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(54) **IMAGE READING DEVICE, IMAGE FORMING APPARATUS, AND IMAGE READING METHOD**

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(57) **ABSTRACT**

An image reading device includes: a conveying portion configured to convey a sheet; a reading portion configured to read an image of the sheet; a driving portion configured to drive the conveying portion; and a switch processing portion configured to switch an operation mode of the driving portion alternately between a drive mode for driving the conveying portion and a cool mode for cooling the driving portion. When, in the drive mode, a total driving time of the driving portion exceeds a first threshold, the switch processing portion switches the operation mode to the cool mode.

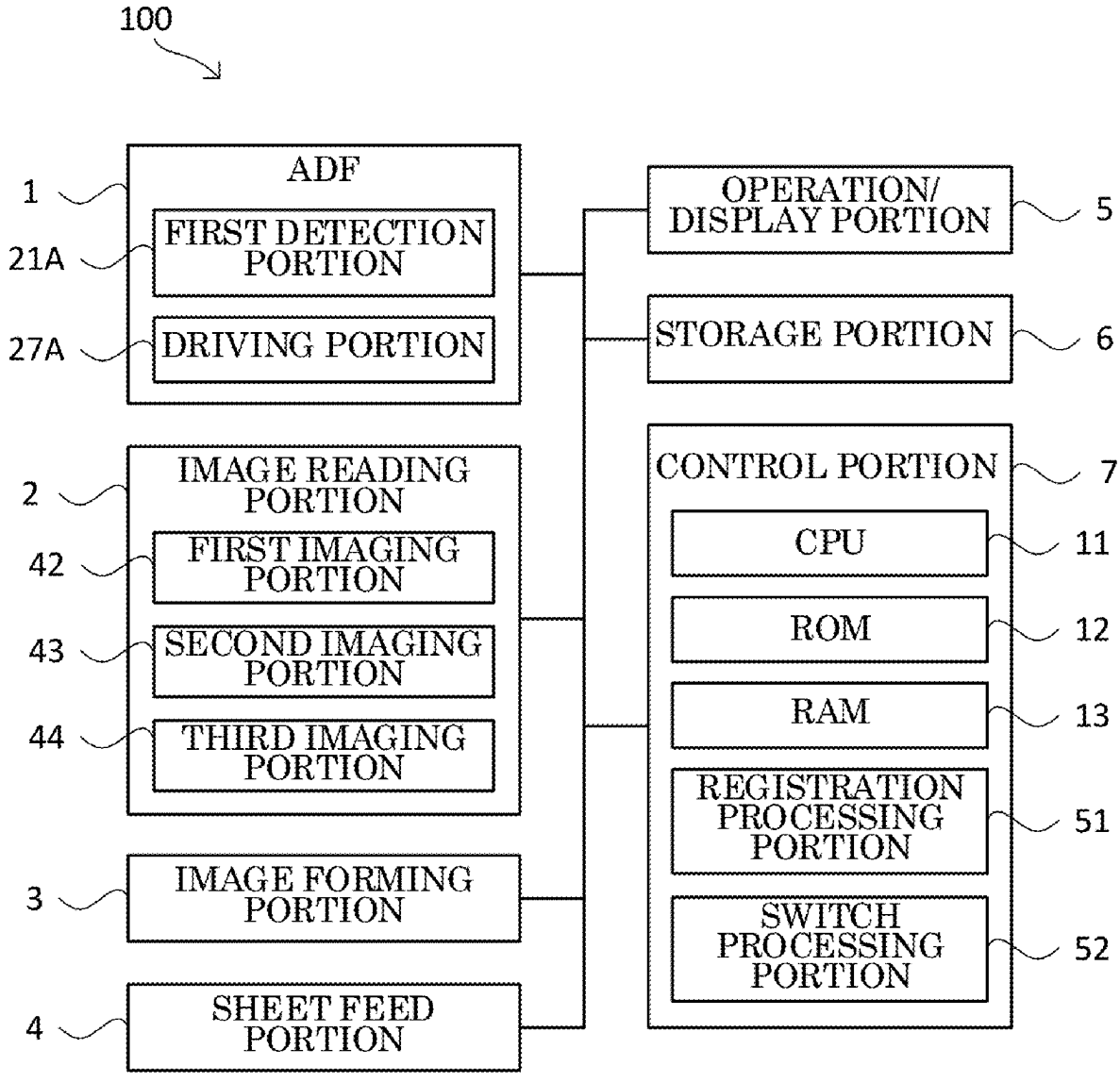

FIG.1

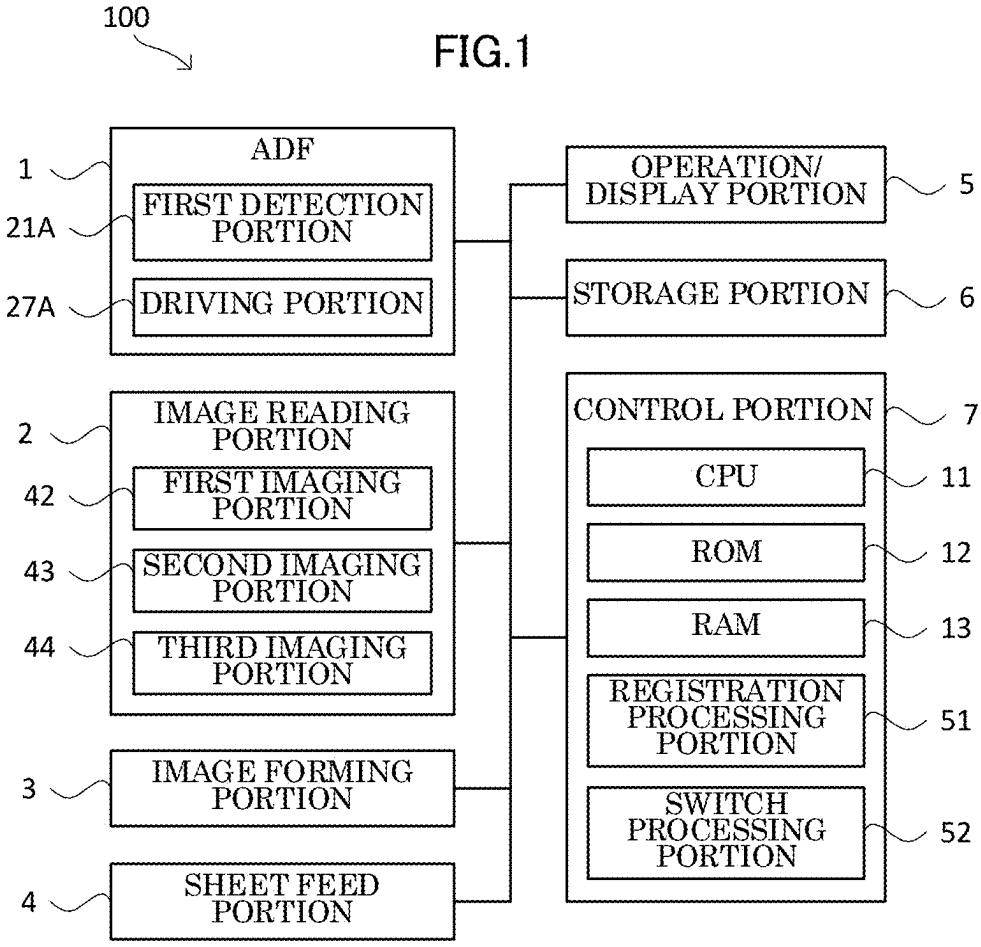
100
ADF
1
FIRST DETECTION PORTION
21A
DRIVING PORTION
27A
IMAGE READING PORTION
2
FIRST IMAGING PORTION
42
SECOND IMAGING PORTION
43
THIRD IMAGING PORTION
44
IMAGE FORMING PORTION
3
SHEET FEED PORTION
4
OPERATION/ DISPLAY PORTION
5
STORAGE PORTION
6
CONTROL PORTION
7
CPU
11
ROM
12
RAM
13
REGISTRATION PROCESSING PORTION
51
SWITCH PROCESSING PORTION
52

