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(54) COLOR IMAGE FORMING APPARATUS AND COLOR MISALIGNMENT ADJUSTING METHOD

(76) Inventors: **Yuji KUMAGAI**, Osaka (JP); **Norio Tomita**, Osaka (JP); **Kiyoshi Sasoh**, Osaka (JP)

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(57) **ABSTRACT**

According to a color image forming apparatus, a plurality of detection patterns respectively corresponding to a plurality of colors are formed from a plurality of photosensitive body units respectively corresponding to the plurality of colors onto a transfer member in a sub-scanning direction of the transfer member, intervals between detection patterns adjacent to each other in the sub-scanning direction among the plurality of formed detection patterns are detected, and adjustment of color misalignment is performed based on the detected intervals. The plurality of detection patterns have the same size and the same shape. In this color image forming apparatus, the adjustment of color misalignment is performed using at least two types of data of detection images having different intervals as data of detection images including the plurality of detection patterns.

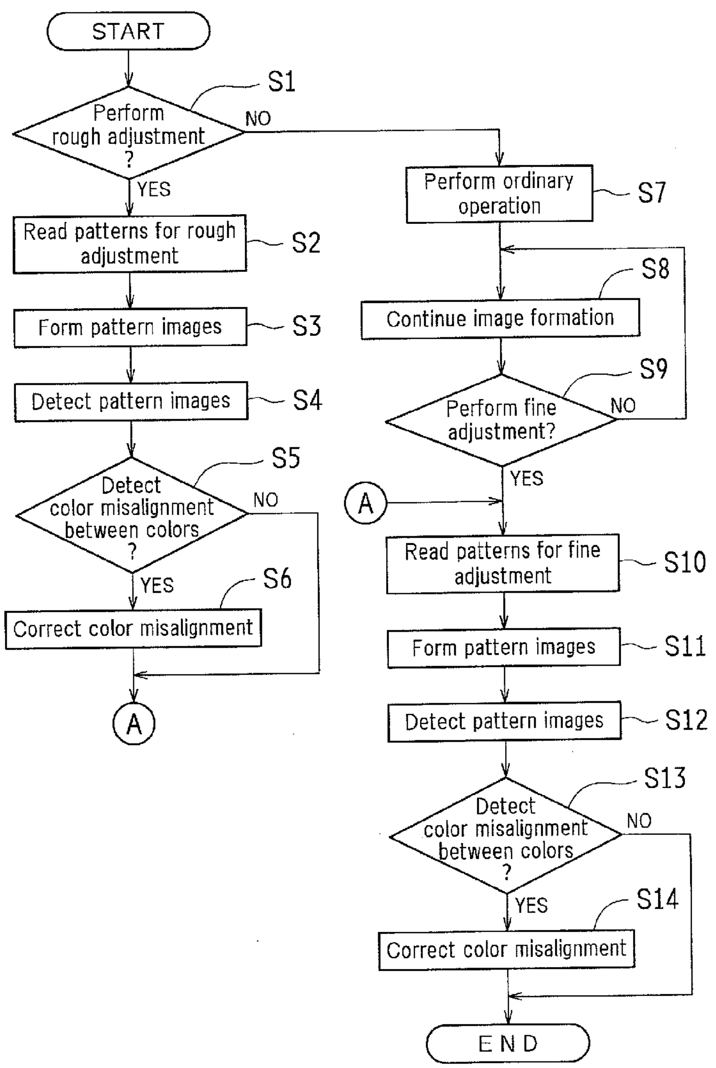


FIG.1

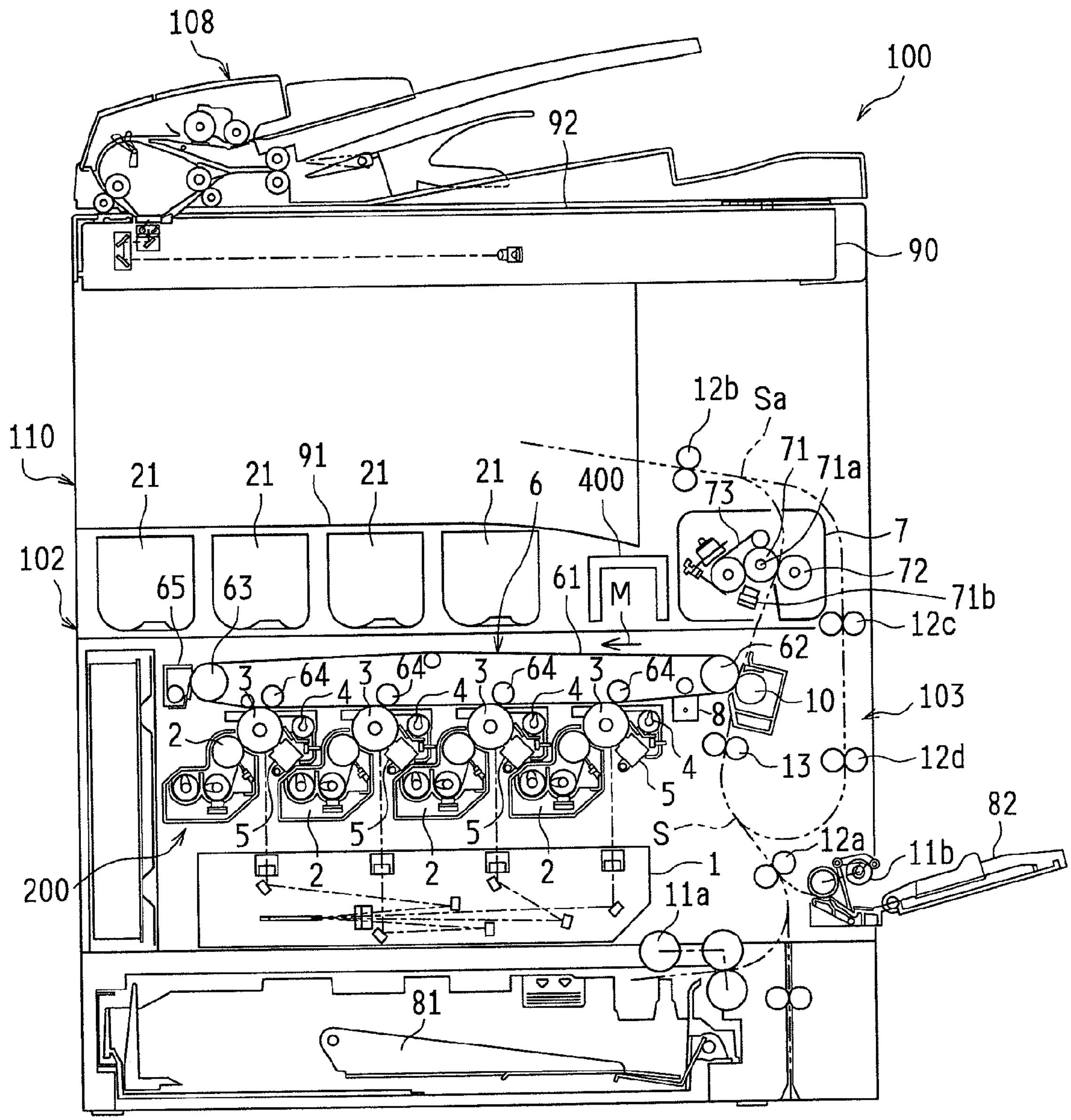

108
100
92
90
110
102
21
21
91
21
21
6
400
M
61
12b
Sa
71
71a
73
7
72
71b
12c
65
63
62
3
64
3
64
3
64
3
64
4
4
4
10
8
103
2
4
13
12d
5
5
5
5
2
2
S
12a
11b
82
200
2
2
2
1
11a
81

