Yes), in response to the start of the operation of the drive motor of, for example, the fixing device **9** (step S**604**), the calculation unit **202** starts counting a timer (step S**605**). Subsequently, the calculation unit **202** determines whether the count value of the timer count exceeds the fixing control period (step **S606**). When the calculation unit **202** determines that the count value does not exceed the fixing control period (step **S606**: No), the process returns to step **S605**.

When the calculation unit **202** determines that the count value exceeds the fixing control period (step **S606**: Yes), the power detection circuit **104** detects DC power (power value W_x) supplied to the control board **201** (step **S607**). Subsequently, the calculation unit **202** determines whether the detection of the DC power is the first detection in the selected print mode (step **S608**). When the calculation unit **202** determines that the DC power detection is the first detection (step **S608**: Yes), the process returns to step **S605**, and the calculation unit **202** continues counting the timer.

By contrast, when the calculation unit **202** determines that the detection of the DC power is not the first detection (step **S608**: No), the calculation unit **202** calculates the amount of fluctuation Wf from the previous power value W_x to the power value W_{x+1} (step **S609**). Further, the calculation unit **202** calculates the amount of fluctuation Wfs by adding the amounts of fluctuation Wf calculated in the selected print mode (step **S610**). Further, the calculation unit **202** counts up the number of additions K_x of the amount of fluctuation Wf (step **S611**).

Subsequently, the calculation unit **202** determines whether the amount of fluctuation Wf is equal to or less than a preset amount of power fluctuation Wr (step **S612**). When the amount of fluctuation Wf is larger than the preset amount of power fluctuation Wr (step **S612**: No), the calculation unit **202** determines that DC power supplied to the control board **201** is not stable. Then, the process returns to step **S605**, and the calculation unit **202** continues counting the timer.

When the amount of fluctuation Wf is equal to or less than the preset amount of power fluctuation Wr (step **S612**: Yes), the calculation unit **202** determines that DC power supplied to the control board **201** is stabilized. Then, the calculation unit **202** divides the amount of fluctuation Wfs by the number of additions K_x to calculate the amount of fluctuation Wf_a, which is the amount of fluctuation until the DC power is stabilized (step **S613**). Then, the calculation unit **202** stores the calculated amount of fluctuation Wf_a in association with the selected print mode in a storage unit such as the RAM **201***c* (step **S614**).

FIGS. **8**A and **8**B (FIG. **8**) is a flowchart of an example of a flow of a process of determining power allocated to fixing in the image forming apparatus **1**, according to Embodiment 1. When a job (printing operation) in the image forming apparatus **1** is started (step **S701**), the calculation unit **202** selects a print mode including, for example, print settings, a DF reading, and a sheet ejection destination (step **S702**).

Subsequently, in response to the operation of the drive motor (step **S703**), the calculation unit **202** starts counting a timer (step **S704**). Then, the calculation unit **202** determines whether the count value of the timer count exceeds the fixing control period (step **S705**). When the calculation unit **202** determines that the count value does not exceed the fixing control period (step **S705**: No), the process returns to step **S704**.

When the calculation unit **202** determines that the count value exceeds the fixing control period (step **S705**: Yes), the power detection circuit **104** detects DC power (power value W_x) supplied to the control board **201** (step **S706**). Subsequently, the calculation unit **202** determines whether the detection of the DC power is the first detection in the selected print mode (step **S707**). When the calculation unit **202** determines that the DC power detection is the first detection (step **S707**: Yes), the process returns to step **S704**, and the calculation unit **202** continues counting the timer.

By contrast, when the calculation unit **202** determines that the DC power detection is not the first detection (step **S707**: No), the calculation unit **202** calculates power W by adding the amount of fluctuation Wf_a that is stored in the storage unit such as the RAM **201***c* in association with the print mode to the detected DC power value W_x (step **S708**). Further, the control unit **203** subtracts the calculated power W from the maximum power product standard value to determine power allocated to fixing (step **S709**). Furthermore, the calculation unit **202** decrements the counter value of the number of additions K_c (step **S710**).

Subsequently, the calculation unit **202** determines whether the number of additions K_c is zero (step **S711**). When the calculation unit **202** determines that the number of additions Kc is not zero (step **S711**: No), the process returns to step **S704**. By contrast, when the calculation unit **202** determines that the number of additions K_c is zero (step **S711**: Yes), the calculation unit **202** starts counting the timer (step **S712**). Then, the calculation unit **202** determines whether the count value of the timer count exceeds the fixing control period (step **S713**). When the calculation unit **202** determines that the count value exceeds the fixing control period (step **S713**: Yes), the power detection circuit **104** detects DC power (power value W_x) supplied to the control board **201** (step **S714**).