FIG.2

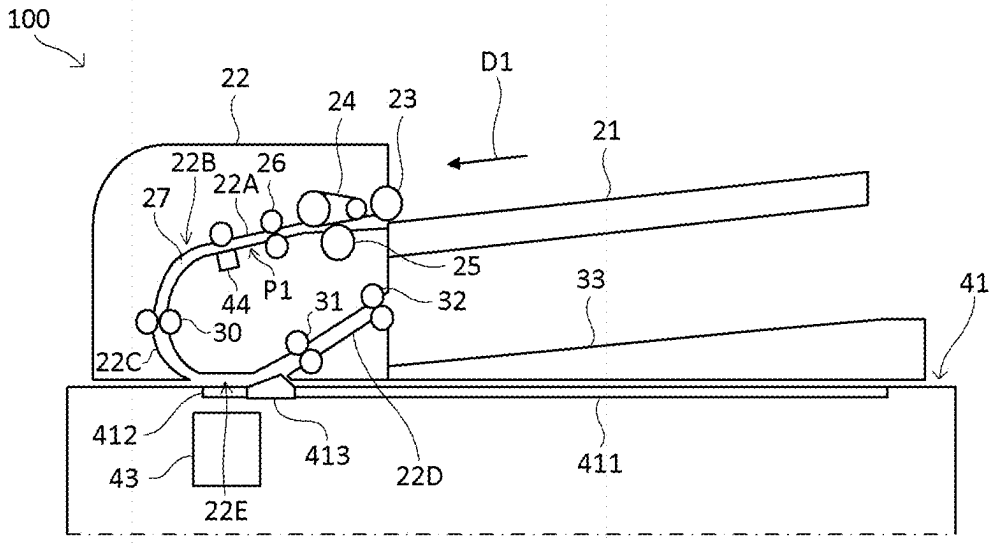
100
22
24
23
D1
21
22B
26
22A
27
25
P1
44
31
32
33
41
30
22C
412
413
22D
411
43
22E

FIG.3

F1

SAMPLING TIME[sec]		DRIVING STATE
1min	10	OFF
	20	OFF
	30	ON
	40	ON
	50	ON
	60	ON
2min	70	ON
	80	ON
	90	ON
	100	ON
	110	OFF
	120	OFF
3min	130	OFF
	140	OFF
	150	ON
	160	ON
	170	OFF
	180	OFF
⋮	⋮	⋮
27min	1570	OFF
	1580	ON
	1590	OFF
	1600	ON
	1610	OFF
	1620	ON
28min	1630	OFF
	1640	OFF
	1650	OFF
	1660	OFF
	1670	ON
	1680	ON

FIG.4

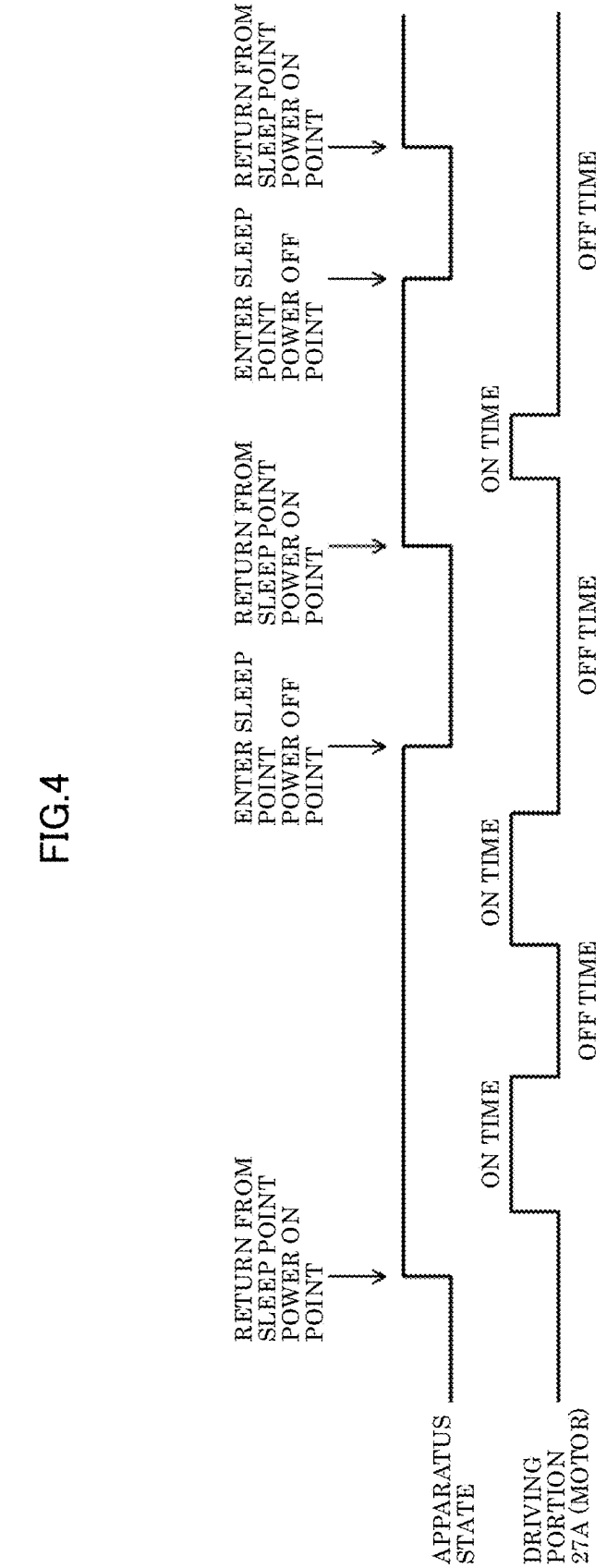
RETURN FROM SLEEP POINT POWER ON POINT
ENTER SLEEP POINT POWER OFF POINT
RETURN FROM SLEEP POINT POWER ON POINT
ENTER SLEEP POINT POWER OFF POINT
RETURN FROM SLEEP POINT POWER ON POINT
APPARATUS STATE
ON TIME
OFF TIME
ON TIME
OFF TIME
ON TIME
OFF TIME
DRIVING PORTION 27A (MOTOR)

