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(54) **IMAGE FORMING APPARATUS AND METHOD OF CONTROLLING IMAGE FORMING APPARATUS**

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(57) **ABSTRACT**

In an image forming apparatus, a storage portion stores a target adhesion amount of toner to adhere to an image bearing member at each of gradation levels as a target gradation level and a setting value of a control parameter used for control on the image forming portion at the target gradation level. A first control processor makes an adhesion amount sensor measure an actual adhesion amount corresponding to the setting value and thereafter compares a resultant measured value and the target adhesion amount and corrects the setting value if needed in association with at least one of the target gradation levels as a subject. A second control processor makes the image forming portion output a calibration image used for correcting the target adhesion amount using a period when the first control processor performs processing if there arises a need to correct the target adhesion amount associated with the subject.

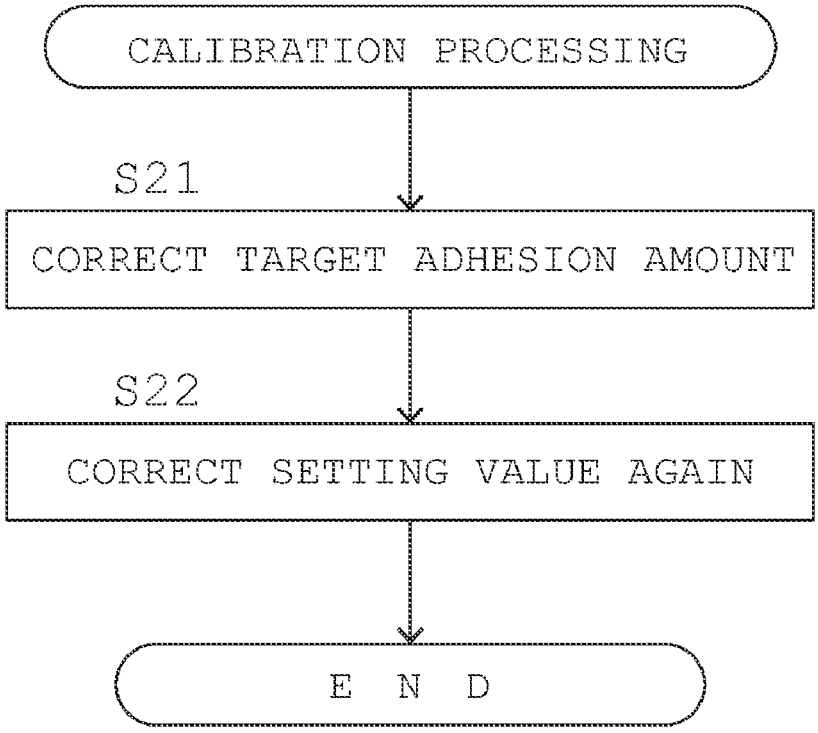


FIG. 1

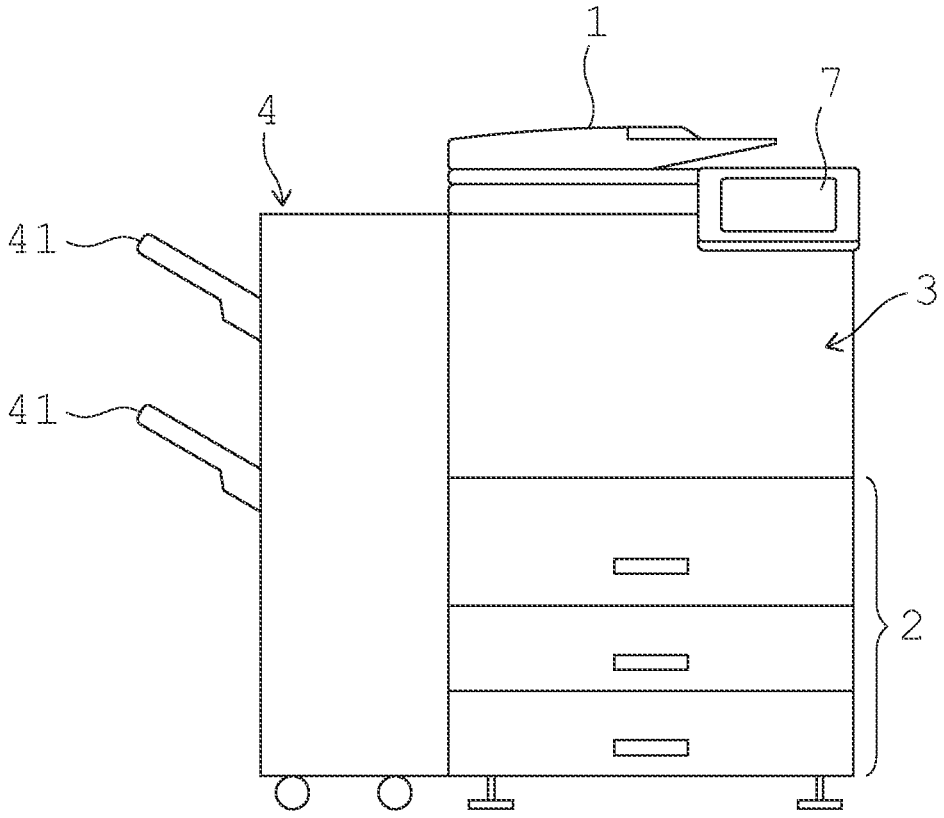


FIG. 2

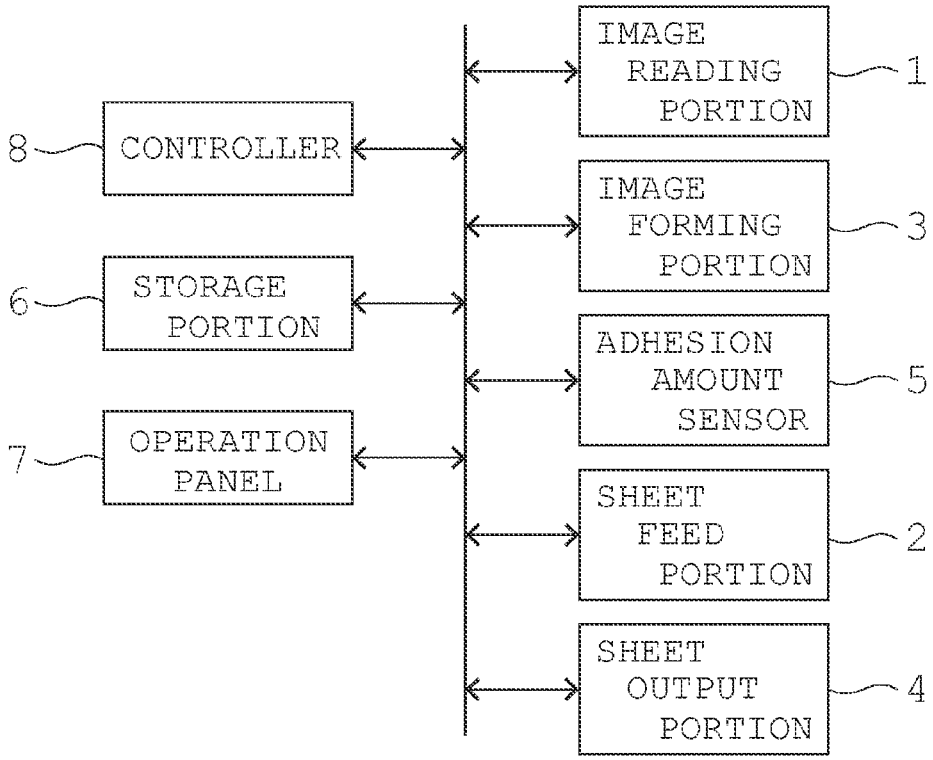


IMAGE READING PORTION
1
8
CONTROLLER
IMAGE FORMING PORTION
3
6
STORAGE PORTION
ADHESION AMOUNT SENSOR
5
7
OPERATION PANEL
SHEET FEED PORTION
2
SHEET OUTPUT PORTION
4