Subsequently, the control unit **203** subtracts the detected power value W_x from the maximum power product standard value to determine power allocated to fixing (step **S715**). Then, the calculation unit **202** determines whether the job is already completed (step **S716**). When the calculation unit **202** determines that the job is not completed yet (step **S716**: No), the process returns to step **S712**. By contrast, when the job is completed (step **S716**: Yes), the calculation unit **202** ends the process of determining power allocated to fixing.

As described heretofore, the image forming apparatus **1** according to Embodiment 1 determines the AC power to the fixing device **9** (i.e., the power allocated to fixing) by correcting the fluctuation, which increases over time, in the DC power at the start of printing with a linear form obtained from the detection result of the DC power at the time of the first printing operation. This prevents the total of the primary-side AC power and the secondary-side DC power from exceeding the maximum power in the actual printing operation.

Embodiment 2

The present embodiment relates to a case in which it is determined that DC power is stabilized from the start of the printing operation when DC power supplied to the control board is lower than DC power in the previous fixing control period. Redundant descriptions of the same configurations as those described above in Embodiment 1 may be omitted below.

In the present embodiment, the calculation unit **202** determines that DC power is stabilized from the start of the printing operation, when DC power supplied to the control board **201** is lower than DC power in the previous fixing control period.

FIGS. **9**A and **9**B (FIG. **9**) are a flowchart of an example of a flow of a process of calculating the amount of fluctuation in DC power in the image forming apparatus **1**, according to Embodiment 2. In the present embodiment, after counting up the number of additions K_x, the calculation unit **202** determines whether the power value W_{x+1} detected by the power detection circuit **104** is equal to or less than the previous power value W_x (step S**801**).

When the power value W_{x+1} is not equal to or less than the power value W_x (step S**801**: No), the calculation unit **202** determines that the DC power supplied to the control board **20** is not stable. In this case, the process returns to step S**605**. By contrast, when the power value W_{x+1} is equal to or less than the power value W_x (step S**801**: Yes), the calculation unit **202** determines that the DC power supplied to the control board **20** is stable. In this case, the process proceeds to step S**613**.

Thus, the image forming apparatus **1** according to Embodiment 2 achieves the same effects as those in Embodiment 1.

Embodiment 3

The present embodiment relates a case in which the amount of fluctuation in DC power from the start of the printing operation until the stabilization of DC power is recalculated at preset time intervals. Redundant descriptions of the same configurations as those described above in Embodiment 1 and Embodiment 2 may be omitted below.

In the present embodiment, the calculation unit **202** recalculates the amount of fluctuation in DC power from the start of the printing operation until the stabilization of DC power at preset time intervals. Such a configuration can determine the power allocated to fixing in accordance with the device status, when the load fluctuation increases or decreases over time. For example, in a case where the load increases over time, the power allocated to fixing is determined such that the total of the primary-side AC power and the secondary-side DC power does not exceed the maximum power even in such a case. In a case the load decreases over time, the optimal power allocated to fixing is determined in accordance with the fluctuation.

FIGS. **10**A and **10**B (FIG. **10**) are a flowchart of an example of a flow of a process of calculating the amount of fluctuation in DC power in the image forming apparatus **1**, according to Embodiment 3. In the present embodiment, when the amount of fluctuation Wf_a in the selected print mode is stored (step S**603**: No), the calculation unit **202** determines whether a preset time T has elapsed since the first print operation in the selected print mode (or the last print operation in the selected print mode) (step S**901**).

When the calculation unit **202** determines that the preset time T has not elapsed since the first printing operation in the selected print mode (step S**901**: No), the calculation unit **202** does not recalculate the amount of fluctuation Wf_a. Then, the process of calculating the amount of fluctuation in the DC power ends. By contrast, when the calculation unit **202** determines that the preset time T has elapsed since the first printing operation in the selected print mode (step S**901**: Yes), the process proceeds to step S**604**.

Thus, when the load fluctuation increases or decreases over time, the image forming apparatus **1** according to Embodiment 3 can determine the power allocated to fixing in accordance with the device status. For example, in a case where the load increases over time, the power allocated to fixing is determined such that the total of the primary-side AC power and the secondary-side DC power does not exceed the maximum power even in such a case. In a case the load decreases over time, the optimal power allocated to fixing is determined in accordance with the load fluctuation.

A program executed by the image forming apparatus **1** according to the embodiments of the present disclosure is preinstalled and provided in, for example, the ROM **201***b*.