FIG.2

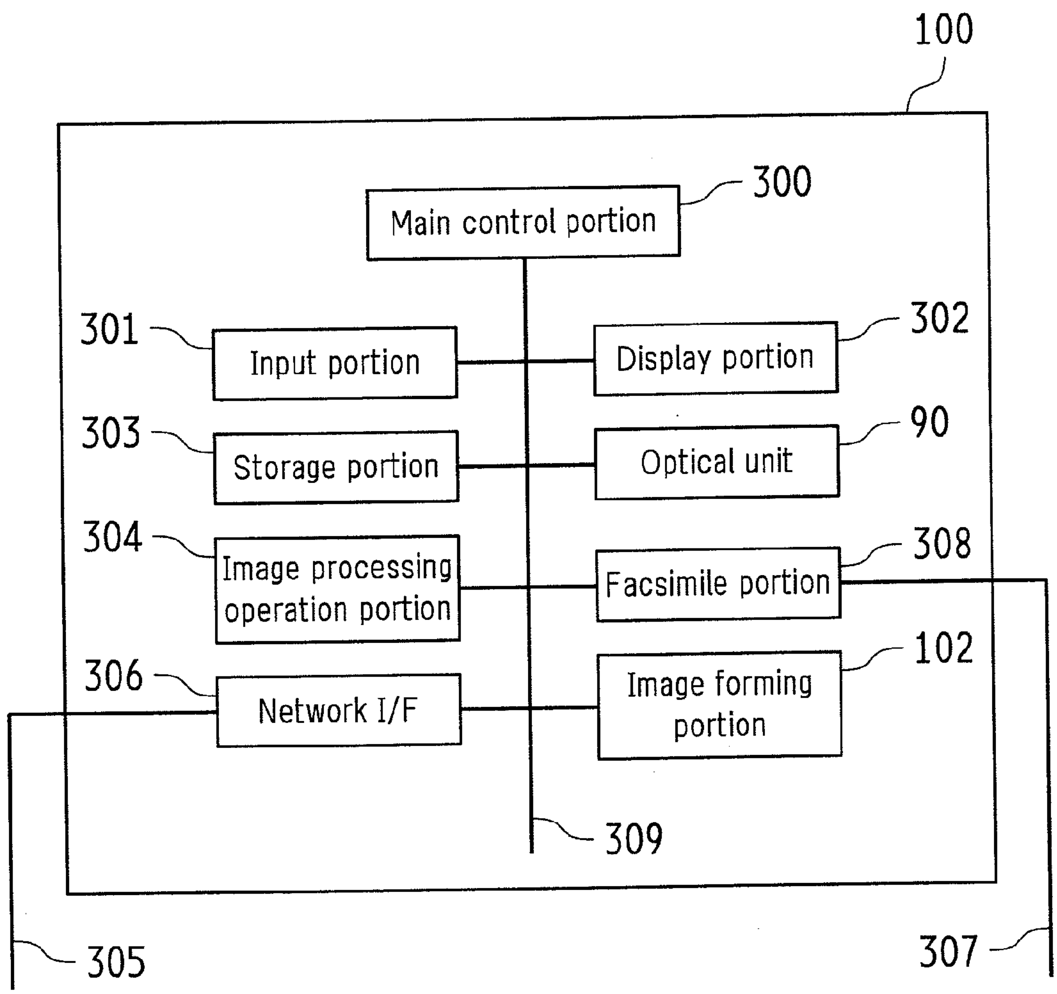
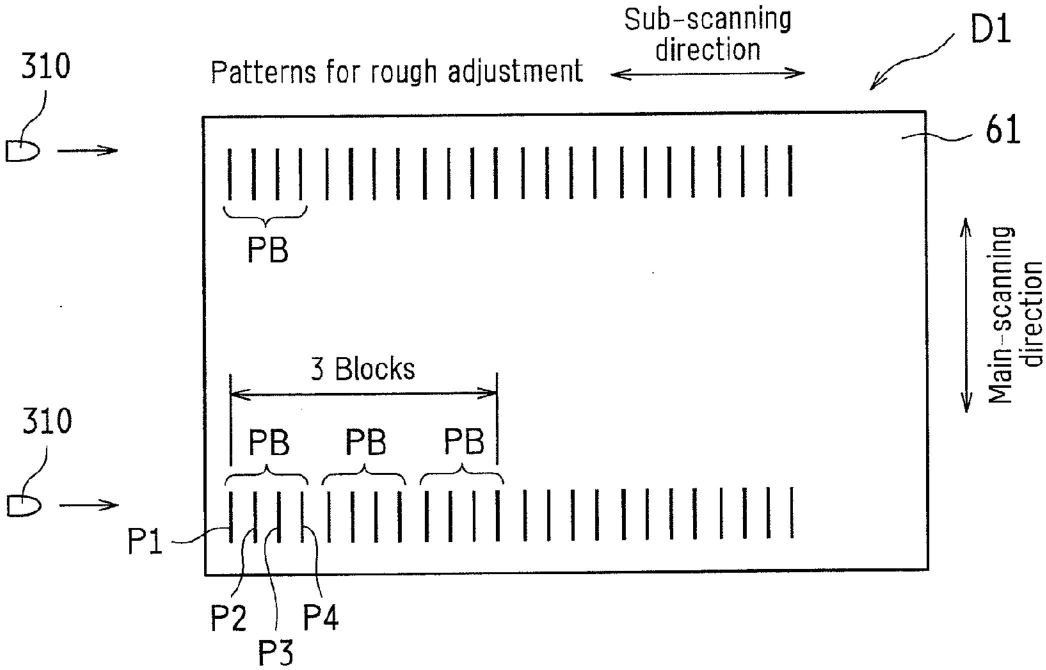
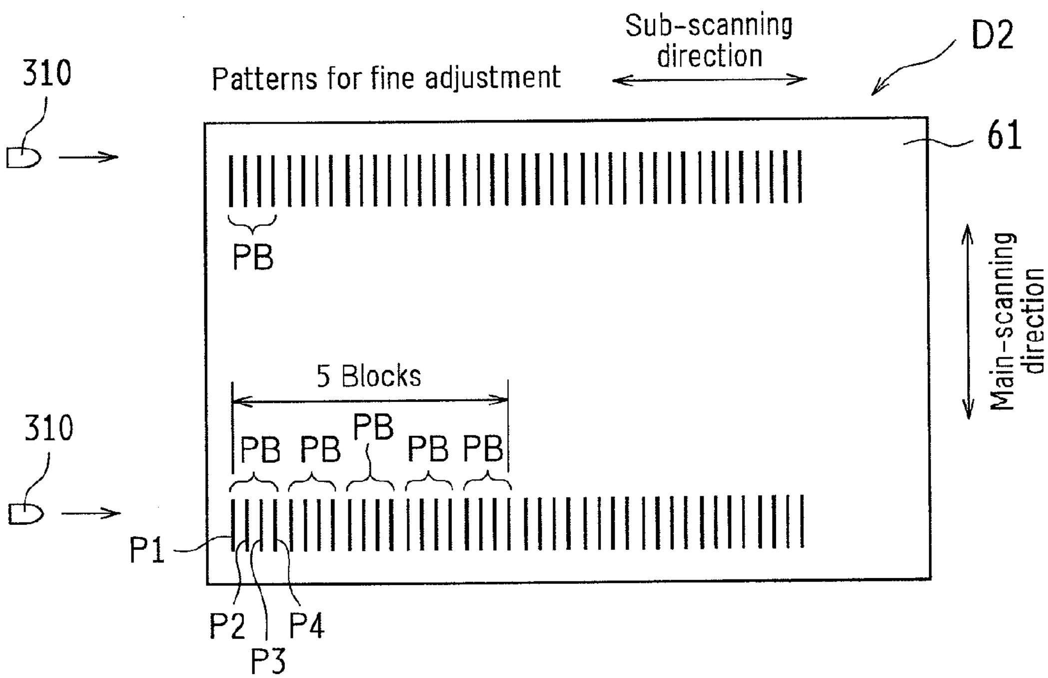