FIG.5

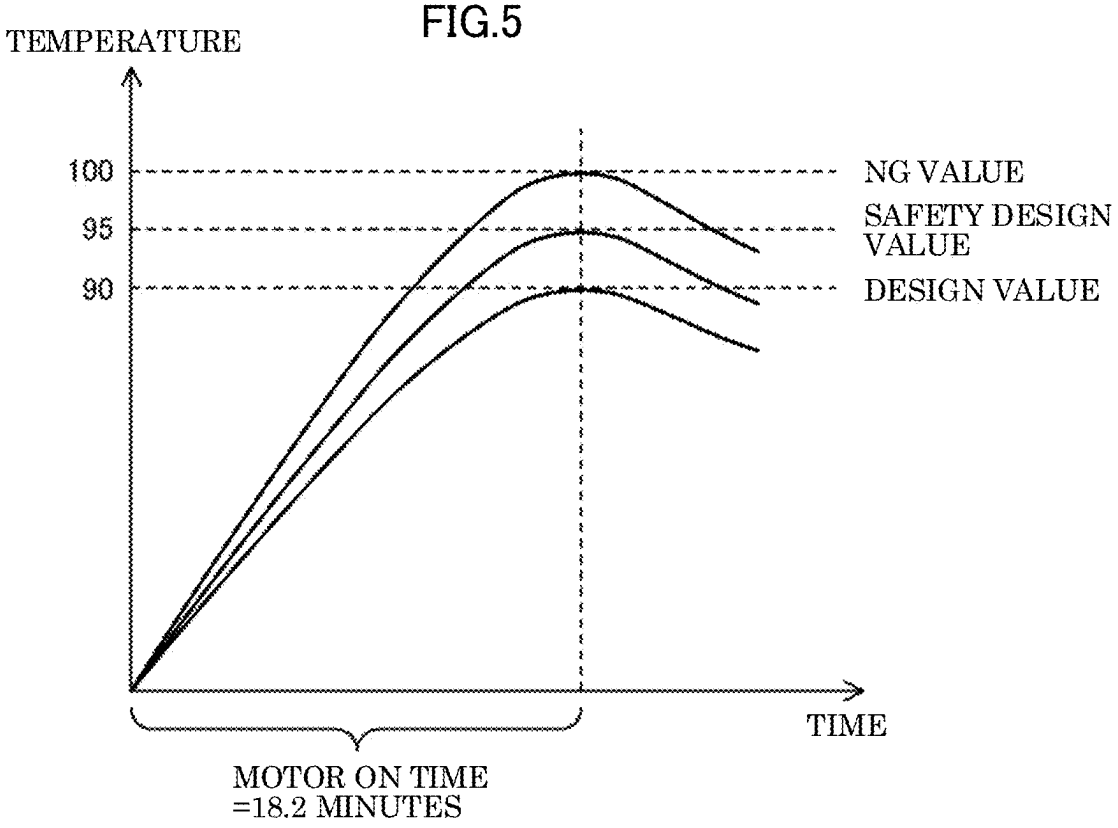
TEMPERATURE
100
95
90
NG VALUE
SAFETY DESIGN VALUE
DESIGN VALUE
TIME
MOTOR ON TIME
=18.2 MINUTES

FIG.6

F1

SAMPLING TIME[sec]		DRIVING STATE
1min	10	OFF
	20	OFF
	30	ON
	40	ON
	50	ON
	60	ON
2min	70	ON
	80	ON
	90	ON
	100	ON
	110	OFF
	120	OFF
⋮	⋮	⋮
27min	1570	OFF
	1580	ON
	1590	OFF
	1600	ON
	1610	OFF
	1620	ON
28min	1630	OFF
	1640	OFF
	1650	OFF
	1660	OFF
	1670	ON
	1680	ON
29min	1690	OFF
	1700	OFF
	1710	OFF
	1720	OFF
	1730	ON
	1740	ON

DETERMINATION SECTION

FIG.7

F1

SAMPLING TIME[sec]		DRIVING STATE
1min	10	OFF
	20	OFF
	30	ON
	40	ON
	50	ON
	60	ON
2min	70	ON
	80	ON
	90	ON
	100	ON
	110	OFF
	120	OFF
⋮	⋮	⋮
27min	1570	OFF
	1580	ON
	1590	OFF
	1600	ON
	1610	OFF
	1620	ON
28min	1630	OFF
	1640	OFF
	1650	OFF
	1660	OFF
	1670	ON
	1680	ON
29min	1690	OFF
	1700	OFF
	1710	OFF
	1720	OFF
	1730	ON
	1740	ON

DETERMINATION SECTION

FIG.8

F1

SAMPLING TIME[sec]		DRIVING STATE
1min	10	OFF
	20	OFF
	30	ON
	40	ON
	50	ON
	60	ON
2min	70	ON
	80	ON
	90	ON
	100	ON
	110	OFF
	120	OFF
⋮	⋮	⋮
27min	1570	OFF
	1580	ON
	1590	OFF
	1600	ON
	1610	OFF
	1620	ON
28min	1630	OFF
	1640	OFF
	1650	OFF
	1660	OFF
	1670	ON
	1680	ON
29min	1690	OFF
	1700	OFF
	1710	OFF
	1720	OFF
	1730	ON
	1740	ON

DETERMINATION SECTION

FIG.9

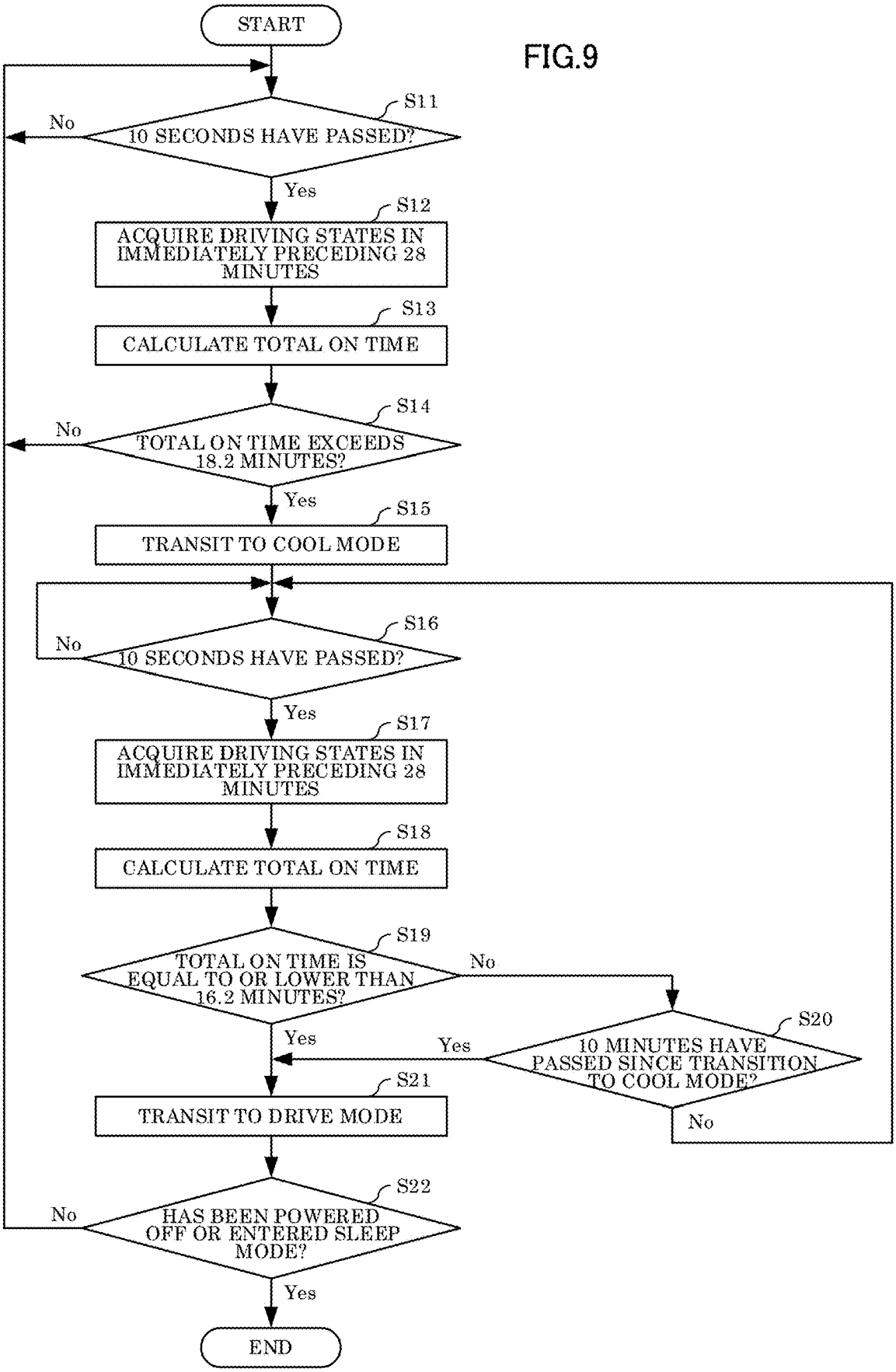
START
S11
10 SECONDS HAVE PASSED?
No
Yes
S12
ACQUIRE DRIVING STATES IN IMMEDIATELY PRECEDING 28 MINUTES
S13
CALCULATE TOTAL ON TIME
S14
TOTAL ON TIME EXCEEDS 18.2 MINUTES?
No
Yes
S15
TRANSIT TO COOL MODE
S16
10 SECONDS HAVE PASSED?
No
Yes
S17
ACQUIRE DRIVING STATES IN IMMEDIATELY PRECEDING 28 MINUTES
S18
CALCULATE TOTAL ON TIME
S19
TOTAL ON TIME IS EQUAL TO OR LOWER THAN 16.2 MINUTES?
No
Yes
S20
10 MINUTES HAVE PASSED SINCE TRANSITION TO COOL MODE?
Yes
No
S21
TRANSIT TO DRIVE MODE
S22
HAS BEEN POWERED OFF OR ENTERED SLEEP MODE?
No
Yes
END