FIG. 3

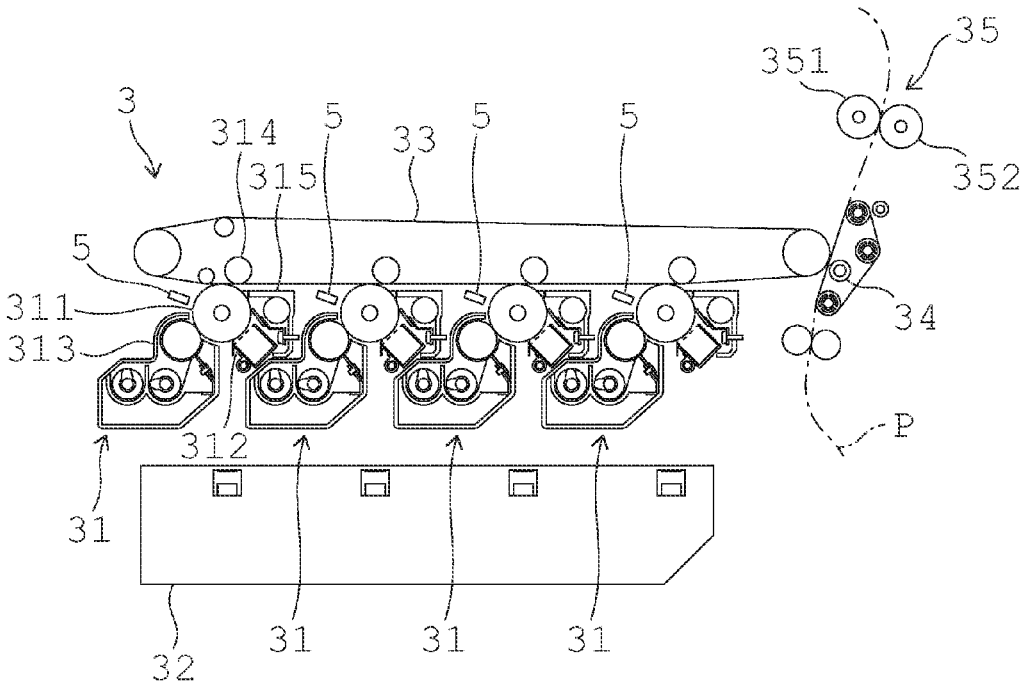


FIG. 4

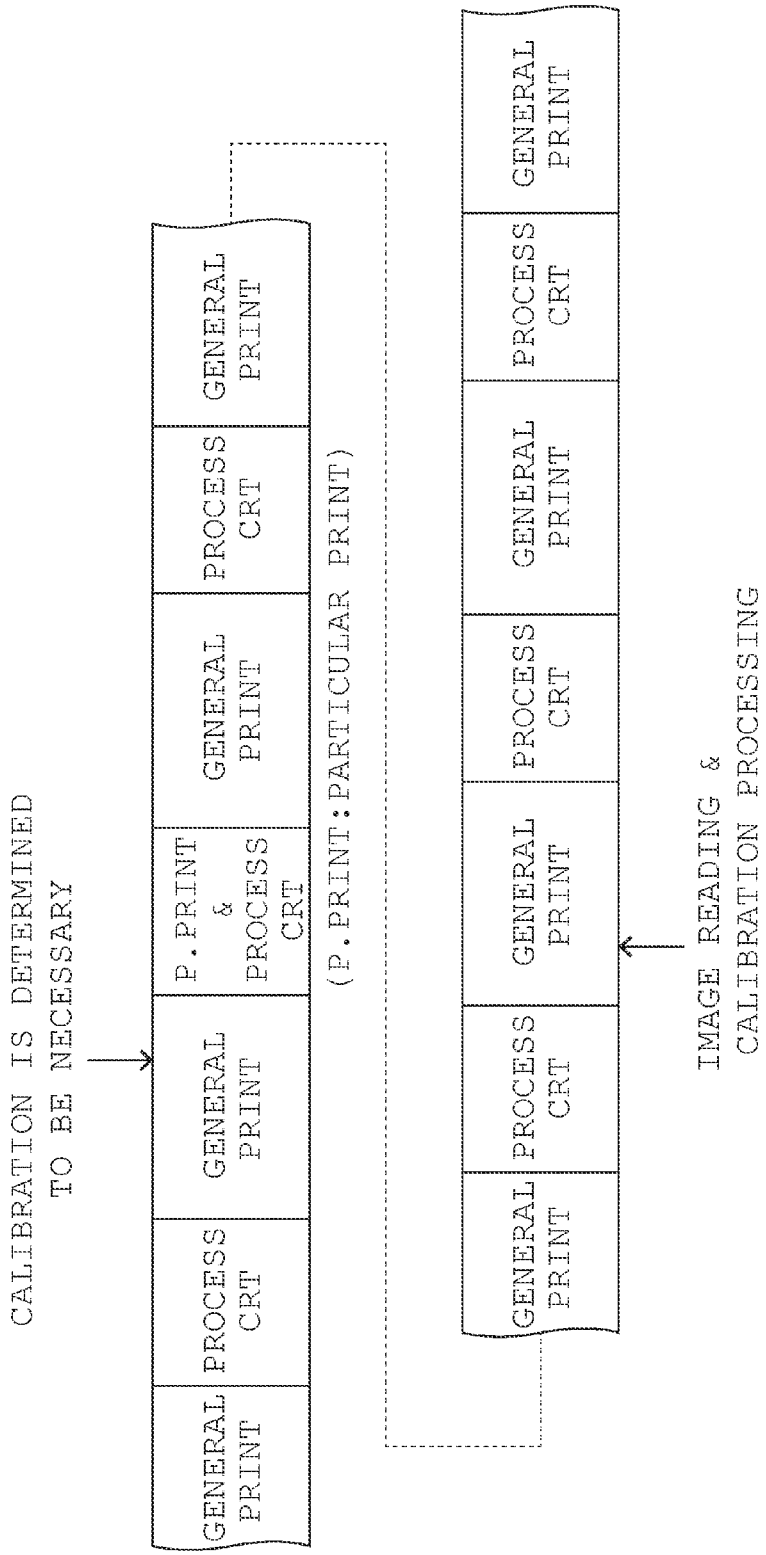

CALIBRATION IS DETERMINED TO BE NECESSARY
GENERAL PRINT
PROCESS CRT
GENERAL PRINT
P. PRINT & PROCESS CRT
GENERAL PRINT
PROCESS CRT
GENERAL PRINT
(P. PRINT: PARTICULAR PRINT)
GENERAL PRINT
PROCESS CRT
GENERAL PRINT
PROCESS CRT
GENERAL PRINT
PROCESS CRT
GENERAL PRINT
IMAGE READING & CALIBRATION PROCESSING