Alternatively or additionally, the program executed by the image forming apparatus **1** according to the embodiments of the present disclosure is stored in a computer-readable storage medium, such as a compact disc read-only memory (CD-ROM), a flexible disk (FD), a compact disc recordable (CD-R), and a digital versatile disc (DVD), in an installable or executable file format, to be provided.

Alternatively or additionally, the program executed by the image forming apparatus **1** according to the embodiments of the present disclosure is stored in a computer connected to a network such as the Internet and downloaded through the network, thus being providable. Alternatively or additionally, the program executed by the image forming apparatus **1** according to the embodiments of the present disclosure is provided or allocated via a network such as the Internet.

The program executed by the image forming apparatus **1** according to the embodiments of the present disclosure has a module configuration including the above-described components (the calculation unit **202** and the control unit **203**). In terms of actual hardware, a processor such as the CPU **201***a* reads the program from the ROM **201***b* and executes the program, and thus the components are loaded onto a main memory and the calculation unit **202** and the control unit **203** is generated on the main memory.

Although, in the above embodiments, the description is provided is of a case in which the image forming apparatus **1** according to the embodiments is a multifunction peripheral having at least two of a copier function, a printer function, a scanner function, and a facsimile function, this is merely one example. In another example, aspects of this disclosure are applicable to any image forming apparatus such as a copier, a printer, a scanner, or a facsimile machine.

The technology in the related art works well when secondary-side DC is stable. However, the technology in the related art does not consider a time lag from detection at the start of printing when the secondary-side DC power fluctuates (e.g., the secondary-side DC power increases over time) to determination of power allocated for fixing. For this reason, if the power allocated to fixing is determined on the basis of the detection result of the DC power, there may be a time when the total of the primary-side AC power and the secondary-side DC power exceeds the maximum power in actual operation. Further, according to the technology in the related art, only a means for maximizing power allocated for fixing during a printing period is provided, and the power allocated for fixing is excessively reduced in the period from the start of paper feeding to the start of printing.

According to one or more embodiments of the present disclosure, power allocated to fixing is determined by correcting the power fluctuation at the start of printing with a linear form obtained from a power detection result in the first printing operation, so that the total of the primary-side AC power and the secondary-side DC power does not exceed the maximum power in the actual printing operation.

A description is now given of some aspects of the present disclosure.

Aspect 1

According to Aspect 1, a power control apparatus includes a power detection unit configured to DC power converted from AC power supplied from a power supply and to be supplied to a control board.

The power control apparatus includes a calculation unit configured to, in a case that a first printing operation is performed in an image forming apparatus, calculate fluctuations in the DC power in each preset control period from a start of a printing operation until stabilization of the DC power.

The power control apparatus includes a control unit configured to, in a case that a printing operation subsequent to the first printing operation is performed in the image forming apparatus, determine allocation of the AC power to a fixing device of the image forming apparatus in a next preset control period based on power obtained by adding, to the DC power, an average of the fluctuations in a plurality of preset control periods.

Aspect 2

According to Aspect 2, the power control apparatus of Aspect 1 further includes a storage unit configured to store the fluctuations calculated in each preset control period by the calculation unit.

Aspect 3

According to Aspect 3, in the power control apparatus of Aspect 1 or 2, the calculation unit determines that the DC power is stabilized after the start of the printing operation in a case that the fluctuations are within a predetermined amount of power fluctuation.

Aspect 4

According to Aspect 4, in the power control apparatus of Aspect 1 or 2, the calculation unit determines that the DC power is stabilized after the start of the printing operation in a case that the DC power is lower than DC power in a previous control period.

Aspect 5

According to Aspect 5, in the power control apparatus of any one of Aspects 1 to 4, the calculation unit calculates the fluctuations for a plurality of printing conditions, respectively, the plurality of printing conditions having different power consumption patterns at the start of the printing operation, respectively.

Aspect 6

According to Aspect 6, in the power control apparatus of any one of Aspects 1 to 5, the calculation unit recalculates the fluctuations at preset period intervals.

Aspect 7

According to Aspect 7, an image forming apparatus includes the power control apparatus of any one of Aspects 1 to 6.

Aspect 8

According to Aspect 8, a power control method performed by a power control apparatus includes detecting DC power converted from AC power supplied from a power supply and to be supplied to a control board.

The power control method includes in a case that a first printing operation is performed in an image forming apparatus, calculating fluctuations in the DC power in each preset control period from a start of a printing operation until stabilization of the DC power.

The power control method includes, in a case that a printing operation subsequent to the first printing operation is performed in the image forming apparatus, determining allocation of the AC power to a fixing device of the image forming apparatus in a next preset control period based on power obtained by adding, to the DC power, an average of the fluctuations in a plurality of preset control periods.