100
300
Main control portion
301
Input portion
302
Display portion
303
Storage portion
90
Optical unit
304
Image processing operation portion
308
Facsimile portion
306
Network I/F
102
Image forming portion
309
305
307

FIG.3



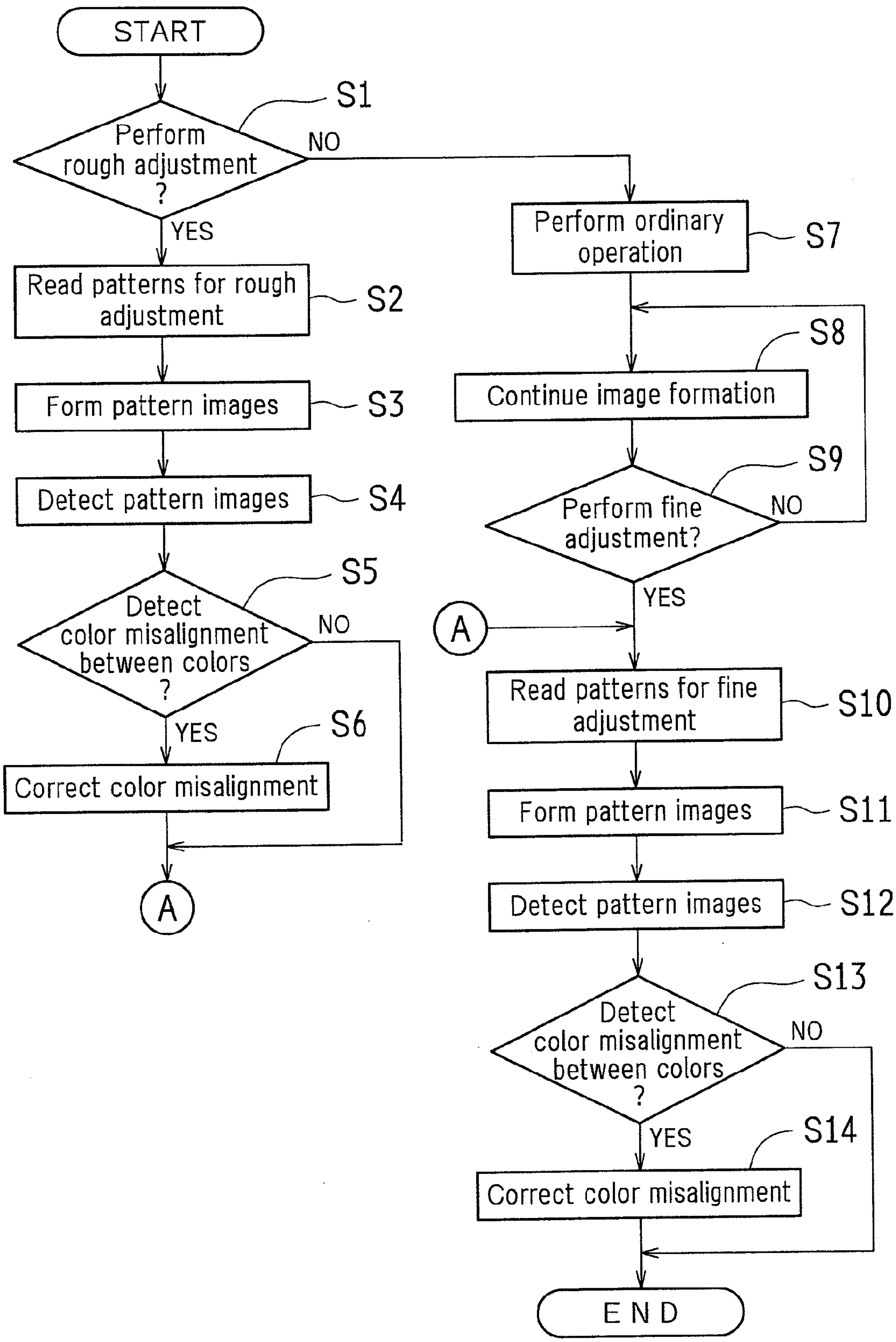
D1
310
Patterns for rough adjustment
Sub-scanning direction
61
PB
Main-scanning direction
3 Blocks
310
PB
PB
PB
P1
P2
P3
P4

FIG.4



D2
310
Patterns for fine adjustment
Sub-scanning direction
61
PB
Main-scanning direction
5 Blocks
310
PB
PB
PB
PB
PB
P1
P2
P3
P4

FIG.5


START
S1
Perform rough adjustment ?
NO
YES
Read patterns for rough adjustment
S2
Form pattern images
S3
Detect pattern images
S4
S5
Detect color misalignment between colors ?
NO
YES
S6
Correct color misalignment
A
Perform ordinary operation
S7
S8
Continue image formation
S9
Perform fine adjustment?
NO
YES
A
Read patterns for fine adjustment
S10
Form pattern images
S11
Detect pattern images
S12
S13
Detect color misalignment between colors ?
NO
YES
S14
Correct color misalignment
END

COLOR IMAGE FORMING APPARATUS AND COLOR MISALIGNMENT ADJUSTING METHOD

BACKGROUND OF THE INVENTION

[0001] This application claims priority under 35 U.S.C. §119 (a) on Patent Application No. 2011-177010 filed in Japan on Aug. 12, 2011, the entire contents of which are herein incorporated by reference.

[0002] The present invention relates to a color image forming apparatus and a color misalignment adjusting method that correct color misalignment of images using a plurality of colors.

[0003] Conventionally, in a color image forming apparatus (hereinafter, referred to as an "image forming apparatus"), an electrostatic latent image is formed by irradiating a photosensitive body such as a photosensitive drum with laser beams modulated according to image data, the electrostatic latent image formed on the photosensitive body is developed with toner, and the toner image is formed on a transfer member such as an intermediate transfer belt (see JP 2003-149907A (Patent Document 1), for example).

[0004] The image forming apparatus according to Patent Document 1 includes a plurality of image forming portions respectively corresponding to a plurality of colors, wherein images of the respective colors are transferred in a superimposed manner from the plurality of image forming portions to an endless belt (transfer member), and then, the images transferred in a superimposed manner are transferred in a batch to a recording paper, forming a color image on the recording paper.

[0005] In the image forming apparatus as described in Patent Document 1, due to factors such as misalignment between installation positions of a plurality of image forming portions occurring when installing the plurality of image forming portions, errors in the optical path length of a laser beam, changes in the optical path, warping of an LED functioning as a light source caused by the environmental temperature, or the like, misalignment between the positions of images of the respective colors formed on the photosensitive bodies may occur. Due to this misalignment, when transferring the respective colors from the plurality of photosensitive bodies in a superimposed manner, the respective colors cannot be transferred to desired positions on the endless belt, and, therefore, color misalignment occurs on the endless belt.