FIG. 5

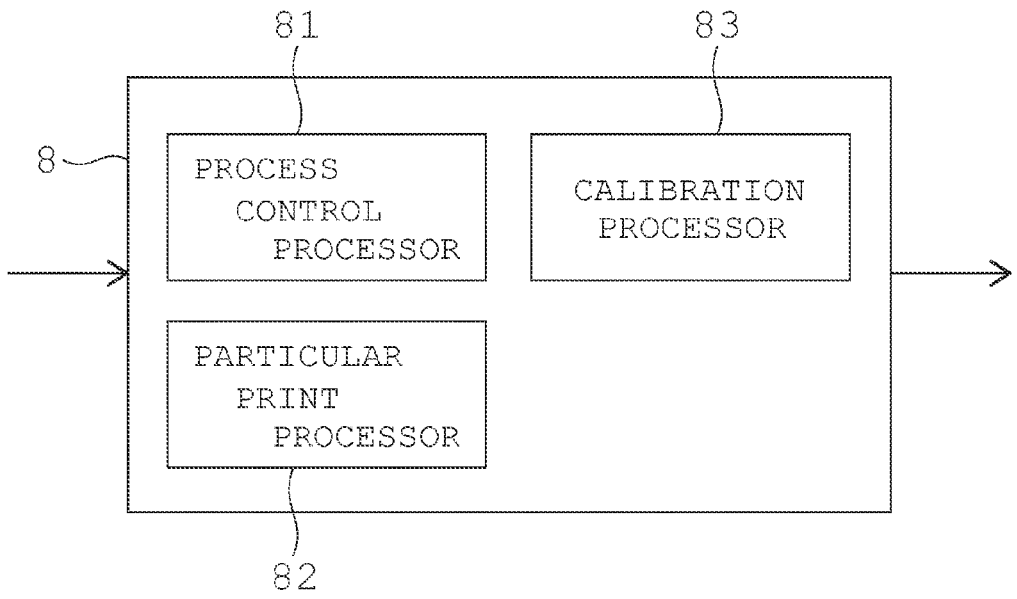

81
83
8
PROCESS CONTROL PROCESSOR
CALIBRATION PROCESSOR
PARTICULAR PRINT PROCESSOR
82

FIG. 6

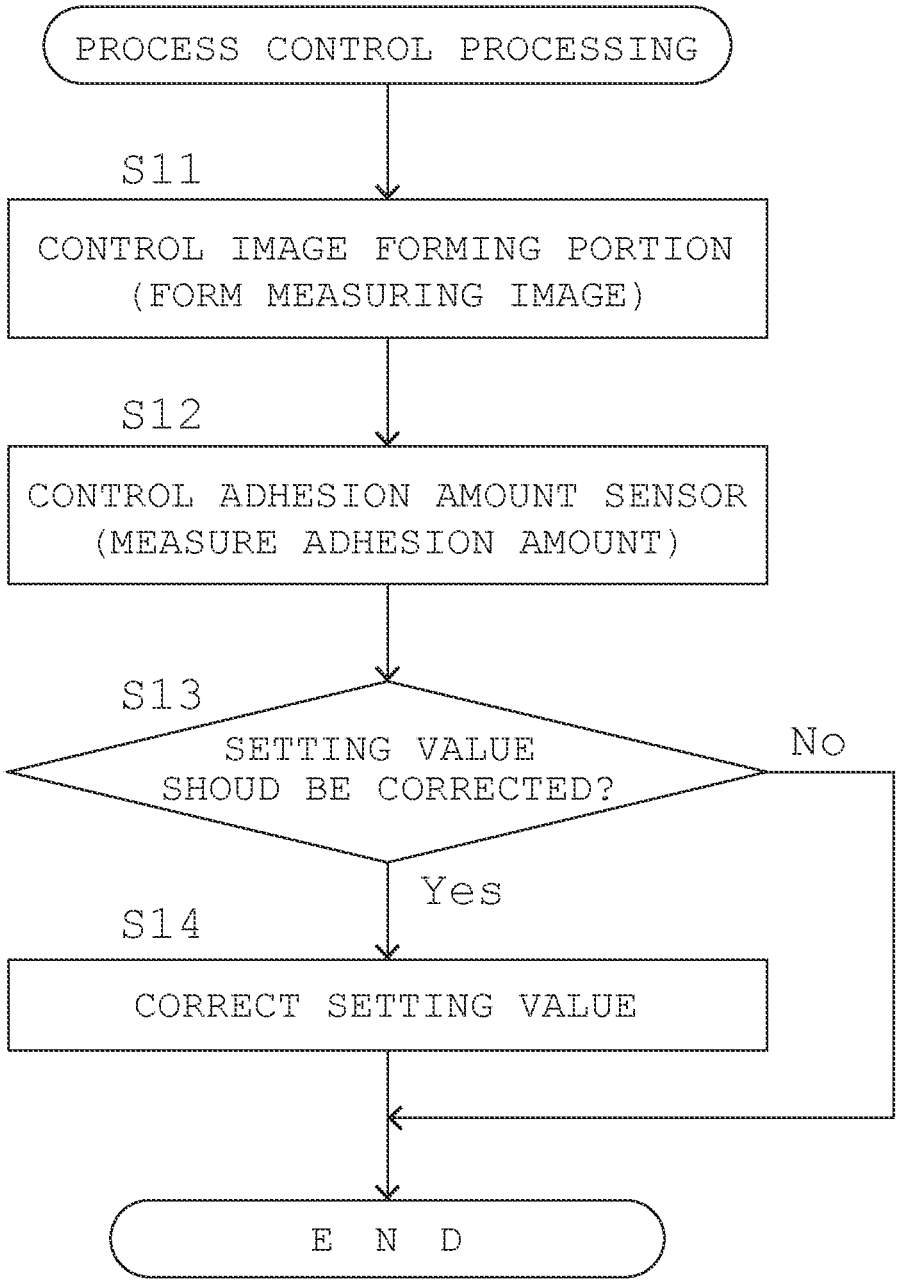

PROCESS CONTROL PROCESSING
S11
CONTROL IMAGE FORMING PORTION (FORM MEASURING IMAGE)