IMAGE READING DEVICE, IMAGE FORMING APPARATUS, AND IMAGE READING METHOD

INCORPORATION BY REFERENCE

[0001] This application is based upon and claims the benefit of priority from the corresponding Japanese Patent Application No. 2024-020834 filed on Feb. 15, 2024, the entire contents of which are incorporated herein by reference.

BACKGROUND

[0002] The present disclosure relates to an image reading device, an image forming apparatus, and an image reading method for reading an image of a conveyed document sheet.

[0003] There is known an image reading device including: a conveying portion for conveying a document sheet that is a reading object; and a reading portion for reading an image of the document sheet. In the image reading device, since the temperature of a motor (a driving portion) for driving the conveying portion rises, a function for suppressing temperature rise of the motor is provided.

SUMMARY

[0004] An image reading device according to an aspect of the present disclosure includes: a conveying portion configured to convey a sheet; a reading portion configured to read an image of the sheet; a driving portion configured to drive the conveying portion; and a switch processing portion configured to switch an operation mode of the driving portion alternately between a drive mode for driving the conveying portion and a cool mode for cooling the driving portion. When, in the drive mode, a total driving time of the driving portion exceeds a first threshold, the switch processing portion switches the operation mode to the cool mode.

[0005] An image forming apparatus according to another aspect of the present disclosure includes the image reading device and an image forming portion configured to form an image on the sheet.

[0006] An image reading method according to a further aspect of the present disclosure includes a switching step of, in an image reading device including: a conveying portion configured to convey a sheet; a reading portion configured to read an image of the sheet; and a driving portion configured to drive the conveying portion, switching an operation mode of the driving portion alternately between a drive mode for driving the conveying portion and a cool mode for cooling the driving portion. In the switching step, when, in the drive mode, a total driving time of the driving portion exceeds a first threshold, the operation mode is switched to the cool mode.

[0007] According to the present disclosure, it is possible to provide an image reading device, an image forming apparatus, and an image reading method that can suppress temperature rise of a motor with a simple configuration.

[0008] 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

[0009] FIG. **1** is a block diagram showing a system configuration of an image forming apparatus according to an embodiment of the present disclosure.

[0010] FIG. **2** is a diagram showing a configuration of an ADF and an image reading portion of the image forming apparatus according to the embodiment of the present disclosure.

[0011] FIG. **3** is a diagram showing an example of driving state information stored in the image forming apparatus according to the embodiment of the present disclosure.

[0012] FIG. **4** is a timing chart showing a change of ON/OFF state of the image forming apparatus and a driving portion according to the embodiment of the present disclosure.

[0013] FIG. **5** is a graph showing an experimental result of a temperature change of the driving portion according to the embodiment of the present disclosure.

[0014] FIG. **6** is a diagram showing an example of the driving state information stored in the image forming apparatus according to the embodiment of the present disclosure.

[0015] FIG. **7** is a diagram showing an example of the driving state information stored in the image forming apparatus according to the embodiment of the present disclosure.

[0016] FIG. **8** is a diagram showing an example of the driving state information stored in the image forming apparatus according to the embodiment of the present disclosure.

[0017] FIG. **9** is a flowchart showing an example of an operation mode switching process executed by the image forming apparatus according to the embodiment of the present disclosure.

DETAILED DESCRIPTION

[0018] The following describes an embodiment of the present disclosure with reference to the accompanying drawings. It should be noted that the following embodiment is an example of a specific embodiment of the present disclosure and should not limit the technical scope of the present disclosure.

Configuration of Image Forming Apparatus **100**

[0019] First, a configuration of an image forming apparatus **100** according to an embodiment of the present disclosure is described with reference to FIG. **1**.

[0020] The image forming apparatus **100** is a multifunction peripheral having a plurality of functions such as a scan function for reading an image from a document sheet, a print function for forming an image based on image data, a facsimile function, and a copy function. The image forming apparatus **100** is an example of an image forming apparatus of the present disclosure. It is noted that the image forming apparatus of the present disclosure may be a scanner, a facsimile device, a copier, or the like.

[0021] As shown in FIG. **1**, the image forming apparatus **100** includes an ADF (Auto Document Feeder) **1**, an image reading portion **2**, an image forming portion **3**, a sheet feed portion **4**, an operation/display portion **5**, a storage portion **6**, and a control portion **7**.

[0022] The ADF **1** is a sheet conveying device for conveying a document sheet (an example of a sheet of the present disclosure) that is a reading object. The ADF **1** executes, in accordance with a control instruction from the control portion **7**, a conveyance process using a driving force supplied from a driving portion **27**A.

[0023] The image reading portion **2** reads an image from a document sheet conveyed by the ADF **1**. In addition, the image reading portion **2** reads an image from a document sheet placed on a document sheet table **41** (see FIG. **2**).

[0024] The image forming portion **3** forms an image by an electrophotographic method on a sheet supplied from the sheet feed portion **4**. For example, the image forming portion **3** includes a photoconductor drum, a charging roller, a laser scanning unit, a developing device, a transfer roller, a cleaning device, a fixing device, and a sheet discharge tray.

[0025] The sheet feed portion **4** supplies a sheet to the image forming portion **3**. For example, the sheet feed portion **4** includes a sheet feed cassette, a manual feed tray, a sheet conveyance path, and a plurality of conveyance rollers.

[0026] The operation/display portion **5** is a user interface of the image forming apparatus **100**. For example, the operation/display portion **5** includes a display portion and an operation portion, wherein the display portion, such as a liquid crystal display, is configured to display a variety of information in response to control instructions from the control portion **7**, and the operation portion, such as operation keys or a touch panel, is configured to input a variety of information to the control portion **7** in response to user operations.

[0027] The storage portion **6** is a nonvolatile storage device. For example, the storage portion **6** is a storage device such as: a nonvolatile memory such as a flash memory or an EEPROM (registered trademark); an SSD (Solid State Drive); or an HDD (Hard Disk Drive).