[0006] In order to correct this color misalignment, conventional image forming apparatuses are provided with adjustment means for adjusting positional misalignment.

[0007] According to this adjustment means, detection patterns respectively corresponding to a plurality of colors are formed on an endless belt in a sub-scanning direction by a plurality of image forming portions (specifically, photosensitive bodies). Then, the intervals between detection patterns adjacent to each other in the sub-scanning direction among the detection patterns formed on the endless belt are detected using light from an optical sensor such as a CCD, color misalignment at the time of development is detected using the detected data, and the optical path length is automatically corrected according to the color misalignment amount.

[0008] In the conventional correction of color misalignment as described in Patent Document 1, since toner images for detection are formed on the transfer member (endless belt), toner is consumed for the detection. The amount of toner consumed increases in proportion to the detection pattern data as the size of the detection pattern data increases. Thus, in order to reduce the amount of toner consumed, it is desirable to reduce the area of the detection patterns.

[0009] However, if the area of the detection patterns is reduced in order to reduce the amount of toner consumed, the outline of the toner images becomes blurred, and, as a result, the detection precision decreases. In order to avoid a decrease in the detection precision, it is necessary to increase the size of the detection patterns, but this countermeasure is problematic in that the amount of toner consumed cannot be suppressed as described above.

[0010] In order to solve the above-described problems, it is an object of the present invention to provide a color image forming apparatus and a color misalignment adjusting method that can improve the detection precision while suppressing the amount of toner consumed.

SUMMARY OF THE INVENTION

[0011] In order to achieve the above-described object, the present invention is directed to a color image forming apparatus, wherein a plurality of detection patterns respectively corresponding to a plurality of colors are formed from a plurality of photosensitive body units respectively corresponding to the plurality of colors onto a transfer member in a sub-scanning direction of the transfer member, intervals between detection patterns adjacent to each other in the sub-scanning direction among the plurality of formed detection patterns are detected, and adjustment of color misalignment is performed based on the detected intervals, the plurality of detection patterns have the same size and the same shape, and the adjustment of color misalignment is performed using at least two types of data of detection images having different intervals as data of detection images including the plurality of detection patterns.

[0012] According to the present invention, since the adjustment of color misalignment is performed using at least two types of data of detection images having different intervals, a plurality of adjustment choices can be provided for the adjustment of color misalignment. As a result, the adjustment of color misalignment can be performed with a given level of precision depending on occasions such as those when performing initial settings or when performing maintenance after use of the color image forming apparatus. That is to say, the detection can be performed with an optimal level of precision depending on the conditions. Furthermore, the amount of toner consumed can be suppressed whichever type of data of detection images is used to perform the adjustment of color misalignment. In a specific embodiment of the present invention, since a plurality of types of data of detection images are used, the adjustment of color misalignment can be performed in a sequential or stepwise manner from rough adjustment to fine adjustment, and the correction of color misalignment can be precisely performed.

[0013] The above-described configuration may be such that the data of detection images include two types of data composed of first data of detection images and second data of detection images having an interval smaller than that of the first data, and that, after the adjustment of color misalignment using the first data is performed, the adjustment of color misalignment using the second data is performed.

[0014] According to the present invention, since the rough adjustment of color misalignment is performed based on the first data having a large interval, after which the fine adjustment of color misalignment is performed based on the second data having a small interval, the correction of color misalignment can be precisely performed.

[0015] The above-described configuration may be such that the adjustment of color misalignment is performed based on a preset condition using the first data and the second data.

[0016] In this case, the rough adjustment of color misalignment using the first data can be performed based on a preset condition (e.g., at the time of initial settings) where the color misalignment amount may be significant, and the fine adjustment of color misalignment using the second data can be periodically performed based on a preset condition in ordinary use (e.g., the time). As a result, since the rough adjustment of color misalignment using the first data has been performed in advance, misalignment in the fine adjustment of color misalignment using the second data is slight, and the adjustment of color misalignment can be more precisely performed. On the other hand, if the adjustment of color misalignment using the second data is performed under, for example, the conditions at the time of initial settings, since the range in which the adjustment of color misalignment can be performed is narrow, misalignment between installation positions when installing the image forming portion such as a plurality of photosensitive body units has to be substantially eliminated. Thus, with the technique at the time of the present application, it is difficult to perform adjustment of color misalignment using the second data when the color misalignment amount may be significant, for example, at the time of initial settings.

[0017] In order to achieve the above-described object, the present invention is further directed to a color misalignment adjusting method of a color image forming apparatus, including: a formation step of forming a plurality of detection patterns respectively corresponding to a plurality of colors from a plurality of photosensitive body units respectively corresponding to the plurality of colors onto a transfer member in a sub-scanning direction of the transfer member; and an adjustment step of detecting intervals between detection patterns adjacent to each other in the sub-scanning direction among the plurality of detection patterns formed in the formation step, and performing adjustment of color misalignment based on the detected intervals; wherein the plurality of detection patterns have the same size and the same shape, and the adjustment of color misalignment is performed in the adjustment step using at least two types of data of detection images having different intervals as data of detection images including the plurality of detection patterns.

[0018] According to the present invention, since the method includes the formation step and the adjustment step, and the adjustment of color misalignment is performed using at least two types of data of detection images having different intervals, a plurality of adjustment choices can be provided for the adjustment of color misalignment. As a result, the adjustment of color misalignment can be performed with a given level of precision depending on occasions such as those when performing initial settings or when performing maintenance after use of the color image forming apparatus. That is to say, the detection can be performed with an optimal level of precision depending on the conditions. Furthermore, the amount of toner consumed can be suppressed whichever type of data of detection images is used to perform adjustment of color misalignment. In a specific embodiment of the present invention, since a plurality of types of data of detection images are used, the adjustment of color misalignment can be performed in a sequential or stepwise manner from rough adjustment to fine adjustment. In this case, the correction of color misalignment can be precisely performed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. **1** is a schematic cross-sectional front view showing the overall configuration an image forming apparatus according to an embodiment.

[0020] FIG. **2** is a schematic block diagram showing essential constituent components of the image forming apparatus according to this embodiment.

[0021] FIG. **3** is a diagram showing detection patterns for rough adjustment used in the adjustment of color misalignment according to this embodiment.

[0022] FIG. **4** is a diagram showing detection patterns for fine adjustment used in the adjustment of color misalignment according to this embodiment.

[0023] FIG. **5** is a flowchart for the adjustment of color misalignment according to this embodiment.