S12
CONTROL ADHESION AMOUNT SENSOR (MEASURE ADHESION AMOUNT)
S13
SETTING VALUE SHOUD BE CORRECTED?
No
Yes
S14
CORRECT SETTING VALUE
E N D

FIG. 7

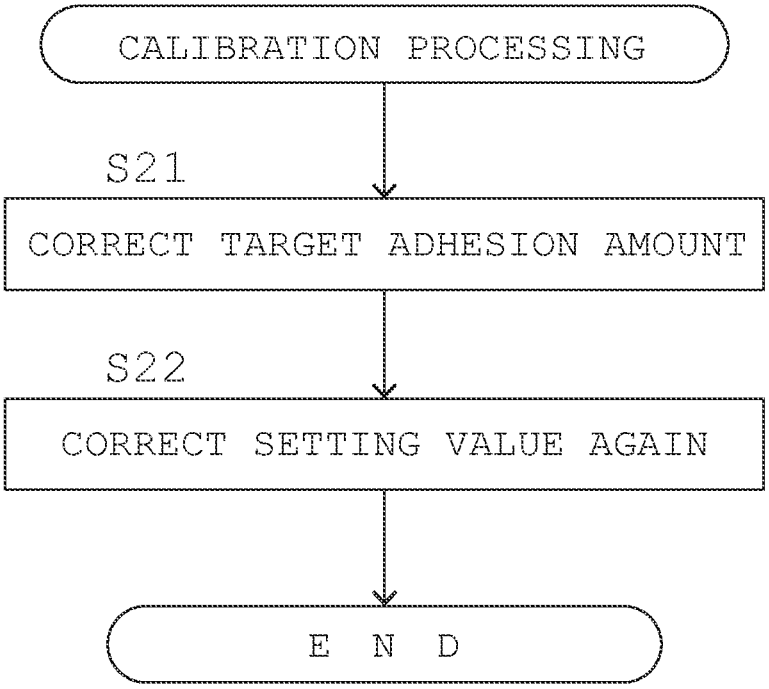
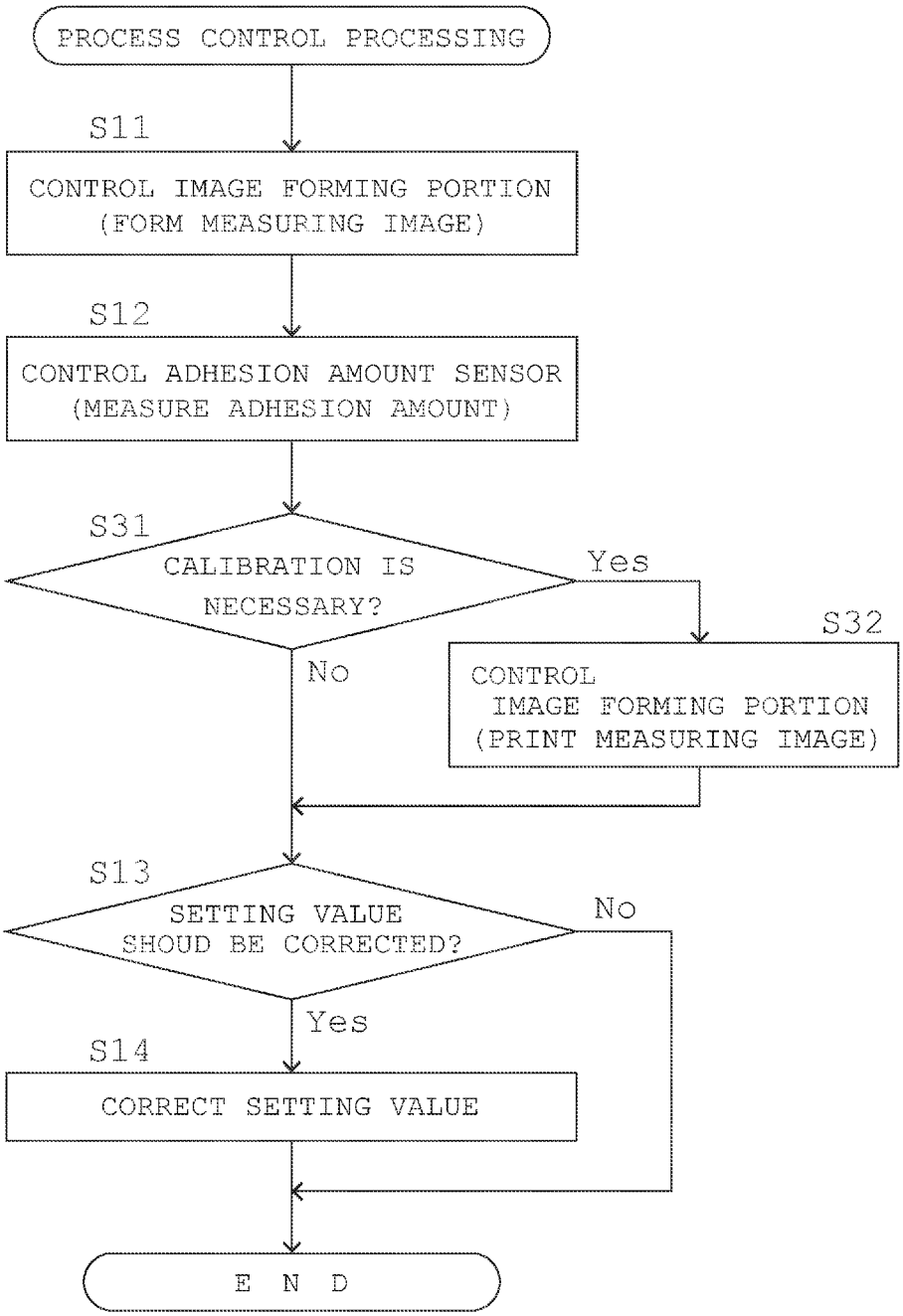

