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IMAGE FORMING APPARATUS

Abstract

An image forming apparatus includes a developing device, a container, a toner replenishment device, a toner conveyance detection portion, and a control portion. The toner replenishment device includes a plurality of toner replenishment paths through which toner in the container is conveyed and replenished to the developing device. The toner conveyance detection portion detects a toner conveyance error in toner conveyance performed by using the plurality of toner replenishment paths. In a case where the toner conveyance detection portion has detected a toner conveyance error in one of the toner replenishment paths that is in use, the control portion switches to another one of the toner replenishment paths to convey the toner.

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Background/Summary

INCORPORATION BY REFERENCE

[0001] This application is based on and claims the benefit of priority from Japanese Patent Application No. 2024-021014 filed on Feb. 15, 2024, the contents of which are hereby incorporated by reference.

BACKGROUND

[0002] The present disclosure relates to an image forming apparatus.

[0003] In electrophotographic image forming apparatuses, such as copiers and printers, developing devices are widely used to develop an electrostatic latent image with toner on the outer circumferential surface of a photosensitive drum, thereby forming a toner image which is later transferred onto a sheet. In these apparatuses, the developing device is replenished with toner from a container that is attachable to and detachable from the main body of the image forming apparatus.

SUMMARY

[0004] According to one aspect of the present disclosure, an image forming apparatus includes a developing device, a container, a toner replenishment device, a toner conveyance detection portion, and a control portion. The developing device supplies toner to an image carrier. The container contains the toner to be replenished to the developing device. The toner replenishment device includes a plurality of toner replenishment paths through which the toner in the container is conveyed and replenished to the developing device. The toner conveyance detection portion detects a toner conveyance error in toner conveyance performed by using the plurality of toner replenishment paths. The control portion controls operations of the developing device and the toner replenishment device. In a case where the toner conveyance detection portion has detected the toner conveyance error in one of the toner replenishment paths that is in use, the control portion switches to another one of the toner replenishment paths to convey the toner.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. **1** is a schematic sectional view of an image forming apparatus according to one embodiment of the present disclosure.

[0006] FIG. **2** is a block diagram schematically showing a configuration of the image forming apparatus shown FIG. **1**.

[0007] FIG. **3** is a sectional view of and around an image forming portion of the image forming apparatus shown in FIG. **1**.

[0008] FIG. **4** is a perspective view of and around a toner replenishment device of the image forming apparatus shown in FIG. **1**.

[0009] FIG. **5** is a front view of and around the toner replenishment device shown in FIG. **4**.

[0010] FIG. **6** is a side view of and around the toner replenishment device shown in FIG. **4**.

[0011] FIG. **7** is a perspective view of the toner replenishment device shown in FIG. **4**.

[0012] FIG. **8** is a plan view of the toner replenishment device shown in FIG. **4**.

[0013] FIG. **9** is a perspective view of a first conveyance pipe and a second conveyance pipe of the toner replenishment device shown in FIG. **7**.

[0014] FIG. **10** is a flowchart schematically showing an example of processing in toner conveyance

error detection performed with respect to a plurality of toner replenishment paths.
[0015] FIG. **11** is a flowchart showing a first example of the processing in the toner conveyance error detection performed with respect to the plurality of toner replenishment paths.
[0016] FIG. **12** is a flowchart showing a second example of the processing in the toner conveyance error detection performed with respect to the plurality of toner replenishment paths.