DESCRIPTION OF REFERENCE NUMERALS

[0024] **1** Light exposure unit
[0025] **2** Development unit
[0026] **3** Photosensitive drum
[0027] **4** Photosensitive body unit
[0028] **5** Charging unit
[0029] **6** Intermediate transfer belt unit
[0030] **7** Fixing unit
[0031] **8** Pre-transfer charging unit
[0032] **10** Transfer roller
[0033] **11***a*, **11***b* Pickup roller
[0034] **12***a*, **12***b*, **12***c*, **12***d* Transport roller
[0035] **13** Registration roller
[0036] **21** Toner cartridge unit
[0037] **61** Intermediate transfer belt
[0038] **62** Drive roller
[0039] **63** Idler roller
[0040] **64** Intermediate transfer roller
[0041] **65** Cleaning unit
[0042] **71** Heat roller
[0043] **71***a* Heater
[0044] **71***b* Temperature detector
[0045] **72** Pressure roller
[0046] **73** External heating belt
[0047] **81** Paper feed tray
[0048] **82** Manual paper feed tray
[0049] **90** Optical unit
[0050] **91** Paper discharge tray
[0051] **92** Document placement platen
[0052] **100** Image forming apparatus
[0053] **102** Image forming portion
[0054] **103** Paper transport system
[0055] **108** Document reading device
[0056] **110** Apparatus main body
[0057] **200** Image forming unit
[0058] **300** Main control portion
[0059] **301** Input portion
[0060] **302** Display portion
[0061] **303** Storage portion
[0062] **304** Image processing operation portion
[0063] **305** Network
[0064] **306** Network interface
[0065] **307** Telephone line
[0066] **308** Facsimile portion

[0067] **309** Bus

[0068] **310** Sensor portion

[0069] D**1** First data

[0070] D**2** Second data

[0071] P**1**, P**2**, P**3**, P**4** Detection pattern

[0072] PB Detection pattern block

[0073] S Paper transport path

DESCRIPTION OF THE EMBODIMENT

[0074] Hereinafter, an embodiment according to the present invention will be described with reference to the drawings.

[0075] <Description of the Overall Configuration of the Image Forming Apparatus>

[0076] FIG. **1** is a schematic cross-sectional front view showing the overall configuration of an image forming apparatus **100** according to this embodiment.

[0077] The image forming apparatus **100** shown in FIG. **1** is a color image forming apparatus that forms an image using at least one color (a plurality of colors or a single color) on a sheet such as a recording paper (hereinafter, referred to as a "recording paper") according to image data transmitted from the outside.

[0078] The image forming apparatus **100** includes a document reading device **108** and an apparatus main body **110**. The apparatus main body **110** is provided with an image forming portion **102** and a paper transport system **103**.

[0079] The image forming portion **102** includes a light exposure unit **1**, a plurality of development units **2**, a plurality of photosensitive body units **4**, an intermediate transfer belt unit **6**, a pre-transfer charging unit **8**, a plurality of toner cartridge units **21**, and a fixing unit **7**. In this embodiment, the light exposure unit **1**, the development units **2**, the photosensitive body units **4**, the intermediate transfer belt unit **6**, and the toner cartridge units **21** function as a plurality of freely detachable image forming units **200** that perform different image forming operations. Here, it is assumed that the photosensitive body units **4** are units each formed by combining a unit for photosensitive operations, a unit for charging, and a unit for cleaning into one unit.

[0080] Furthermore, the paper transport system **103** includes a paper feed tray **81**, a manual paper feed tray **82**, and a paper discharge tray **91**.

[0081] A document placement platen **92** made of transparent glass on which a sheet such as a document (hereinafter, referred to as a "document") is to be placed is provided above the apparatus main body **110**, and an optical unit **90** for reading a document is provided below the document placement platen **92**. Furthermore, the document reading device **108** is provided above the document placement platen **92**.

[0082] Image data processed in the image forming apparatus **100** corresponds to a color image using a plurality of colors (colors consisting of black (K), cyan (C), magenta (M), and yellow (Y), in this example). Accordingly, for each unit group of the development units **2**, the photosensitive body units **4** (including photosensitive bodies in the present invention), and the toner cartridge units **21**, a plurality of units (four units, respectively corresponding to black, cyan, magenta, and yellow, in this example) are provided in order to form a plurality of types (four types in this example) of images corresponding to the respective colors, and these units form image stations for the respective colors (four colors, in this example).

[0083] In the photosensitive body units **4**, charging units **5** are charging means for uniformly charging the surfaces of photosensitive drums **3** to a predetermined potential, and, as the charging units **5**, charging units of contact type such as rollers or brushes can be used as well as those of charger type as shown in FIG. **1**.

[0084] The light exposure unit **1** is configured as a laser scanning unit (LSU) including a laser emitting portion and reflective mirrors. The light exposure unit **1** is provided with a polygon mirror scanned by a laser beam, and optical elements such as lenses and mirrors for guiding the laser beam reflected by the polygon mirror to the photosensitive drums **3**. Furthermore, for the light exposure unit **1**, other concepts can be used, such as a concept employing a writing head in which light-emitting elements such as EL (electroluminescence) elements or LEDs (light-emitting diodes) are arranged in an array.

[0085] The light exposure unit **1** irradiates the photosensitive drums **3** that are charged according to input image data, thereby forming electrostatic latent images according to the image data on the respective surfaces of the photosensitive drums **3**.

[0086] The toner cartridge units **21** are units containing toner, and are configured such that the toner is supplied to development baths of the development units **2**. In the apparatus main body **110** of the image forming apparatus **100**, the toner supplied from the toner cartridge units **21** to the development baths of the development units **2** is controlled such that the toner concentration of a developer in the development baths is constant.

[0087] The development units **2** make the electrostatic latent images formed on the respective photosensitive drums **3** visible with toner of the four colors (Y, M, C, and K). Furthermore, the photosensitive body units **4** further have a cleaning function of removing and recovering toner that has remained on the surfaces of the photosensitive drums **3** after development and image transfer.

[0088] The intermediate transfer belt unit **6** disposed above the photosensitive drums **3** includes an intermediate transfer belt **61** functioning as an intermediate transfer member, a drive roller **62**, an idler roller **63**, a plurality of intermediate transfer rollers **64**, and a cleaning unit **65**.

[0089] Four intermediate transfer rollers **64** are provided respectively corresponding to colors Y, M, C, and K. The drive roller **62** supports the intermediate transfer belt **61** in a tensioned state in cooperation with the idler roller **63** and the intermediate transfer rollers **64**. When the drive roller **62** is driven to rotate, the intermediate transfer belt **61** is revolved in the movement direction (direction indicated by arrow M in FIG. **1**), which causes the idler roller **63** and the intermediate transfer rollers **64** to be idly rotated.

[0090] The intermediate transfer rollers **64** are supplied with a transfer bias for transferring toner images formed on the photosensitive drums **3** to the intermediate transfer belt **61**.

[0091] The intermediate transfer belt **61** is provided so as to be in contact with each of the photosensitive drums **3**. Toner images of the respective colors formed on the photosensitive drums **3** are sequentially transferred to the intermediate transfer belt **61** so as to be superimposed one after another, so that a color toner image (multicolor toner image) can be formed on the surface of the intermediate transfer belt **61**. The intermediate transfer belt **61** is, for example, formed in the form of an endless belt made of a film having a thickness of approximately 100 μm to 150 μm.

[0092] Toner images are transferred from the photosensitive drums **3** to the intermediate transfer belt **61** by means of the intermediate transfer rollers **64** that are in contact with the back face of the intermediate transfer belt **61**. The intermediate transfer rollers **64** are supplied with a high voltage transfer bias (high voltage having a polarity (+) opposite the polarity (−) of the charged toner) for transferring toner images. The intermediate transfer rollers **64** are each made by forming its core with a metal (e.g., stainless steel) shaft having a diameter of 8 mm to 10 mm and covering the surface of the core with a conductive elastic material (e.g., EPDM (ethylene propylene diene rubber) or resin material such as foamed urethane). The intermediate transfer rollers **64** function as transfer electrodes that apply a high voltage uniformly to the intermediate transfer belt **61** with the conductive elastic material. Although roller-like transfer electrodes are used as the transfer electrodes in this embodiment, other transfer electrodes such as brush-like transfer electrodes can be used.