CALIBRATION PROCESSING
S21
CORRECT TARGET ADHESION AMOUNT
S22
CORRECT SETTING VALUE AGAIN
E N D

FIG. 8


PROCESS CONTROL PROCESSING
S11
CONTROL IMAGE FORMING PORTION (FORM MEASURING IMAGE)
S12
CONTROL ADHESION AMOUNT SENSOR (MEASURE ADHESION AMOUNT)
S31
CALIBRATION IS NECESSARY?
Yes
S32
CONTROL IMAGE FORMING PORTION (PRINT MEASURING IMAGE)
No
S13
SETTING VALUE SHOUD BE CORRECTED?
No
Yes
S14
CORRECT SETTING VALUE
E N D

# IMAGE FORMING APPARATUS AND METHOD OF CONTROLLING IMAGE FORMING APPARATUS

## CROSS REFERENCE

**[0001]** This Nonprovisional application claims priority under 35 U.S.C. §119(a) on Patent Application No. 2015-166329 filed in Japan on Aug. 26, 2015, the entire contents of which are hereby incorporated by reference.

## BACKGROUND OF THE INVENTION

**[0002]** 1. Field of the Invention

**[0003]** This invention relates to an image forming apparatus and a method of controlling the image forming apparatus. More specifically, this invention relates to an image quality adjustment technique employed in an image forming apparatus of an electrophotographic system.

**[0004]** 2. Description of Related Art

**[0005]** In an image forming apparatus of an electrophotographic system, to obtain an intended image quality, a setting value of a control parameter is determined in advance in association with each gradation level of each color forming certain color space (CMYK color space, for example). An image quality is likely to change under influence of change in environment (such as temperature or humidity) or aging degradation of the apparatus, for example. Hence, to maintain the intended image quality, the setting value of the control parameter has been required to be corrected by performing calibration at regular intervals. The necessity of calibration has been determined by a user based on an image on a printed matter. If determining that calibration is necessary, the user has been required to make the image forming apparatus output a calibration image for example through operation using a button and to read the output image using a scanner, etc.

**[0006]** For example, an image forming apparatus to be used for producing a large quantity of printed matters is required to perform printing continuously at high speed. This is because such printing reduces a period of time from when printing is started to when the printing is finished. However, determination as to the necessity of calibration should be made by a user. Hence, during the printing, the user has been required to check an image quality at regular intervals. In the case of a conventional image forming apparatus, the user has been required to interrupt printing if there arises a need for calibration. This interruption has been a cause for a delay in the end of production of a large quantity of printed matters.

**[0007]** Then, the following image quality adjustment technique has been suggested (see Japanese published unexamined patent application No. 2013-148808, for example). Specifically, a setting value of a control parameter is determined in association with each gradation level of each color forming certain color space and the adhesion amount (target adhesion amount) of toner to adhere to an image bearing member using the setting value is determined in advance. Then, the adhesion amount of the toner actually adhering to the image bearing member using the setting value is measured using a sensor such as an adhesion amount sensor. A resultant measured value and a corresponding target adhesion amount are compared to correct the setting value if needed. Such an image quality adjustment technique is generally called process control processing and can easily be performed automatically by an image forming apparatus. By performing the process control processing at regular intervals, an intended image quality can be maintained without requiring monitoring by a user. In the below, unless otherwise specified, the term "process control" is distinguished from the term "calibration."

**[0008]** However, even if control is executed so as to achieve a target adhesion amount, with the target adhesion amount being unchanged, the risk of failing to achieve an intended image quality is still caused due to environmental change, for example. Hence, while the process control processing is performed, a need for calibration still arises. If there arises a need for calibration, printing should be interrupted like in the conventional case. Such interruption of printing reduces printing efficiency.

## SUMMARY OF THE INVENTION

**[0009]** An image forming apparatus includes: an image forming portion that forms a toner image on an image bearing member; an adhesion amount sensor that measures the amount of toner adhering to the image bearing member; a controller that controls the image forming portion and the adhesion amount sensor; and a storage portion. In association with gradation levels of each color forming certain color space, the storage portion stores a target adhesion amount of toner to adhere to the image bearing member at each of the gradation levels as a target gradation level and a setting value of a control parameter used for control on the image forming portion at the target gradation level. The controller includes a first control processor and a second control processor. The first control processor makes the adhesion amount sensor measure an actual adhesion amount corresponding to the setting value of the control parameter and thereafter compares a resultant measured value and the target adhesion amount and corrects the setting value if needed, in association with at least one of the target gradation levels as a subject. This processing by the first control processor is what is called process control processing. The second control processor makes the image forming portion output a calibration image used for correcting the target adhesion amount using a period when the first control processor performs the processing, if there arises a need to correct the target adhesion amount associated with the subject target gradation level.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0010]** FIG. **1** is a front view of an image forming apparatus according to an embodiment of this invention;

**[0011]** FIG. **2** is a block diagram of the image forming apparatus;

**[0012]** FIG. **3** is a conceptual view of an image forming portion in the image forming apparatus;

**[0013]** FIG. **4** is a timing diagram showing a period when general printing is performed and periods when various types of processing for image quality adjustment are performed;

**[0014]** FIG. **5** is a block diagram of a controller in the image forming apparatus;

**[0015]** FIG. **6** is a flowchart of process control processing;

**[0016]** FIG. **7** is a flowchart of calibration processing; and

**[0017]** FIG. **8** is a flowchart showing a modification of the process control processing.

## DETAILED DESCRIPTION OF THE EMBODIMENTS

### 1. Structure of Image Forming Apparatus

**[0018]** As shown in FIGS. **1** and **2**, an image forming apparatus includes an image reading portion **1**, a sheet feed portion **2**, an image forming portion **3**, a sheet output portion **4**, an adhesion amount sensor **5**, a storage portion **6**, an operation panel **7**, and a controller **8**. The image reading portion **1** generates image data by optically reading an image on a document loaded on a document platen. The image reading portion **1** can read an image in parallel with formation of an image by the image forming portion described later. The image reading portion **1** may have an automatic document feeding mechanism.

**[0019]** The sheet feed portion **2** stores sheets and feeds them one by one to the image forming portion **3**. These sheets are not limited to sheets made from paper such as plain paper or photographic paper but include sheets made from a resin material such as OHP films and sheets made from various other materials. The sheet feed portion **2** is not limited to a sheet feed cassette but it may include a manual feed tray.