DETAILED DESCRIPTION

[0017] Hereinafter, an embodiment of the present disclosure will be described with reference to the accompanying drawings. It should be understood that the present disclosure is not limited to the following descriptions.
[0018] FIG. **1** is a schematic sectional view of an image forming apparatus **1** according to an embodiment. FIG. **2** is a block diagram schematically showing a configuration of the image forming apparatus **1** shown in FIG. **1**. FIG. **3** is a sectional view of and around an image forming portion **20** of the image forming apparatus **1** shown in FIG. **1**. The image forming apparatus **1** of the present embodiment is, for example, a tandem-type color printer that uses an intermediate transfer belt **31** to transfer a toner image onto a sheet S. The image forming apparatus **1** may be what is called a multifunction peripheral having functions including, for example, printing, scanning (image reading), facsimile transmission, etc.
[0019] As shown in FIG. **1**, FIG. **2**, and FIG. **3**, the image forming apparatus **1** includes, arranged in a main body **2** thereof, a sheet feed portion **3**, a sheet conveyance portion **4**, an exposure portion **5**, the image forming portion **20**, a transfer portion **30**, a fixing portion **6**, a sheet discharge portion **7**, and a control portion **8**.
[0020] The main body **2** includes an operation panel **2***c*. The operation panel **2***c* is disposed in an upper front part of the main body **2**, for example, and includes a display portion **2***d*, which is a liquid crystal display or the like. The operation panel **2***c* displays, on the display portion **2***d*, screen images related to inputs of settings such as printing conditions including the type and size of a sheet S to be used for printing, execution instructions, and the like, and accepts those inputs directly from a user. Furthermore, the display portion **2***d* also serves as a notification portion that displays, for example, statuses of the image forming apparatus **1**, cautions, error massages, and the like, to thereby provide the use with those pieces of information.
[0021] The sheet feed portion **3** is disposed in a bottom part of the main body **2**. The sheet feed portion **3** accommodates a plurality of sheets S for printing and sends out the sheets S separately one by one during printing. The sheet conveyance portion **4** extends in an up-down direction along a side wall of the main body **2**. The sheet conveyance portion **4** conveys a sheet S sent out from the sheet feed portion **3** to a secondary transfer portion **33** and the fixing portion **6**, and further discharges the sheet S, after fixing, through a sheet discharge port **4***a* into the sheet discharge portion **7**. The exposure portion **5** is disposed above the sheet feed portion **3**. The exposure portion **5** emits laser light, which is controlled based on image data, toward the image forming portion **20** to irradiate it with the laser light.
[0022] The image forming portion **20** is disposed above the exposure portion **5** but below the intermediate transfer belt **31**. The image forming portion **20** includes an image forming portion **20**Y for yellow, an image forming portion **20**C for cyan, an image forming portion **20**M for magenta, and an image forming portion **20**B for black. These four image forming portions **20** are identical in basic configuration. Thus, in the following description, unless specific distinction is necessary, color identification symbols “Y,” “C,” “M,” and “B” may be omitted.
[0023] The image forming portions **20** each include a photosensitive drum (image carrier) **21** that is supported so as to be rotatable in a predetermined direction (clockwise in FIG. **1** and FIG. **3**). The image forming portions **20** each further include, around the photosensitive drum **21**, a charging portion **22**, a developing device **40**, and a drum cleaning portion **23**, which are arranged along a rotation direction of the photosensitive drum **21**. Note that, between the developing device **40** and the drum cleaning portion **23**, a primary transfer portion **32** is disposed.

[0024] The photosensitive drum **21** is formed in a horizontally extending cylindrical shape and has a photosensitive layer on an outer circumferential surface thereof. The charging portion **22** charges a surface (the outer circumferential surface) of the photosensitive drum **21** to a predetermined potential. The exposure portion **5** exposes the outer circumferential surface of the photosensitive drum **21** with light after the outer circumferential surface is charged by the charging portion **22**, and thereby, an electrostatic latent image of an original image is formed on the outer circumferential surface of the photosensitive drum **21**. The developing device **40** supplies toner onto the electrostatic latent image to develop it, and thereby a toner image is formed. The four image forming portions **20** each form a toner image in a corresponding one of the different colors. After the toner image is primarily transferred onto an outer circumferential surface of the intermediate transfer belt **31**, the drum cleaning portion **23** performs cleaning by removing residual toner and the like remaining on the outer circumferential surface of the photosensitive drum **21**. In this manner, the image forming portions **20** form images (toner images), which are to be later transferred onto a sheet S.

[0025] The transfer portion **30** includes the intermediate transfer belt **31**, primary transfer portions **32**Y, **32**C, **32**M, and **32**B, the secondary transfer portion **33**, and a belt cleaning portion **34**. The intermediate transfer belt **31** is disposed above the four image forming portions **20**. The intermediate transfer belt **31** is an endless intermediate transfer member that is supported to be rotatable in a predetermined direction (counterclockwise in FIG. **1**), and onto which the toner images formed respectively in the four image forming portions **20** are primarily transferred sequentially to be superimposed on one another. The four image forming portions **20** are arranged in what is called a tandem manner so as to be arrayed in line from an upstream side toward a downstream side in a rotation direction of the intermediate transfer belt **31**.