[0093] As described above, toner images that are made visible according to the color phases on the respective photosensitive drums **3** are superimposed on the intermediate transfer belt **61**. When the intermediate transfer belt **61** is revolved, the toner images superimposed on the intermediate transfer belt **61** are transferred to a recording paper by a transfer roller **10** that forms a second transfer mechanism portion disposed in a contact position where the recording paper is in contact with the intermediate transfer belt **61**. Note that, as the configuration of the second transfer mechanism portion, not only transfer rollers but also other transfer configurations such as those employing corona chargers or transfer belts can be used.

[0094] At this time, the transfer roller **10** is supplied with a voltage (high voltage having a polarity (+) opposite the polarity (−) of the charged toner) for transferring toner to the recording paper in a state where a transfer nip is formed between the transfer roller **10** and the intermediate transfer belt **61**. The transfer nip is formed between the transfer roller **10** and the intermediate transfer belt **61** by the transfer roller **10** and the drive roller **62** pressing against each other. In order to maintain the transfer nip steadily, either one of the transfer roller **10** and the drive roller **62** is a hard roller made of a hard material (e.g., metal), and the other is an elastic roller made of a soft material (e.g., elastic rubber or resin material such as foamed resin).

[0095] When transferring a toner image from the intermediate transfer belt **61** to a recording paper with the transfer roller **10**, toner may remain on the intermediate transfer belt **61** without being transferred to the recording paper. The toner that has remained on the intermediate transfer belt **61** will cause mixture of toner colors in subsequent processes. Therefore, the toner that has remained on the intermediate transfer belt **61** is removed and recovered by the cleaning unit **65**. Specifically, the cleaning unit **65** includes a cleaning member (e.g., a cleaning blade) that is in contact with the intermediate transfer belt **61**. The idler roller **63** supports the intermediate transfer belt **61** from the inside (back face side), and the cleaning member is in contact with the intermediate transfer belt **61** so as to press the intermediate transfer belt **61** toward the idler roller **63** from the outside.

[0096] The pre-transfer charging unit **8** in this example has a pre-transfer charger (PTC), and is provided near the intermediate transfer belt **61** on the upstream side of the transfer nip between the transfer roller **10** and the intermediate transfer belt **61** and on the downstream side of the photosensitive body units **4** in the movement direction M of the intermediate transfer belt **61**.

[0097] Incidentally, the toner images that are transferred from the photosensitive drums **3** to the intermediate transfer belt **61** include halftone areas or solid areas, or include areas having different numbers of toner layers, and, therefore, the charge level may vary from area to area. Furthermore, the charge level within a toner image on the intermediate transfer belt **61** after the primary transfer may vary due to exfoliation discharges generated in a gap on the downstream side adjacent to the primary transfer portion in the movement direction M of the intermediate transfer belt **61**. Such variations in the charge level in the same toner image decrease the transfer margin when transferring a toner image on the intermediate transfer belt **61** to a sheet.

[0098] Therefore, the pre-transfer charging unit **8** is used to uniformly charge a toner image before transfer to a sheet, so that the variations in the charge level in the same toner image are cancelled, which makes it possible to improve the transfer margin in the secondary transfer.

[0099] Furthermore, the apparatus main body **110** is provided with a paper transport path S such that a recording paper from the paper feed tray **81** and the manual paper feed tray **82** is transported via the transfer roller **10** and the fixing unit **7** to the paper discharge tray **91**. Arranged in the vicinity of the paper transport path S are pickup rollers **11***a* and **11***b*, a plurality of transport rollers **12***a* to **12***d*, registration rollers **13**, the transfer roller **10**, and a heat roller **71** and a pressure roller **72** in the fixing unit **7**.

[0100] The registration rollers **13** temporarily hold a recording paper that is being transported on the paper transport path S. Then, the registration rollers **13** transport the recording paper to the transfer roller **10** at a timing where the leading edge of the toner image on the photosensitive drums **3** is aligned with the leading edge of the recording paper.

[0101] The fixing unit **7** fixes an unfixed toner image onto the recording paper, and includes the heat roller **71** and the pressure roller **72** that function as fixing rollers. The heat roller **71** is heated with a heater **71***a* provided inside it, and is kept at a predetermined fixing temperature based on a signal from a temperature detector **71***b*. The fixing unit **7** is further provided with an external heating belt **73** for heating the heat roller **71** from the outside.

[0102] In the thus configured image forming apparatus **100**, when there is a request for simplex printing on a recording paper, a recording paper fed from the paper feed tray **81** or the manual paper feed tray **82** is transported to the registration rollers **13** with the transport rollers **12***a* arranged along the paper transport path S, and is transported by the transfer roller **10** at a timing where the leading edge of the recording paper is aligned with the leading edge of the toner image on the intermediate transfer belt **61**, and then the toner image is transferred to the recording paper. Subsequently, the recording paper passes through the fixing unit **7**, so that unfixed toner on the recording paper is melted by heat and adheres to the recording paper, and then the recording paper is discharged to the paper discharge tray **91** through the transport rollers **12***b*.

[0103] When there is a request for duplex printing on a recording paper, in a state where the simplex printing as described above is completed and the trailing edge of the recording paper that has passed through the fixing unit **7** is positioned between the last transport rollers **12***b* and a branching portion Sa on the paper transport path S, the transport rollers **12***b* are rotated in reverse, and, therefore, the recording paper is guided to the transport rollers **12***c* and **12***d*.

Then, the recording paper that has been transported to the transfer nip through the registration rollers **13** undergoes printing on its back face, and then is discharged onto the paper discharge tray **91**.

[0104] The thus configured image forming apparatus **100** according to this embodiment includes essential constituent components shown in FIG. **2**. Specifically, the image forming apparatus **100** is provided with a main control portion **300** that controls various operations of the image forming apparatus **100**, an input portion **301** on which a user directly performs an input operation, a display portion **302** that displays information such as an image, a storage portion **303** that stores image data and the like, an image processing operation portion **304** that performs an image processing operation, a network interface **306** (network I/F) that is connected to the outside via a network **305**, the optical unit **90** that scans a document, the image forming portion **102** that forms an image of a document on a recording paper, and a facsimile portion **308** that is connected to the outside (that transmits a FAX) via a telephone line **307**. These constituent components are connected to each other via a bus **309** such that image data (signals) can be transmitted and received.

[0105] The main control portion **300** controls the input portion **301**, the display portion **302**, the storage portion **303**, the image processing operation portion **304**, the network interface **306**, the optical unit **90**, the image forming portion **102**, and the facsimile portion **308**. For example, the main control portion **300** causes the image forming portion **102** to perform a printing process (image forming process) based on image data received via the network interface **306**. Furthermore, the main control portion **300** causes the facsimile portion **308** to perform a facsimile transmitting process that dials a designated destination phone number and transmits image data that is a transmission target. Furthermore, the main control portion **300** causes the optical unit **90** to perform a scanning process that reads an image formed on a document. In this manner, the main control portion **300** causes these constituent components of the image forming apparatus **100** to perform various operations based on input from the input portion **301**, input from the outside via the network interface **306**, input from the outside via the facsimile portion **308**, and the like.

[0106] The image forming portion **102** is a so-called imaging engine that is controlled by the main control portion **300**, and refers to a group consisting of a device that forms (outputs) an image on a recording paper at an image formation position based on document image data, printing image data, and the like, and a constituent component such as an MPU that controls the device.