[0028] The control portion **7** comprehensively controls the image forming apparatus **100**. As shown in FIG. **1**, the control portion **7** includes a CPU **11**, a ROM **12**, and a RAM **13**. The CPU **11** is a processor that executes various types of calculation processes. The ROM **12** is a nonvolatile storage device in which are preliminarily stored various types of information such as control programs for causing the CPU **11** to execute various processes. The RAM **13** is a volatile or nonvolatile storage device that is used as a temporary storage memory (working area) for the various types of processes executed by the CPU **11**. In the control portion **7**, the CPU **11** executes the various types of control programs preliminarily stored in the ROM **12**. This allows the control portion **7** to comprehensively control the image forming apparatus **100**.

Configuration of ADF **1** and Image Reading Portion **2**

[0029] Next, with reference to FIG. **1** and FIG. **2**, a configuration of the ADF **1** and the image reading portion **2** is described. Here, FIG. **2** is a cross section diagram showing the configuration of the ADF **1** and the image reading portion **2**. The ADF **1** and the image reading portion **2** are an example of an image reading device of the present disclosure.

[0030] As shown in FIG. **2**, the ADF **1** includes a document sheet placement portion **21**, a housing **22**, a pickup roller **23**, a sheet feed belt **24**, a separation roller **25**, a resist roller **26**, a first conveyance roller **30**, a second conveyance roller **31**, a second discharge roller **32**, and a discharge portion **33**.

[0031] A document sheet that is a conveyance object is placed on the document sheet placement portion **21**. In the ADF **1**, the document sheet placed on the document sheet placement portion **21** is conveyed in a conveyance direction D**1** shown in FIG. **2**.

[0032] The document sheet placement portion **21** is provided with a first detection portion **21**A shown in FIG. **1**. The first detection portion **21**A detects presence or absence of a document sheet on the document sheet placement portion **21**. For example, the first detection portion **21**A is a reflection-type optical sensor provided on a document sheet placement surface of the document sheet placement portion **21**.

[0033] In addition, the document sheet placement portion **21** is provided with a lift plate (not shown). The lift plate lifts a bunch of document sheets placed on the document sheet placement portion **21** up to a position of contacting with the pickup roller **23**.

[0034] The housing **22** stores rollers and the like used to convey the document sheet. As shown in FIG. **2**, a first conveyance path **22**A and a second conveyance path **22**D for guiding the document sheet are formed inside the housing **22**. The second conveyance path **22**D, including a curved portion **22**C (see FIG. **2**) curved from the first conveyance path **22**A, reaches the discharge portion **33**. The curved portion **22**C is curved with a curvature with which the document sheet can make a U-turn in the housing **22**.

[0035] In the ADF **1**, the document sheet placed on the document sheet placement portion **21** is conveyed along a conveyance route that travels the first conveyance path **22**A, the curved portion **22**C, and the second conveyance path **22**D to reach the discharge portion **33**.

[0036] As shown in FIG. **2**, an opening portion **22**E is provided at a bottom portion of the housing **22**. The opening portion **22**E exposes a part of the second conveyance path **22**D to outside. At the opening portion **22**E, a second imaging portion **43** (see FIG. **1** and FIG. **2**) of the image reading portion **2** reads an image of the document sheet conveyed by the ADF **1**.

[0037] The pickup roller **23** is provided above the document sheet placement portion **21**. The pickup roller **23** contacts with a surface (an upper surface) of a document sheet at the top of the bunch of document sheets lifted by the lift plate, and conveys the document sheet in the conveyance direction D**1**.

[0038] The sheet feed belt **24** is provided in the first conveyance path **22**A. The sheet feed belt **24** contacts with a surface of the document sheet conveyed in the conveyance direction D**1** by the pickup roller **23**, and conveys the document sheet toward the downstream in the conveyance direction D**1**.

[0039] The separation roller **25** is provided under the sheet feed belt **24** in contact with the sheet feed belt **24**. The separation roller **25** separates a document sheet contacting with the sheet feed belt **24** from a document sheet thereunder among a plurality of document sheets conveyed to a position where they contact with the sheet feed belt **24**.

[0040] The resist roller **26** is provided downstream of the sheet feed belt **24** in the first conveyance path **22**A in the conveyance direction D**1**. The resist roller **26** contacts with

the document sheet conveyed by the sheet feed belt **24** and conveys the document sheet toward the downstream in the conveyance direction D**1**.

[0041] The first conveyance roller **30** is provided at the curved portion **22**C of the second conveyance path **22**D. Upon contacting with a document sheet, the first conveyance roller **30** conveys the document sheet toward the downstream in the conveyance direction D**1**.

[0042] The opening portion **22**E is formed downstream of the first conveyance roller **30** in the second conveyance path **22**D in the conveyance direction D**1**. At the opening portion **22**E, the second imaging portion **43** (see FIG. **1** and FIG. **2**) of the image reading portion **2** reads an image of the document sheet passing over the opening portion **22**E.

[0043] The second conveyance roller **31** is provided downstream of the opening portion **22**E in the second conveyance path **22**D in the conveyance direction D**1**. Upon contacting with the document sheet conveyed by the first conveyance roller **30**, the second conveyance roller **31** conveys the document sheet toward the downstream in the conveyance direction D**1**.

[0044] The second discharge roller **32** is provided downstream of the second conveyance roller **31** in the second conveyance path **22**D in the conveyance direction D**1**. Upon contacting with the document sheet conveyed by the second conveyance roller **31**, the second discharge roller **32** discharges the document sheet to the discharge portion **33**. The document sheet discharged by the second discharge roller **32** is stacked on the discharge portion **33**.

[0045] As shown in FIG. **1** and FIG. **2**, the image reading portion **2** includes the document sheet table **41**, a first imaging portion **42**, a second imaging portion **43**, and a third imaging portion **44**.

[0046] A document sheet that is a reading object is placed on the document sheet table **41**. The document sheet table **41** is provided at an upper part of a housing of the image forming apparatus **100**. The ADF **1** is provided in an openable and closable manner with respect to the document sheet table **41**, and also serves as a document sheet cover that supports one surface of a document sheet placed on a first contact glass **411** of the document sheet table **41**.

[0047] As shown in FIG. **2**, the document sheet table **41** includes the first contact glass **411**, a second contact glass **412**, and a guide member **413**. A document sheet from which an image is to be read by the second imaging portion **43** is placed on the first contact glass **411**. In a state where the ADF **1** is closed to the document sheet table **41**, the second contact glass **412** and the guide member **413** face the opening portion **22**E of the housing **22** and form a part of the second conveyance path **22**D. The second contact glass **412** transmits the light that has been emitted from the second imaging portion **43** toward the opening portion **22**E, and transmits the light reflected from the document sheet. The guide member **413**, at a position downstream of the second contact glass **412** in the conveyance direction D**1**, guides the document sheet to the second conveyance roller **31**.

[0048] The second imaging portion **43** is provided below the first contact glass **411** and the second contact glass **412**. The second imaging portion **43** is elongated in the depth direction of FIG. **2**, and is provided movable along the left/right direction of FIG. **2**. In a state of being disposed below the second contact glass **412**, the second imaging portion **43** reads an image of a front surface of a document sheet conveyed by the ADF **1**. Specifically, the second imaging portion **43** includes a CIS (Contact Image Sensor) and a housing storing the CIS. The second imaging portion **43** outputs an analog signal corresponding to the image read from the front surface of the document sheet. The analog signal output from the second imaging portion **43** is converted into a digital signal (image data) by an analog front-end circuit (not shown) and is input to the control portion **7**.

[0049] The first imaging portion **42** is provided downstream in the first conveyance path **22**A in the conveyance direction D**1** and upstream of a first discharge roller **28** in the conveyance direction D**1**. The first imaging portion **42** reads an image of a front surface of a document sheet guided to the downstream in the first conveyance path **22**A. Specifically, the first imaging portion **42** is a CIS. The first imaging portion **42** outputs an analog signal corresponding to the image read from the front surface of the document sheet. The analog signal output from the first imaging portion **42** is converted into a digital signal (image data) by the analog front-end circuit and is input to the control portion **7**.