[0026] The primary transfer portions **32**Y, **32**C, **32**M, and **32**B are respectively disposed above the image forming portion **20**Y, **20**C, **20**M, and **20**B corresponding to their respective colors, with the intermediate transfer belt **31** interposed therebetween. The secondary transfer portion **33** is disposed upstream of the fixing portion **6** with respect to a sheet conveyance direction of the sheet conveyance portion **4** but downstream of the four image forming portions **20**Y, **20**C, **20**M, and **20**B with respect to the rotation direction of the intermediate transfer belt **31**. The belt cleaning portion **34** is disposed downstream of the secondary transfer portion **33** with respect to the rotation direction of the intermediate transfer belt **31**.

[0027] The primary transfer portion **32** transfers the toner image formed on the outer circumferential surface of the photosensitive drum **21** onto the intermediate transfer belt **31**. In other words, the toner images are primarily transferred onto the outer circumferential surface of the intermediate transfer belt **31** in the primary transfer portions **32**Y, **32**C, **32**M, and **32**B corresponding to the four different colors. Along with rotation of the intermediate transfer belt **31**, at predetermined timings, the toner images of the four image forming portions **20** are transferred successively onto the intermediate transfer belt **31** to be superimposed on one another, and thereby, on the outer circumferential surface of the intermediate transfer belt **31**, a color toner image is formed in which toner images of the four colors, namely, yellow, cyan, magenta, and black, are superimposed on one another.

[0028] The color toner image on the outer circumferential surface of the intermediate transfer belt **31** is transferred onto the sheet S, having been synchronously conveyed by the sheet conveyance portion **4**, at a secondary transfer nip portion formed in the secondary transfer portion **33**. The belt cleaning portion **34** performs cleaning, after the secondary transfer, by removing deposits such as residual toner and the like remaining on the outer circumferential surface of the intermediate transfer belt **31**. In this manner, the transfer portion **30** transfers (records) the toner image formed on the outer circumferential surface of the photosensitive drum **21** onto the sheet S.

[0029] The fixing portion **6** is disposed above the secondary transfer portion **33**. The fixing portion **6** applies heat and pressure to the sheet S having the toner image transferred thereon, and thereby

fixes the toner image on the sheet S.
[0030] The sheet discharge portion **7** is disposed above the transfer portion **30**. The sheet S having undergone printing with the toner image fixed thereon is conveyed to the sheet discharge portion **7**. From the sheet discharge portion **7**, a printed sheet (printed matter) can be taken out from above.
[0031] The control portion **8** includes a CPU, an image processor, a storage portion, and other electronic circuits and electronic components (of which none is illustrated). The CPU controls operations of various components provided in the image forming apparatus **1** based on a control program and control data stored in the storage portion, and thereby performs processing related to the functions of the image forming apparatus **1**. The sheet feed portion **3**, the sheet conveyance portion **4**, the exposure portion **5**, the image forming portion **20**, the transfer portion **30**, and the fixing portion **6** each individually receive a command from the control portion **8**, and cooperate with each other to perform printing with respect to a sheet S. The storage portion is composed of, for example, a combination of nonvolatile storage devices such as a program ROM (read only memory), a data ROM, and the like, and a volatile storage device such as a RAM (random access memory) and the like.
[0032] Next, a description will be given of a configuration of and around the developing device **40** with reference to FIG. **3**. Note that the developing devices **40** each corresponding to one of the four different colors are identical to each other in basic configuration, and thus the color identification symbols representing respective colors of the components and overlapping descriptions thereof will be omitted.
[0033] The developing device **40** supplies toner to the outer circumferential surface of the photosensitive drum **21**. The developing device **40** includes a development container **41**, a first stirring conveyance member **42**, a second stirring conveyance member **43**, a developing roller **44**, a regulation member **45**, and a toner concentration sensor (developing toner amount detection portion) **46**.
[0034] The development container **41** has an elongated shape extending along an axis direction of the photosensitive drum **21** (a depth direction of the plane of FIG. **3**) and is disposed with a longitudinal direction thereof aligned horizontally. The development container **41** contains, as a developer that includes toner to be supplied to the photosensitive drum **21**, a two-component developer that includes a toner and a magnetic carrier. The development container **41** includes a partition portion **411**, a first conveyance chamber **412**, and a second conveyance chamber **413**.
[0035] The partition portion **411** is disposed in a lower part inside the development container **41**. The partition portion **411** is disposed, in a lower part of the development container **41**, substantially at a central part in a direction (a right-left lateral direction in FIG. **3**) intersecting with the axis direction, so as to extend in the axis direction and an up-down direction. The partition portion **411** divides an inside of the development container **41** in the direction (the right-left lateral direction in FIG. **3**) intersecting with the axis direction. The development container **41** includes communication portions (not shown) that allow communication between the first conveyance chamber **412** and the second conveyance chamber **413**, the communication portions being disposed one at each of opposite ends of the development container **41** in an axis direction of the partition portion **411** (the depth direction of the plane of FIG. **3**).
[0036] The first conveyance chamber **412** and the second conveyance chamber **413** are provided inside the development container **41**. The first conveyance chamber **412** and the second conveyance chamber **413** are formed by the partition portion **411** dividing the inside of the development container **41** and are arranged parallel to each other. The second conveyance chamber **413** is disposed inside the development container **41** so as to be below and adjacent to an area where the developing roller **44** is disposed. The first conveyance chamber **412** is disposed in an area, inside the development container **41**, that is more separated from the developing roller **44** than the second conveyance chamber **413**. The first conveyance chamber **412** receives replenishment of the developer via a replenishment pipe connection portion **412***a*, which is shown in FIG. **3**.