[0107] Incidentally, the image forming apparatus **100** according to this embodiment is provided with an adjustment means for adjusting positional misalignment in order to correct color misalignment of an image. The adjustment means includes sensor portions **310** that are provided in the image forming portion **102** (see FIGS. **3** and **4**). The main control portion **300** controls the image forming portion **102** to perform adjustment of positional misalignment using the adjustment means, so that detection patterns respectively corresponding to the four respective colors (see P**1**, P**2**, P**3**, and P**4** shown in FIGS. **3** and **4**) are formed on the intermediate transfer belt **61**, the sensor portions **310** are used to detect whether or not there is positional misalignment between the detection patterns P**1**, P**2**, P**3**, and P**4**, and, if there is positional misalignment, the optical path length in the LSU is corrected. As the sensor portions **310** in this example, an imaging device such as a CCD is used. The detection patterns formed on the intermediate transfer belt **61** are detected by scanning and irradiating the imaging device, and, if color misalignment has occurred, the optical path length in the LSU is corrected.

[0108] Hereinafter, the adjustment of positional misalignment using the adjustment means will be described in more detail. First, the detection patterns P**1**, P**2**, P**3**, and P**4** respectively corresponding to the four respective colors, which function as references, are set. It is assumed that the detection patterns P**1**, P**2**, P**3**, and P**4** are arranged at constant intervals. Furthermore, four detection patterns P**1**, P**2**, P**3**, and P**4** form one detection pattern block (symbol PB shown in FIGS. **3** and **4**), and such a detection pattern block PB is repeatedly formed a plurality of times in the sub-scanning direction of the sensor portions **310** (imaging devices) (hereinafter, referred to as a "sub-scanning direction"), thereby forming a plurality of detection pattern blocks PB. The storage portion **303** stores data of detection images of four detection patterns P**1**, P**2**, P**3**, and P**4** and a plurality of detection pattern blocks PB that have been formed in this manner and intervals between the detection patterns P**1**, P**2**, P**3**, and P**4** (hereinafter, referred to as "reference intervals") as data of reference detection images.

[0109] At the time of detection in the adjustment of color misalignment, four image stations sequentially form the detection patterns P**1**, P**2**, P**3**, and P**4** (see FIGS. **3** and **4**) respectively corresponding to the four respective colors in the sub-scanning direction on the intermediate transfer belt **61**.

[0110] The intervals between the detection patterns P**1**, P**2**, P**3**, and P**4** formed on the intermediate transfer belt **61** are detected by the sensor portions **310**, the detected data and the reference interval data are compared with each other to detect color misalignment, and the optical path length is corrected according to the color misalignment amount.

[0111] Regarding the adjustment of color misalignment using the above-described adjustment means, in this embodiment, data of detection images having two different intervals (see FIGS. **3** and **4**) is stored in the storage portion **303** as reference intervals. Specifically, data of detection images having a reference interval of 6.3 mm as shown in FIG. **3** (hereinafter, referred to as "first data D**1**") and data of detection images having a reference interval of 3.8 mm, which is smaller than that of the first data D**1**, as shown in FIG. **4** (hereinafter, referred to as "second data D**2**") are stored.

[0112] The first data D**1** of detection images is used as reference interval data for rough adjustment of color misalignment. As shown in FIG. **3**, the detection images are respectively formed at portions corresponding to both sides in the width direction (upper and lower sides in the drawing) on the intermediate transfer belt **61**, the detection patterns P**1**, P**2**, P**3**, and P**4** are formed as rectangles having the same size and the same shape, and the longitudinal direction of the patterns matches the main-scanning direction. According to the first data D**1** of the detection images having an interval of 6.3 mm, three detection pattern blocks PB can be formed with respect to one revolution of the photosensitive drums **3**.

[0113] The second data D**2** of detection images is used as reference interval data for fine adjustment of color misalignment. As shown in FIG. **4**, the detection image are respectively formed at portions corresponding to both sides in the width direction (upper and lower sides in the drawing) on the intermediate transfer belt **61**, the detection patterns P**1**, P**2**, P**3**, and P**4** are formed as rectangles having the same size and the same shape, and the longitudinal direction of the patterns matches the main-scanning direction. According to the second data D**2** of the detection images having an interval of 3.8 mm, five detection pattern blocks PB can be formed with respect to one revolution of the photosensitive drums **3**.

[0114] The first data D**1** and the second data D**2** are different from each other only in terms of the interval in the sub-scanning direction, and are the same in terms of the width (the length in the sub-scanning direction), the length (the length in the main-scanning direction), and the color arrangement order of the detection patterns of the respective colors. Thus, the amount of toner consumed in fine adjustment using the second data D**2** is only 5/3 of the amount of toner consumed in rough adjustment using the first data D**1**. Accordingly, it is possible to improve the detection precision while suppressing the amount of toner consumed in correction of color misalignment.

[0115] Next, the color misalignment adjusting method using the above-described adjustment means (the first data D**1** and the second data D**2**) will be described in detail with reference to FIG. **5**.

[0116] If there is a request to perform initial settings of the image forming apparatus **100**, for example, when performing inspection in the plant, when installing the image forming apparatus **100**, or when performing correction of color misalignment as designated by the user (manual operation), these occasions being conditions preset by the user (YES in Step S**1**), the first data D**1** (the patterns for rough adjustment) is read from the storage portion **303** (Step S**2**).

[0117] After the first data D**1** is read in Step S**2**, the image forming portion **102** uses the photosensitive body units **4** corresponding to the four respective colors to form the detection patterns P**1**, P**2**, P**3**, and P**4** on the intermediate transfer belt **61** based on the first data D**1** and its related data (reference interval, etc.) (Step S**3**, which corresponds to the formation step in the present invention).

[0118] After the detection patterns P**1**, P**2**, P**3**, and P**4** are formed on the intermediate transfer belt **61** as shown in FIG. **3** in Step S**3**, actual intervals between adjacent detection patterns P**1**, P**2**, P**3**, and P**4** are detected by the sensor portions **310** (Step S**4**).

[0119] The data actually detected in Step S**4** and the first data D**1** are compared with each other to detect color misalignment (Step S**5**).

[0120] If there is color misalignment in Step S**5** (YES in Step S**5**), the optical path length is corrected according to the color misalignment amount (Step S**6**, which corresponds to the adjustment step in the present invention), and the rough adjustment of color misalignment ends. Next, in order to perform fine adjustment using the second data D**2**, the second data D**2** (the patterns for fine adjustment) is read from the storage portion **303** (Step S**10**).

[0121] Furthermore, if there is no color misalignment in Step S**5** (NO in Step S**5**), the rough adjustment of color misalignment ends. Next, in order to perform fine adjustment using the second data D**2** (the patterns for fine adjustment), the second data D**2** is read from the storage portion **303** (Step S**10**).

[0122] After the second data D**2** is read in Step S**10**, the image forming portion **102** uses the photosensitive body units **4** corresponding to the four respective colors to form the detection patterns P**1**, P**2**, P**3**, and P**4** on the intermediate transfer belt **61** based on the second data D**2** and its related data (reference interval, etc.) (Step S**11**, which corresponds to the formation step in the present invention).

[0123] After the detection patterns P**1**, P**2**, P**3**, and P**4** are formed on the intermediate transfer belt **61** in Step S**11**, actual intervals between adjacent detection patterns P**1**, P**2**, P**3**, and P**4** are detected by the sensor portions **310** (Step S**12**).

[0124] The data actually detected in Step S**12** and the second data D**2** are compared with each other to detect color misalignment (Step S**13**).

[0125] If there is color misalignment in Step S**13** (YES in Step S**13**), the optical path length is corrected according to the color misalignment amount (Step S**14**, which corresponds to the adjustment step in the present invention), and the fine adjustment of color misalignment ends, thereby ending the adjustment of color misalignment.