**[0020]** The image forming portion **3** prints an image on a sheet fed from the sheet feed portion **2** by performing image forming processing of an electrophotographic system based on the image data. The image data is not limited to data generated by the image reading portion **1** but it may include image data obtained from an external information processing apparatus through a network, for example.

**[0021]** As shown in FIG. **3**, the image forming portion **3** includes four main processors **31**, an exposure portion **32**, an intermediate transfer belt **33**, a secondary transfer roller **34**, and a fixing portion **35**. Color space intended to be employed in the image forming apparatus of this embodiment is CMYK space. Thus, the four main processors **31** are to generate toner images of the four colors (cyan, magenta, yellow, and black) forming the CMYK space. The number of the main processors **31** to be installed may be changed according to color space to be employed. For example, an image forming apparatus intended for monochrome printing includes one main processor **31**.

**[0022]** Each of the main processors **31** includes a photoreceptor drum **311**, a charging portion **312**, a developing portion **313**, a primary transfer roller **314**, and a cleaning portion **315**. The photoreceptor drum **311** is an electrostatic latent image bearing member. The charging portion **312** charges the photoreceptor drum **311** in such a manner that the circumferential surface of the photoreceptor drum **311** is placed at a given potential. In response to irradiation with laser from the exposure portion **32**, an electrostatic latent image responsive to the image data is formed on the circumferential surface of the charged photoreceptor drum **311**.

**[0023]** The developing portion **313** applies a bias (developing bias) to a developing roller, thereby moving toner (developer) adhering to the circumferential surface of the developing roller to the circumferential surface of the photoreceptor drum **311**. In this way, the electrostatic latent image is developed into a toner image. In response to the rotation of the photoreceptor drum **311**, the toner image is carried to a position (primary transfer position) where the toner image is to be transferred to the intermediate transfer belt **33** (primary transfer).

**[0024]** The primary transfer roller **314** transfers the toner image born on the photoreceptor drum **311** onto the intermediate transfer belt **33** passing between the primary transfer roller **314** and the photoreceptor drum **311**. More specifically, in response to application of a bias to the primary transfer roller **314**, the primary transfer roller **314** generates electrostatic force on the toner forming the toner image and moves the toner image to the intermediate transfer belt **33** using the electrostatic force.

**[0025]** Toner images of the four colors generated by the four main processors **31** based on the image data are transferred to the same region on the intermediate transfer belt **33** so as not to shift from each other. In this way, the toner images of the four colors overlap each other to form a full-color toner image on the intermediate transfer belt **33**. In response to the rotation of the intermediate transfer belt **33**, the full-color toner image is carried to a position where the full-color toner image is to be transferred to a sheet (secondary transfer). In FIG. **3**, the sheet is indicated by a sign P.

**[0026]** The cleaning portion **315** removes toner and other subjects (including dirt) remaining adhering to the circumferential surface of the photoreceptor drum **311** after the primary transfer. In this way, preparation for next image forming processing is made.

**[0027]** The secondary transfer roller **34** transfers the full-color toner image born on the intermediate transfer belt **33** onto a sheet fed from the sheet feed portion **2**. More specifically, in response to application of a bias to the secondary transfer roller **34**, the secondary transfer roller **34** generates electrostatic force on the toner forming the toner image and moves the toner image to the sheet using the electrostatic force.

**[0028]** The fixing portion **35** includes a heating roller **351** and a pressure roller **352** contacting the heating roller **351** under pressure. The sheet including the transferred toner image is passed through between the heating roller **351** and the pressure roller **352** to apply appropriate heat and appropriate pressure to the toner image. In this way, the toner image is fixed on the sheet. Then, the sheet is carried to the sheet output portion **4**.

**[0029]** The sheet output portion **4** includes a plurality of sheet output trays **41**. In response to a command from the controller **8**, the sheet output portion **4** outputs the sheet on which the toner image has been fixed to any of the sheet output trays **41** selectively.

**[0030]** The adhesion amount sensor **5** includes four adhesion amount sensors **5** provided in corresponding relationship with the photoreceptor drums **311** of the four main processors **31**. Each of the adhesion amount sensors **5** measures the amount of toner adhering to a corresponding one of the photoreceptor drums **311**. More specifically, each of the adhesion amount sensors **5** is arranged to face a toner image formed on a corresponding one of the photoreceptor drums **311** in the course of carriage of this toner image to the primary transfer position.

**[0031]** The storage portion **6** stores image data used for printing and a setting value of a control parameter (such as a developing bias) used for control on each portion (such as the image forming portion **3**) of the image forming apparatus. The controller **8** controls each portion of the image forming apparatus based on the image data and the setting value stored in the storage portion **6**.

**[0032]** The operation panel **7** is a touch panel, for example, and functions as a user interface. Specifically, the operation panel has a function as an input portion to accept a command relating to operation input from a user, and a function as a display portion to present information such as an operating condition to the user.

**[0033]** Various control processors such as a central processing unit (CPU) and a microcomputer are applicable as the controller **8**. Processing by the controller **8** may be performed by making the image forming apparatus execute a series of programs corresponding to this processing. Such programs may be stored in a storage medium (such as a flash memory) in a state of being readable by the storage medium, or may be stored in the storage portion **6**.

## 2. Control on Image Forming Apparatus

**[0034]** Control executed by the controller **8** in the image forming apparatus is described in detail next. The controller **8** performs image quality adjustment processing so as to obtain an intended image quality of a printed matter in addition to general print processing. As shown in FIG. **4**, in this embodiment, the image quality adjustment processing to be performed includes process control processing, particular print processing, and calibration processing. More specifically, as shown in FIG. **5**, the controller **8** includes a process control processor **81**, a particular print processor **82**, and a calibration processor **83**. These processors **81** to **83** correspond to a first control processor, a second control processor, and a third control processor respectively recited in the claims. In FIGS. **4** and **5**, the process control processing is abbreviated as "PROCESS CRT PROCESSING."

**[0035]** To permit image quality adjustment by the controller **8**, in association with gradation levels of each of the four colors forming CMYK space (cyan, magenta, yellow, and black), the storage portion **6** stores a target adhesion amount of toner to adhere to the photoreceptor drum **311** at each of the gradation levels as a target gradation level and a setting value of a control parameter (such as a developing bias) used for control at the target gradation level.

**[0036]** In order for an actual adhesion amount to agree with a target adhesion amount in association with each target gradation level of each color, the process control processor **81** corrects a setting value of a corresponding control parameter. In order to achieve an intended gradation level in an image on a printed matter, the calibration processor **83** corrects the target adhesion amount corresponding to each target gradation level. During manufacture or shipment from a factory of the image forming apparatus, predetermined values are stored as the target adhesion amount and the setting value into the storage portion **6**. Then, these values stored in the storage portion **6** are corrected through the process control processing and the calibration processing.