[0050] The third imaging portion **44** is provided upstream in the first conveyance path **22**A in the conveyance direction D**1** and downstream of the resist roller **26** in the conveyance direction D**1**. The third imaging portion **44** reads an image of a back surface of a document sheet conveyed by the resist roller **26**. Specifically, the third imaging portion **44** is a CIS. The third imaging portion **44** outputs an analog signal corresponding to the image read from the back surface of the document sheet. The analog signal output from the third imaging portion **44** is converted into a digital signal (image data) by the analog front-end circuit and is input to the control portion **7**.

[0051] The ADF **1** operates upon receiving a driving force supplied from the driving portion **27**A shown in FIG. **1**. The driving portion **27**A is a driving portion of the present disclosure and is, for example, a motor. The driving portion **27**A outputs a driving force to the ADF **1** in accordance with a control instruction from the control portion **7**. In addition, the driving portion **27**A is set to an ON state or an OFF state in accordance with a control instruction from the control portion **7**.

[0052] Meanwhile, when the motor (the driving portion **27**A) performs driving (operates) for a long time continuously, the temperature rises and it may lead to a failure. Conventionally known is a technology for predicting the temperature of the motor from the rotation amount of the motor and controls the driving of the motor based on the predicted temperature. However, according to this technology, since it is necessary to always monitor the rotation amount of the motor, processes are complicated. In particular, in an image reading device that is ideally reduced in weight and size, the processes need to be simplified. It is accordingly required that suppression of temperature rise of the motor is realized by a simpler configuration. On the other hand, in the image forming apparatus **100** according to the embodiment of the present disclosure, as described below, it is possible to suppress temperature rise of the driving portion (motor) by a simple configuration.

Configuration of Control Portion **7**

[0053] Next, a configuration of the control portion **7** is described in more detail with reference to FIG. **1**. As shown in FIG. **1**, the control portion **7** includes a registration processing portion **51** and a switch processing portion **52**.

[0054] Specifically, an operation mode switching program for causing the CPU **11** to execute an operation mode switching process (see FIG. **9**) described below is preliminarily stored in the ROM **12**. The control portion **7** functions as the registration processing portion **51** and the switch processing portion **52** by executing the operation mode switching program stored in the ROM **12**. Here, a device including the ADF **1**, the image reading portion **2**, and the control portion **7** is an example of the image reading device of the present disclosure. It is noted that the present disclosure may be realized by a device including the ADF **1** and the control portion **7**.

[0055] It is noted that the operation mode switching program may be recorded on a non-transitory computer-readable recording medium such as a CD, a DVD, or a flash memory, and may be read from the recording medium and stored in a storage device such as the storage portion **6**. In addition, the registration processing portion **51** and the switch processing portion **52** may be composed of an electronic circuit such as an integrated circuit (ASIC).

[0056] The registration processing portion **51** registers a driving state of the driving portion **27**A in the storage portion **6**. Specifically, the registration processing portion **51** acquires, at a predetermined cycle (a sampling time), the driving state of the driving portion **27**A that is the ON state or the OFF state, and registers the driving state in driving state information F**1** (see FIG. **3**) stored in the storage portion **6**. In the example shown in FIG. **3**, the sampling time is set to 10 seconds. The registration processing portion **51** acquires the driving state of the driving portion **27**A every 10 seconds, and registers the driving state in the driving state information F**1**. It is noted that, for example, the driving portion **27**A is in the ON state while the user is performing the image reading operation and the ADF **1** is operating (conveying the sheet, and so on), and is in the OFF state while the image reading operation is not performed.

[0057] In addition, as shown in FIG. **4**, the driving portion **27**A is repeatedly in the ON state and the OFF state alternately while the power of the image forming apparatus **100** is in the ON state after it is powered on or after it returns from a sleep mode. The driving portion **27**A is in the OFF state while the power of the image forming apparatus **100** is in the OFF state.

[0058] In addition, the registration processing portion **51** registers the following ON times and OFF times in the storage portion **6**: an ON time for which the image forming apparatus **100** is in the ON state; an OFF time for which the image forming apparatus **100** is in the OFF state; an ON time for which the driving portion **27**A is in the ON state; and an OFF time for which the driving portion **27**A is in the OFF state. For example, the registration processing portion **51** updates the OFF time of the driving portion **27**A at a timing when the power of the image forming apparatus **100** enters the ON state or at a timing when it returns from the sleep mode, and the registration processing portion **51** updates the ON time of the driving portion **27**A at a timing when the power of the image forming apparatus **100** enters the OFF state or at a timing when it enters the sleep mode.

[0059] The switch processing portion **52** switches the operation mode of the driving portion **27**A alternately between a drive mode (normal mode) for driving the ADF **1** and a cool mode for cooling the driving portion **27**A. When the driving portion **27**A performs driving continuously, the temperature rises. As a result, when a temperature rise is expected, the switch processing portion **52** switches the operation mode of the driving portion **27**A to the cool mode. For example, as shown in an experimental result of FIG. **5**, when the motor performs driving continuously for 18.2 minutes, the temperature of the motor rises up to 90 degrees (design value). As understood from this, it is possible to grasp the temperature of the motor from a total driving time (total ON time) of the motor in a predetermined time period that has passed from a time when the image forming apparatus **100** was powered on or from a time when it returned from the sleep mode.

[0060] Taking the above into consideration, when the total driving time of the motor in the predetermined time period exceeds a first threshold, the switch processing portion **52** switches the operation mode to the cool mode. In the cool mode, when a front edge of a new document sheet reaches a read wait position (e.g. a position in front of the opening portion **22**E), the process for reading the document sheet is not executed, but it is stopped at the position for a certain time (e.g. four seconds), and after the certain time passes, the image reading portion **2** executes the image reading process. That is, when a document sheet is conveyed to the read wait position, the document sheet waits at the position until a permission is given. In this way, in the cool mode, a temporary stop period is set for each image reading in such a way as to stop the driving portion **27**A temporarily (OFF state), thereby suppressing temperature rise.

[0061] As described above, the switch processing portion **52** switches the operation mode of the driving portion **27**A such that in each of the drive mode and the cool mode, the driving portion **27**A outputs the driving force to drive the ADF **1**.

[0062] The switch processing portion **52** switches from the drive mode to the cool mode by having a configuration of, for example, a first to third practical examples shown below.

[0063] As a first practical example, the switch processing portion **52** calculates, as the total driving time, a total of times for each of which the driving portion **27**A is continuously in the ON state in the initial predetermined time period (determination section) after transition to the drive mode. For example, the switch processing portion **52** consults the driving state information F**1** (see FIG. **6**) and calculates the total driving time by totaling times for each of which the driving state is the ON state continuously in the initial 28 minutes (determination section) after transition to the drive mode. Here, when the total driving time (continuous ON time) exceeds the first threshold (e.g. 18.2 minutes), the switch processing portion **52** switches the operation mode to the cool mode.

[0064] As a second practical example, the switch processing portion **52** calculates, as the total driving time, a total of times for each of which the driving portion **27**A is in the ON state in the initial predetermined time period after transition to the drive mode. For example, the switch processing portion **52** consults the driving state information F**1** (see FIG. **6**) and calculates the total driving time by totaling times for each of which the driving state is the ON state in the initial 28 minutes (determination section) after transition to the drive mode. Here, when the total driving time exceeds the first threshold (e.g. 18.2 minutes), the switch processing portion **52** switches the operation mode to the cool mode.