[0126] Furthermore, if there is no color misalignment in Step S**13** (NO in Step S**13**), the fine adjustment of color misalignment ends, thereby ending the adjustment of color misalignment.

[0127] Furthermore, if there is no request to perform initial settings of the image forming apparatus **100**, for example, when performing inspection in the plant or when installing the image forming apparatus **100** (NO in Step S**1**), the ordinary image forming operation (image forming process) is performed (Step S**7**), and the image forming operation (image forming process) is performed based on a preset condition (Step S**8**). The preset condition in this example may be a condition relating to the image forming process or may be a condition relating to the image forming time. Specifically, the preset condition may be the number of recording papers that have undergone image formation or may be the time at which image formation was performed.

[0128] If the preset condition is not satisfied in Step S**8** (NO in Step S**9**), the image forming operation (image forming process) is continuously performed (Step S**8**).

[0129] Furthermore, if the preset condition is satisfied in Step S**8** (YES in Step S**9**), the main control portion **300** automatically (periodically) or forcibly performs fine adjustment of color misalignment (YES in Step S**9**), and the second data D**2** (the patterns for fine adjustment) is read from the storage portion **303** (Step S**10**).

[0130] After the second data D**2** is read in Step S**10**, the image forming portion **102** uses the photosensitive body units **4** corresponding to the four respective colors to form the detection patterns P**1**, P**2**, P**3**, and P**4** on the intermediate transfer belt **61** based on the second data D**2** and its related data (reference interval, etc.) (Step S**11**, which corresponds to the formation step in the present invention).

[0131] After the detection patterns P**1**, P**2**, P**3**, and P**4** are formed on the intermediate transfer belt **61** in Step S**11**, actual intervals between adjacent detection patterns P**1**, P**2**, P**3**, and P**4** are detected by the sensor portions **310** (Step S**12**).

[0132] The data actually detected in Step S**12** and the second data D**2** are compared with each other to detect color misalignment (Step S**13**).

[0133] If there is color misalignment in Step S**13** (YES in Step S**13**), the optical path length is corrected according to the color misalignment amount (Step S**14**, which corresponds to the adjustment step in the present invention), and the fine adjustment of color misalignment ends, thereby ending the adjustment of color misalignment.

[0134] Furthermore, if there is no color misalignment in Step S**13** (NO in Step S**13**), the fine adjustment of color misalignment ends, thereby ending the adjustment of color misalignment.

[0135] In this manner, according to the image forming apparatus **100** according to this embodiment or the color misalignment adjusting method using the image forming apparatus **100**, since the first data D**1** and the second data D**2** having different intervals are used to perform adjustment of color misalignment, two adjustment choices can be provided for the adjustment of color misalignment. As a result, the adjustment of color misalignment can be performed with a given level of precision depending on occasions such as those when performing initial settings or when performing maintenance after use of the image forming apparatus **100**. That is to say, the detection can be performed with an optimal level of precision depending on the conditions. Furthermore, the amount of toner consumed can be suppressed whichever type of data of detection images is used to perform adjustment of color misalignment. In this embodiment, since the first data D**1** and the second data D**2** are used, the adjustment of color misalignment can be sequentially performed from rough adjustment to fine adjustment. In this case, the correction of color misalignment can be precisely performed.

[0136] Furthermore, since the main control portion **300** performs rough adjustment of color misalignment based on the first data D**1** having an interval larger than that of the second data D**2**, and then performs fine adjustment of color misalignment based on the second data D**2** having an interval smaller than that of the first data D**1**, the correction of color misalignment can be precisely performed.

[0137] Furthermore, since the first data D**1** and the second data D**2** are used to perform adjustment of color misalignment based on the preset conditions, rough adjustment of color misalignment using the first data D**1** can be performed based on a preset condition (e.g., at the time of initial settings) where the color misalignment amount may be significant, and fine adjustment of color misalignment using the second data D**2** can be periodically performed based on a preset condition in ordinary use (e.g., the time). As a result, since the rough adjustment of color misalignment using the first data D**1** has been performed in advance, misalignment in the fine adjustment of color misalignment using the second data D**2** is slight, and the adjustment of color misalignment can be more precisely performed. On the other hand, if the adjustment of color misalignment using the second data D**2** is performed under, for example, the conditions at the time of initial settings, since the range in which the adjustment of color misalignment can be performed is narrow, misalignment between installation positions when installing the image forming portion **102** such as the plurality of photosensitive body units **4** has to be substantially eliminated. Thus, with the technique at the time of the present application, it is difficult to perform adjustment of color misalignment using the second data D**2** when the color misalignment amount may be significant, for example, at the time of initial settings.

[0138] In this embodiment, although the adjustment of color misalignment is performed with respect to four colors, the number of colors is not limited to this. For example, any number is possible as long as it is a plural.

[0139] Furthermore, in this embodiment, although the first data D**1** and the second data D**2** are used to perform adjustment of color misalignment, the number of data types of detection images is not limited to this. For example, three or more data types of detection images may be used. In this case, the adjustment of color misalignment can be performed in a stepwise manner from rough adjustment to fine adjustment, and, therefore, the correction of color misalignment can be more precisely performed.

[0140] Note that the color image forming apparatus according to the present invention showing this embodiment as an example is applicable also to other image forming apparatuses such as copiers, printers, and facsimile machines.

[0141] The present invention may be embodied in various other forms without departing from the spirit, gist, or essential characteristics thereof. The embodiments disclosed in this application are to be considered in all respects as illustrative and not limiting. The scope of the invention is indicated by the appended claims rather than by the foregoing description. All variations and modifications falling within the meaning and range of equivalency of the appended claims are intended to be embraced therein.

[0142] Furthermore, the present invention is effective for color image forming apparatuses.

What is claimed is:

1. A color image forming apparatus,

wherein a plurality of detection patterns respectively corresponding to a plurality of colors are formed from a plurality of photosensitive body units respectively corresponding to the plurality of colors onto a transfer member in a sub-scanning direction of the transfer member, intervals between detection patterns adjacent to each other in the sub-scanning direction among the plurality of formed detection patterns are detected, and adjustment of color misalignment is performed based on the detected intervals,

the plurality of detection patterns have the same size and the same shape, and

the adjustment of color misalignment is performed using at least two types of data of detection images having different intervals as data of detection images including the plurality of detection patterns.

2. The color image forming apparatus according to claim **1**,

wherein the data of detection images includes two types of data composed of first data of detection images and second data of detection images having an interval smaller than that of the first data, and

after the adjustment of color misalignment using the first data is performed, the adjustment of color misalignment using the second data is performed.

3. The color image forming apparatus according to claim **2**, wherein the adjustment of color misalignment is performed based on a preset condition using the first data and the second data.

4. A color misalignment adjusting method of a color image forming apparatus, comprising:

a formation step of forming a plurality of detection patterns respectively corresponding to a plurality of colors from a plurality of photosensitive body units respectively corresponding to the plurality of colors onto a transfer member in a sub-scanning direction of the transfer member; and

an adjustment step of detecting intervals between detection patterns adjacent to each other in the sub-scanning direction among the plurality of detection patterns formed in the formation step, and performing adjustment of color misalignment based on the detected intervals;

wherein the plurality of detection patterns have the same size and the same shape, and

the adjustment of color misalignment is performed in the adjustment step using at least two types of data of detection images having different intervals as data of detection images including the plurality of detection patterns.

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