**[0037]** The storage portion **6** further stores image data for process control and image data for calibration. The image data for process control is about a plurality of patch images drawn to represent the respective gradation levels of the four colors separately and to represent the gradation levels of each of the four colors in stages. If the density of a color is expressed in 256 gradation levels, for each color drawn are patch images whose densities are changed in stages at an interval of 16 gradation levels, for example. Likewise, the image data for calibration is about a plurality of patch images drawn to represent the respective gradation levels of the four colors separately and to represent the gradation levels of each of the four colors in stages. These two pieces of image data may be the same image data or may be different pieces of image data about different numbers of drawn patch images (specifically, one image data has patch images whose densities are changed at an interval different from an interval for the other image data). Alternatively, one piece of image data may be used in common as these two pieces of image data.

### 2-1. Process Control Processing

**[0038]** The process control processing is performed based on determination by the controller **8**. Specifically, the controller determines whether or not the process control processing should be performed. If determining that the process control processing should be performed, the controller **8** makes the process control processor **81** perform the process control processing. As an example, the controller **8** counts the number of sheets printed by general printing and determines whether or not the counted number has reached a given number of sheets. If determining that the counted number agrees with the given number, the controller **8** makes the process control processor **81** perform the process control processing. As shown in FIG. **4**, the process control processing is performed repeatedly at a higher frequency than the calibration processing.

**[0039]** FIG. **6** is a flowchart of the process control processing. In the process control processing, the process control processor **81** makes the image forming portion **3** form a toner image based on the image data for process control (step S**11**). As a result of this step, the image forming portion **3** forms a patch image (measuring image) representing the density of each color on the photoreceptor drum **311** corresponding to this color using a setting value of a control parameter stored in the storage portion **6**. More specifically, the image forming portion **3** forms each patch image using the setting value of the control parameter corresponding to a gradation level (target gradation level) intended to be represented by this patch image.

**[0040]** Next, with the patch image (measuring image) formed on each photoreceptor drum **311** being taken as a subject of measurement, the process control processor **81** makes the adhesion amount sensor **5** measure an actual adhesion amount about each patch image (step S**12**). Then, the process control processor **81** compares the resultant measured value (actual adhesion amount) and a target adhesion amount in association with each color or each gradation level of each color, and corrects the setting value of the control parameter if needed (steps S**13** and S**14**). In this way, control is executed in such a manner that the actual adhesion amount agrees with the target adhesion amount in association with each target gradation level of each color. Specifically, an image quality is adjusted by performing the process control processing. The patch image formed on the corresponding photoreceptor drum **311** is generally removed from this photoreceptor drum **311** after the measurement (step S**12**) of an adhesion amount.

### 2-2. Particular Print Processing

**[0041]** A calibration image is printed on a sheet by the particular print processing. The particular print processing is performed as follows based on determination by the controller **8**. Specifically, the controller **8** determines whether or not calibration is necessary. If determining that calibration is

necessary, the controller **8** makes the particular print processor **82** perform the particular print processing using a period when the process control processing is performed (see FIGS. **4** and **5**). The controller **8** makes determination as to the necessity of calibration. This differs from the conventional technique according to which a user is to make the same determination. The calibration image is printed using a period when the process control processing is performed. This differs from the conventional technique according to which a calibration image is printed in response to a command given through user's operation using a button, for example.

**[0042]** Determination as to the necessity of calibration is made as follows. As an example, the controller **8** makes such determination based on the number of sheets printed by general printing. More specifically, the controller **8** counts the number of sheets printed by the general printing and determines whether or not the counted number has reached a given number of sheets. If determining that the counted number has reached the given number, the controller **8** determines that calibration is necessary. As another example, the controller **8** makes determination as to the necessity of calibration based on the measured value (actual adhesion amount) measured during implementation of the process control processing and the target adhesion amount. More specifically, the controller **8** obtains a difference between the measured value and the target adhesion amount and determines whether or not the absolute of the difference is a given value or more. If determining that the absolute is the given value or more, the controller **8** determines that calibration is necessary.

**[0043]** The particular print processor **82** makes the image forming portion **3** form a toner image based on the image data for calibration. As a result of this step, the image forming portion forms a patch image (calibration image) representing the density of each color on the photoreceptor drum **311** corresponding to this color using a setting value of a control parameter stored in the storage portion **6**. More specifically, the image forming portion **3** forms each patch image using the setting value of the control parameter corresponding to a gradation level (target gradation level) intended to be represented by this patch image. The setting value used in this step is not a setting value corrected by the process control processing performed in the same period but a setting value before being corrected.

**[0044]** Patch images formed on the four photoreceptor drums **311** are all subjected to primary transfer, secondary transfer, and fixation to be printed onto one sheet. This sheet is output as a printed matter of the calibration image to the sheet output tray **41**. At this time, the particular print processor **82** selects one from the plurality of sheet output trays **41** different from a sheet output tray **41** to which a general printed matter is to be output. Then, the particular print processor **82** outputs the printed matter of the calibration image to the selected sheet output tray **41**. In this way, the printed matter of the calibration image is prevented from being mixed with the general printed matter. As a result of the following control, the printed matter of the calibration image can be output to the sheet output tray **41** to which a general printed matter is to be output without being mixed with this general printed matter. Specifically, the particular print processor **82** shifts an output position for the printed matter of the calibration image from an output position for other printed matters.

**[0045]** In addition to printing of the calibration image, the particular print processor **82** stores the measured value (actual adhesion amount) in association with a corresponding target gradation level of each color into the storage portion **6**. This measured value is a value measured in the particular print processing performed in the same period as the printing of the calibration image, and is retained in the storage portion **6** at least for a period before it is used in the calibration processing.

### 2-3. Calibration Processing

**[0046]** The calibration processing is performed when the calibration image is read by the image reading portion **1**. The image reading portion **1** reads the calibration image through user's operation as follows. First, the user recognizes the necessity of calibration by knowing that the printed matter of the calibration image is output to the sheet output tray **41**. Then, for execution of calibration, the user makes the image reading portion **1** read the calibration image. The image reading portion **1** can read the image in parallel with image formation by the image forming portion **3**. Thus, even after the user starts calibration, general printing being performed is not interrupted.

**[0047]** FIG. **7** is a flowchart of the calibration processing. Based on a gradation level obtained from the calibration image, the calibration processor **83** corrects the target adhesion amount and stores the corrected target adhesion amount as a new target adhesion amount into the storage portion **6** (step S**21**). More specifically, the calibration processor **83** compares the gradation level obtained from the calibration image and the corresponding target gradation level. Further, the calibration processor **83** compares the measured value of the adhesion amount (actual adhesion amount) stored into the storage portion **6** during implementation of the particular print processing and the target adhesion amount. Then, the calibration processor **83** corrects the target adhesion amount based on these comparisons to correct a gradation level deviation of each color.