[0065] As a third practical example, the switch processing portion **52** calculates, as the total driving time, a total of times for each of which the driving portion **27**A is in the ON

state in the immediately preceding predetermined time period. For example, the switch processing portion **52** consults the driving state information F**1** (see FIG. **6**) and calculates the total driving time by totaling times for each of which the driving state is the ON state in the immediately preceding 28 minutes (determination section). Here, when the total driving time exceeds the first threshold (e.g. 18.2 minutes), the switch processing portion **52** switches the operation mode to the cool mode. When the total driving time is equal to or lower than the first threshold, the switch processing portion **52** consults the next sequence of driving state information F**1** after 10 seconds (see FIG. **7**) and calculates the total driving time by totaling times for each of which the driving state is the ON state in the immediately preceding 28 minutes (determination section). Here, when the total driving time exceeds the first threshold (e.g. 18.2 minutes), the switch processing portion **52** switches the operation mode to the cool mode. Similarly, when the total driving time is equal to or lower than the first threshold, the switch processing portion **52** consults the next sequence of driving state information F**1** after further 10 seconds (see FIG. **8**) and calculates the total driving time by totaling times for each of which the driving state is the ON state in the immediately preceding 28 minutes (determination section). Here, when the total driving time exceeds the first threshold (e.g. 18.2 minutes), the switch processing portion **52** switches the operation mode to the cool mode. It is noted that in the third practical example, the switch processing portion **52** may calculate, as the total driving time, a total of times for each of which the driving portion **27**A is continuously in the ON state in the immediately preceding predetermined time period.

[0066] As described above, the ON state or the OFF state of the driving portion **27**A is recorded in the storage portion **6** (driving state information F**1**) at the predetermined cycle, and the switch processing portion **52** calculates the total driving time by consulting the driving state information F**1**. In addition, when, in the drive mode, the total driving time of the driving portion **27**A exceeds the first threshold, the switch processing portion **52** switches the operation mode of the driving portion **27**A to the cool mode. While the total driving time of the driving portion **27**A is equal to or lower than the first threshold, the switch processing portion **52** maintains the drive mode.

[0067] In addition, when, after transition to the cool mode, the total driving time of the driving portion **27**A is equal to or lower than a second threshold, the switch processing portion **52** switches the operation mode to the drive mode. Specifically, when, in the cool mode, a total of times for each of which the driving portion **27**A is in the ON state (total driving time) in the predetermined time period (e.g. 28 minutes) becomes equal to or lower than the second threshold (e.g. 16.2 minutes), the switch processing portion **52** switches the operation mode to the drive mode.

[0068] Even when the total driving time exceeds the second threshold (e.g. 16.2 minutes) in the cool mode, the switch processing portion **52** switches the operation mode to the drive mode when a certain time (e.g. 10 minutes) has passed since the transition to the cool mode. This is because in that case, it is expected that the temperature of the driving portion **27**A has decreased sufficiently. It is noted that in this case, the switch processing portion **52** registers the total driving time as 16.2 minutes.

[0069] In the above-described configuration, the times of the first threshold and the second threshold are not limited to the above-mentioned ones, but may be appropriately set. For example, the first threshold and the second threshold may be set based on the experimental result (see FIG. **5**) that varies depending on the use environment of the image forming apparatus **100**.

[0070] In processes other than the above-described ones, the control portion **7** causes the image reading portion **2** to execute the image reading process and causes the image forming portion **3** to execute the image forming process. In addition, the control portion **7** displays various types of operation screens on the operation/display portion **5**.

Operation Mode Switching Process

[0071] FIG. **9** shows an example of the procedure of an operation mode switching process executed by the control portion **7** in the image forming apparatus **100**.

[0072] It is noted that the present disclosure can be recognized as an operation mode switching method (the image reading method of the present disclosure) that executes one or more steps included in the operation mode switching process. In addition, one or more steps included in the operation mode switching process described here may be omitted as necessary. In addition, steps of the operation mode switching process may be executed in different orders as far as the same action effect is obtained. Furthermore, although in this description the control portion **7** executes the steps of the operation mode switching process, in other embodiments, one or more processors may execute the steps of the operation mode switching process dispersedly.

[0073] The operation mode switching process is executed when the power of the image forming apparatus **100** enters the ON state or when it returns from the sleep mode.

Step S**11**

[0074] First, in step S**11**, the control portion **7** determines whether or not the sampling time (e.g. 10 seconds) has passed. Upon determining that the sampling time has passed (S**11**: Yes), the control portion **7** moves the process to step S**12**. The control portion **7** waits until the sampling time passes (S**11**: No).

[0075] Here, the control portion **7** checks the driving state of the driving portion **27**A, for example, every one second, and registers the ON time or the OFF time of the driving portion **27**A in the driving state information F**1** (see FIG. **3**) every 10 seconds.

Step S**12**

[0076] In step S**12**, the control portion **7** acquires, from the driving state information F**1** (see FIG. **3**), the driving states (the ON time and the OFF time) of the driving portion **27**A in the immediately preceding predetermined time period (e.g. 28 minutes).

Step S**13**

[0077] In step S**13**, the control portion **7** calculates the total driving time (total ON time) by totaling times for each of which the driving state of the driving portion **27**A is the ON state. It is noted that the control portion **7** may calculate the total driving time by totaling times for each of which the driving state of the driving portion **27**A is the ON state continuously.

Step S14

[0078] In step S14, the control portion 7 determines whether or not the calculated total ON time exceeds the first threshold (e.g. 18.2 minutes). Upon determining that the total ON time exceeds the first threshold (S14: Yes), the control portion 7 moves the process to step S15. On the other hand, upon determining that the total ON time does not exceed 18.2 minutes (S14: No), the control portion 7 returns the process to step S11.

Step S15

[0079] In step S15, the control portion 7 switches the operation mode of the driving portion 27A to the cool mode. After the operation mode of the driving portion 27A is set to the cool mode, when, for example, the image reading instruction is received, the document sheet is stopped at the read wait position (e.g. a position in front of the opening portion 22E) for a certain time (e.g. four seconds), and after the certain time passes, the image reading portion 2 executes the image reading process. In this way, in the cool mode, the temporary stop period is set for each image reading, thereby reducing the temperature of the driving portion 27A. It is noted that after the certain time passes, the control portion 7 updates the total ON time of the driving portion 27A. Step S15 is an example of a switching step of the present disclosure.

Step S16

[0080] In step S16, the control portion 7 determines whether or not the sampling time (e.g. 10 seconds) has passed since the transition to the cool mode. Upon determining that the sampling time has passed (S16: Yes), the control portion 7 moves the process to step S17. The control portion 7 waits until the sampling time passes (S16: No).

Step S17

[0081] In step S17, the control portion 7 acquires, from the driving state information F1 (see FIG. 3), the driving states (the ON time and the OFF time) of the driving portion 27A in the immediately preceding predetermined time period (e.g. 28 minutes).

Step S18

[0082] In step S18, the control portion 7 calculates the total ON time of the driving portion 27A.

Step S19

[0083] In step S19, the control portion 7 determines whether or not the calculated total ON time is equal to or lower than the second threshold (e.g. 16.2 minutes). Upon determining that the total ON time is equal to or lower than 16.2 minutes (S19: Yes), the control portion 7 moves the process to step S21. In addition, in this case, the control portion 7 registers 16.2 minutes as the total ON time. On the other hand, upon determining that the total ON time exceeds 16.2 minutes (S19: No), the control portion 7 returns the process to step S20.