Aspect 9

According to Aspect 9, a program causes one or more processors to function as a calculation unit configured to acquire a result of detecting DC power converted from AC power supplied from a power supply and to be supplied to a control board, and to, in a case that a first printing operation is performed in an image forming apparatus, calculate fluctuations in the DC power in each preset control period from a start of a printing operation until stabilization of the DC power.

The program causes the one or more processors to function as a control unit configured to, in a case that a printing operation subsequent to the first printing operation is performed in the image forming apparatus, determine allocation of the AC power to a fixing device of the image forming apparatus in a next preset control period based on power obtained by adding, to the DC power, an average of the fluctuations in a plurality of preset control periods.

The above-described embodiments are illustrative and do not limit the present invention. Thus, numerous additional modifications and variations are possible in light of the above teachings. For example, elements and/or features of different illustrative embodiments may be combined with each other and/or substituted for each other within the scope of the present invention. Any one of the above-described operations may be performed in various other ways, for example, in an order different from the one described above.

The functionality of the elements disclosed herein may be implemented using circuitry or processing circuitry which includes general purpose processors, special purpose processors, integrated circuits, application specific integrated circuits (ASICs), digital signal processors (DSPs), field programmable gate arrays (FPGAs), conventional circuitry and/or combinations thereof which are configured or programmed to perform the disclosed functionality. Processors are considered processing circuitry or circuitry as they include transistors and other circuitry therein. In the disclosure, the circuitry, units, or means are hardware that carry out or are programmed to perform the recited functionality. The hardware may be any hardware disclosed herein or otherwise known which is programmed or configured to carry out the recited functionality. When the hardware is a processor which may be considered a type of circuitry, the circuitry, means, or units are a combination of hardware and software, the software being used to configure the hardware and/or processor.

The invention claimed is:

1. A power control apparatus, comprising:
- a power detection circuit to detect direct current (DC) power converted from alternating current (AC) power supplied from a power supply and to be supplied to a control board of an image forming apparatus; and
- circuitry configured to:
  - in response to a first printing operation performed by the image forming apparatus, calculate fluctuations in the DC power in each preset control period from a start of the first printing operation until stabilization of the DC power; and

in response to a printing operation subsequent to the first printing operation performed by the image forming apparatus, determine allocation of the AC power to a fixing device of the image forming apparatus in a next preset control period based on power obtained by adding, to the DC power, an average of the fluctuations in a plurality of preset control periods.

2. The power control apparatus of claim **1**, further comprising a memory that stores the fluctuations calculated in each preset control period.

3. The power control apparatus of claim **1**, wherein

the circuitry is configured to determine that the DC power is stabilized after the start of the printing operation in a case that a fluctuation obtained by subtracting the DC power from DC power in a previous control period is within a predetermined amount of power fluctuation.

4. The power control apparatus of claim **1**, wherein

the circuitry is configured to determine that the DC power is stabilized after the start of the printing operation in a case that the DC power is lower than DC power in a previous control period.

5. The power control apparatus of claim **1**, wherein

the circuitry is configured to calculate the fluctuations for a plurality of printing conditions, respectively, the plurality of printing conditions having different power consumption patterns at the start of the printing operation, respectively.

6. The power control apparatus of claim **1**, wherein

the circuitry is configured to recalculate the fluctuations at preset period intervals.

7. An image forming apparatus, comprising:

an image forming device to form an image; and

the power control apparatus of claim **1**.

8. A power control method performed by a power control apparatus, the power control method comprising:

detecting DC power converted from AC power supplied from a power supply and to be supplied to a control board of an image forming apparatus;

in response to a first printing operation performed by the image forming apparatus, calculating fluctuations in the DC power in each preset control period from a start of the first printing operation until stabilization of the DC power; and

in response to a printing operation subsequent to the first printing operation performed by the image forming apparatus, determining allocation of the AC power to a fixing device of the image forming apparatus in a next preset control period based on power obtained by adding, to the DC power, an average of the fluctuations in a plurality of preset control periods.

9. A non-transitory computer-executable medium storing a plurality of instructions which, when executed by one or more processors, cause the one or more processors to perform a power control method comprising:

acquiring a result of detecting DC power converted from AC power supplied from a power supply and to be supplied to a control board of an image forming apparatus;

in response to a first printing operation performed by the image forming apparatus, calculating fluctuations in the DC power in each preset control period from a start of the first printing operation until stabilization of the DC power; and

in response to a printing operation subsequent to the first printing operation performed by the image forming apparatus, determining allocation of the AC power to a fixing device of the image forming apparatus in a next preset control period based on power obtained by adding, to the DC power, an average of the fluctuations in a plurality of preset control periods.

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