**[0048]** Next, the calibration processor **83** corrects the setting value of the control parameter based on the corrected target adhesion amount (step S**22**). More specifically, based on the corrected target adhesion amount and the adhesion amount measured by the process control processing performed last before the calibration image is read, the calibration processor **83** again corrects the setting value of the control parameter having been used for formation of the patch image by this process control processing. Then, the calibration processor **83** stores the re-corrected setting value into the storage portion **6**.

**[0049]** In the image forming apparatus of this embodiment, if there arises a need for calibration (correction of a target adhesion amount) during the course of production of a large quantity of printed matters, the particular print processing is performed (a calibration image is output) using a period when the process control processing is planned to be performed. Thus, the production of a large quantity of printed matters is not interrupted. Further, a calibration image is read and the calibration processing is performed without interrupting general printing. Thus, even if there arises a need for calibration, the image forming apparatus of this embodiment does not interrupt printing, thereby enhancing printing efficiency.

## 3. Other Embodiments

### 3-1. Second Embodiment

**[0050]** As described above, the controller **8** determines whether or not calibration is necessary. If determining that calibration is necessary, the controller **8** makes the particular print processor **82** perform the particular print processing using a period when the process control processing is performed. In the aforementioned embodiment, the particular print processor **82** forms and prints a calibration image separately from a measuring image having been used in the process control processing. However, this is not the only control relating to the particular print processing.

**[0051]** As shown in FIG. **8**, the controller **8** may determine whether or not calibration is necessary during the course of implementation of the process control processing (step S**31**). If determining that calibration is necessary, the particular print processor **82** may make the image forming portion **3** print a measuring image having been used in the process control processing as a calibration image (step S**32**). This enhances printing efficiency further.

**[0052]** Determination as to the necessity of calibration may be made before implementation of the process control processing is started. In this case, if determining that calibration is necessary, the controller **8** sets a flag. The controller **8** determines in step S**31** whether or not such a flag is set. Like in the aforementioned embodiment, in step S**32**, a calibration image may be formed and printed separately from the measuring image having been used in the process control processing.

### 3-2. Third Embodiment

**[0053]** In the aforementioned embodiments, the controller **8** (calibration processor **83**) performs the calibration processing to automatically correct a target adhesion amount. However, this is not the only way of calibration.

**[0054]** For example, a result of reading of a calibration image may be displayed on the operation panel **7** and a user may correct a target adhesion amount manually based on the displayed result. Alternatively, a user may correct a target adhesion amount manually by checking a printed calibration image visually without making the image reading portion **1** read a calibration image.

### 3-3. Other Examples

**[0055]** A color multifunction machine is employed as an example of the aforementioned image forming apparatus. However, a range of application of the structure of each portion and control on each portion of the image forming apparatus is not limited to a color multifunction machine but can be extended to various types of image forming apparatuses such as a color copier and a color printer. Additionally, the aforementioned image forming apparatus is not limited to an image forming apparatus to form color images but can be modified as an image forming apparatus to form monochrome images.

**[0056]** In the aforementioned embodiments, with a patch image formed on the photoreceptor drum **311** being taken as a subject of measurement, an adhesion amount is measured using the adhesion amount sensor **5**. However, a patch image on the photoreceptor drum **311** is not the only subject of measurement. For example, with a patch image transferred on the intermediate transfer belt **33** being taken as a subject of measurement, an adhesion amount may be measured using the adhesion amount sensor **5**. In this case, the intermediate transfer belt **33** corresponds to an image bearing member recited in the appended claims.

**[0057]** It should be noted that the foregoing description of the embodiments is in all aspects illustrative and not restrictive. The scope of this invention is defined by the appended claims rather than by the embodiments described above. All changes that fall within a meaning and a range equivalent to the scope of the claims are therefore intended to be embraced by the claims.

What is claimed is:

**1**. An image forming apparatus comprising:

an image forming portion that forms a toner image on an image bearing member;

an adhesion amount sensor that measures the amount of toner adhering to the image bearing member;

a controller that controls the image forming portion and the adhesion amount sensor; and

a storage portion, wherein

in association with gradation levels of each color forming certain color space, the storage portion stores a target adhesion amount of toner to adhere to the image bearing member at each of the gradation levels as a target gradation level and a setting value of a control parameter used for control on the image forming portion at the target gradation level, and

the controller includes:

a first control processor that makes the adhesion amount sensor measure an actual adhesion amount corresponding to the setting value and thereafter compares a resultant measured value and the target adhesion amount and corrects the setting value if needed, in association with at least one of the target gradation levels as a subject; and

a second control processor that makes the image forming portion output a calibration image used for correcting the target adhesion amount using a period when the first control processor performs processing, if there arises a need to correct the target adhesion amount associated with the subject target gradation level.

**2**. The image forming apparatus according to claim **1**, further comprising an image reading portion that reads an image on a document,

wherein the controller further includes a third control processor that corrects the target adhesion amount based on a gradation level obtained from the calibration image if the image reading portion reads the calibration image.

**3**. The image forming apparatus according to claim **2**, wherein

based on the adhesion amount measured in the processing performed last by the first control processor before the calibration image is read and the corrected target adhesion amount, the third control processor corrects the setting value again.

**4**. The image forming apparatus according to claim **1**, wherein

the first control processor makes the image forming portion form a measuring image on the image bearing member to be used for measurement of the actual adhesion amount and thereafter makes the adhesion amount sensor measure the actual adhesion amount on the measuring image, and

the second control processor makes the image forming portion output the measuring image as the calibration image.

**5**. A method of controlling an image forming apparatus, the image forming apparatus comprising: an image forming portion that forms a toner image on an image bearing member; an adhesion amount sensor that measures the amount of toner adhering to the image bearing member; a controller that controls the image forming portion and the adhesion amount sensor; and a storage portion, in association with gradation levels of each color forming certain color space, the storage portion storing a target adhesion amount of toner to adhere to the image bearing member at each of the gradation levels as a target gradation level and a setting value of a control parameter used for control on the image forming portion at the target gradation level,

the method comprising the steps of:

(i) making the adhesion amount sensor measure an actual adhesion amount corresponding to the setting value and thereafter comparing a resultant measured value and the target adhesion amount and correcting the setting value if needed, in association with at least one of the target gradation levels as a subject; and

(ii) making the image forming portion output a calibration image used for correcting the target adhesion amount using a period when the step (i) is performed, if there arises a need to correct the target adhesion amount associated with the subject target gradation level.

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