Step S20

[0084] In step S20, the control portion 7 determines whether or not a certain time (e.g. 10 minutes) has passed since the transition to the cool mode. Upon determining that the certain time has passed (S20: Yes), the control portion 7 moves the process to step S21. That is, even when the total ON time exceeds the second threshold (e.g. 16.2 minutes) in the cool mode, the control portion 7 moves the process to step S21 when the certain time (e.g. 10 minutes) has passed since the transition to the cool mode (S20: Yes). In this case, the control portion 7 registers 16.2 minutes as the total ON time. On the other hand, upon determining that the certain time has not passed (S20: No), the control portion 7 returns the process to step S16.

Step S21

[0085] In step S21, the control portion 7 switches the operation mode of the driving portion 27A to the drive mode. After the operation mode of the driving portion 27A is set to the drive mode, when, for example, the image reading instruction is received, the normal reading process is executed without temporarily stopping the document sheet at the read wait position. Step S21 is an example of the switching step of the present disclosure.

Step S22

[0086] In step S22, the control portion 7 determines whether the power of the image forming apparatus 100 has entered the OFF state or it has entered the sleep mode. Upon determining that the power of the image forming apparatus 100 has entered the OFF state or that it has entered the sleep mode (S22: Yes), the control portion 7 ends the operation mode switching process. On the other hand, upon determining that the power of the image forming apparatus 100 is in the ON state or that it has not entered the sleep mode (S22: No), the control portion 7 returns the process to step S11.

[0087] In the way described above, each time the power of the image forming apparatus 100 enters the ON state or it returns from the sleep mode, the control portion 7 executes the operation mode switching process repeatedly. It is noted that the above-described operation mode switching process is presented as an example, and the contents of the process and the order thereof can be changed as necessary. For example, the control portion 7 may reset the total ON time after the total ON time determination process (S14, S19). In addition, the control portion 7 may update the total OFF time of the driving portion 27A at the power ON point and the return from sleep point shown in FIG. 4, and update the total ON time of the driving portion 27A at the power OFF point and the enter sleep point. In addition, every predetermined time period (e.g. 28 minutes), the control portion 7 may register: the time for which the power of the image forming apparatus 100 is in the ON state; the time for which the power of the driving portion 27A is in the ON state; the state of the operation mode of the driving portion 27A; and the power state of the image forming apparatus 100.

[0088] As described above, when, while the driving portion 27A (motor) is set to the drive mode, the total driving time (total ON time) of the driving portion 27A exceeds the first threshold, the image forming apparatus 100 switches the operation mode of the driving portion 27A to the cool mode. For example, when, in the drive mode, the total driving time in 28 minutes (determination section) exceeds the first threshold (e.g. 18.2 minutes), the control portion 7 switches the operation mode of the driving portion 27A to the cool mode. In this way, when the ON state of the driving

portion **27**A reaches a predetermined time, the operation mode is switched to the cool mode, thereby suppressing temperature rise of the driving portion **27**A. With the above-described configuration, it is possible to suppress temperature rise of the driving portion **27**A without using a cooling fan, a temperature sensor or the like and to protect the driving portion **27**A from the overheated state. It is therefore possible to suppress temperature rise of the driving portion **27**A with a simple configuration. In addition, this makes it possible to reduce the cost of the image forming apparatus **100**.

[0089] In addition, the control portion **7** has a configuration of switching the operation mode of the driving portion **27**A to the drive mode when, after transition to the cool mode, the total driving time of the driving portion **27**A is lower than the second threshold. This allows the driving portion **27**A to return to the normal driving mode quickly as soon as the temperature of the driving portion **27**A is decreased, thereby preventing the efficiency of the image reading process from being reduced.

APPENDED NOTES ON THE DISCLOSURE

[0090] The following notes are appended concerning a summary of the disclosure extracted from the above-described embodiment. It is noted that the configurations and processing functions explained in the following notes can be arbitrarily selected and combined.

Note 1

[0091] An image reading device comprising:

[0092] a conveying portion configured to convey a sheet;

[0093] a reading portion configured to read an image of the sheet;

[0094] a driving portion configured to drive the conveying portion; and

[0095] a switch processing portion configured to switch an operation mode of the driving portion alternately between a drive mode for driving the conveying portion and a cool mode for cooling the driving portion, wherein

[0096] when, in the drive mode, a total driving time of the driving portion exceeds a first threshold, the switch processing portion switches the operation mode to the cool mode.

Note 2

[0097] The image reading device according to Note 1, wherein

[0098] when, after transition to the cool mode, the total driving time of the driving portion is lower than a second threshold, the switch processing portion switches the operation mode to the drive mode.

Note 3

[0099] The image reading device according to Note 1 or 2, wherein

[0100] the switch processing portion calculates, as the total driving time, a total of times for each of which the driving portion is continuously in an ON state in a predetermined time period in the drive mode.

Note 4

[0101] The image reading device according to Note 1 or 2, wherein

[0102] the switch processing portion calculates, as the total driving time, a total of times for each of which the driving portion is in an ON state in a predetermined time period in the drive mode.

Note 5

[0103] The image reading device according to Note 1 or 2, wherein

[0104] the switch processing portion calculates, as the total driving time, a total of times for each of which the driving portion is in an ON state in an immediately preceding predetermined time period in the drive mode.

Note 6

[0105] The image reading device according to any one of Notes 1 to 5, wherein in the cool mode, the sheet is temporarily stopped before the reading portion reads an image.

Note 7

[0106] The image reading device according to any one of Notes 1 to 6, wherein

[0107] an ON state or an OFF state of the driving portion is recorded in a storage portion at a predetermined cycle, and

[0108] the switch processing portion calculates the total driving time by consulting the storage portion.

Note 8

[0109] An image forming apparatus comprising:

[0110] the image reading device according to any one of Notes 1 to 7; and

[0111] an image forming portion configured to form an image on the sheet.

[0112] 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. An image reading device comprising:

a conveying portion configured to convey a sheet;

a reading portion configured to read an image of the sheet;

a driving portion configured to drive the conveying portion; and

a switch processing portion configured to switch an operation mode of the driving portion alternately between a drive mode for driving the conveying portion and a cool mode for cooling the driving portion, wherein

when, in the drive mode, a total driving time of the driving portion exceeds a first threshold, the switch processing portion switches the operation mode to the cool mode.

2. The image reading device according to claim **1**, wherein

when, after transition to the cool mode, the total driving time of the driving portion is lower than a second

threshold, the switch processing portion switches the operation mode to the drive mode.

3. The image reading device according to claim **1**, wherein

the switch processing portion calculates, as the total driving time, a total of times for each of which the driving portion is continuously in an ON state in a predetermined time period in the drive mode.

4. The image reading device according to claim **1**, wherein

the switch processing portion calculates, as the total driving time, a total of times for each of which the driving portion is in an ON state in a predetermined time period in the drive mode.

5. The image reading device according to claim **1**, wherein

the switch processing portion calculates, as the total driving time, a total of times for each of which the driving portion is in an ON state in an immediately preceding predetermined time period in the drive mode.

6. The image reading device according to claim **1**, wherein in the cool mode, the sheet is temporarily stopped before the reading portion reads an image.

7. The image reading device according to claim **1**, wherein

an ON state or an OFF state of the driving portion is recorded in a storage portion at a predetermined cycle, and

the switch processing portion calculates the total driving time by consulting the storage portion.

8. An image forming apparatus comprising:

the image reading device according to claim **1**; and

an image forming portion configured to form an image on the sheet.

9. An image reading method comprising

a switching step of, in an image reading device including: a conveying portion configured to convey a sheet; a reading portion configured to read an image of the sheet; and a driving portion configured to drive the conveying portion, switching an operation mode of the driving portion alternately between a drive mode for driving the conveying portion and a cool mode for cooling the driving portion, wherein

in the switching step, when, in the drive mode, a total driving time of the driving portion exceeds a first threshold, the operation mode is switched to the cool mode.

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