[0037] The first stirring conveyance member **42** is disposed inside the first conveyance chamber **412**. The second stirring conveyance member **43** is disposed inside the second conveyance chamber **413**. The second stirring conveyance member **43** extends close to and parallel to the developing roller **44**. The first stirring conveyance member **42** and the second stirring conveyance member **43** are each supported in the development container **41** so as to be rotatable about an axis thereof extending parallel to the photosensitive drum **21**. The first stirring conveyance member **42** and the second stirring conveyance member **43** rotate about their respective rotation axes and thereby convey, while stirring, the developer along their respective rotation axes in mutually opposite directions.

[0038] Due to the rotations of the first stirring conveyance member **42** and the second stirring conveyance member **43**, the developer is caused to pass through the communication portions, which are disposed at the opposite ends of the partition portion **411** in the axis direction, so as to circulate between the first conveyance chamber **412** and the second conveyance chamber **413**. In the first conveyance chamber **412** and the second conveyance chamber **413**, externally replenished toner is stirred and charged.

[0039] The developing roller **44**, which is located above the second stirring conveyance member **43** inside the development container **41**, is disposed so as to face the photosensitive drum **21**. The developing roller **44** is supported in the development container **41** to be rotatable about an axis thereof extending parallel to the axis of the photosensitive drum **21**.

[0040] The developing roller **44** has part of an outer circumferential surface thereof exposed out of the development container **41** so as to face, and be close to, the photosensitive drum **21**. The developing roller **44** carries, on the outer circumferential surface thereof, the toner to be supplied to the outer circumferential surface of the photosensitive drum **21** in a facing area with respect to the photosensitive drum **21**. The developing roller **44** causes the toner inside the second conveyance chamber **413** to adhere to an electrostatic latent image formed on the outer circumferential surface of the photosensitive drum **21**, and thereby a toner image is formed.

[0041] The regulation member **45** is disposed upstream of the facing region between the developing roller **44** and the photosensitive drum **21** in a rotation direction of the developing roller **44**. The regulation member **45** is disposed close to, and facing, the developing roller **44** with a predetermined space between a leading edge thereof and the outer circumferential surface of the developing roller **44**. The regulation member **45** extends along an entire length of the developing roller **44** in the axis direction thereof (the depth direction of the plane of FIG. **3**). The regulation member **45** regulates layer thickness of the developer (toner) carried on the outer circumferential surface of the developing roller **44** when the developer passes through the space between the leading edge of the regulation member **45** and the outer circumferential surface of the developing roller **44**.

[0042] The toner concentration sensor **46** is disposed on a wall of the first conveyance chamber **412** along a longitudinal direction thereof. The toner concentration sensor **46** is disposed so as to face the first stirring conveyance member **42**. In the present embodiment, a headless sensor is used as the toner concentration sensor **46**. The toner concentration sensor **46**, which is a headless sensor, has a sensing surface thereof embedded in an inner wall surface of the first conveyance chamber **412**. The toner concentration sensor **46** detects toner concentration in the developer.

[0043] More specifically, the toner concentration sensor **46** is a sensor of a type that detects magnetic permeability, and acquires a toner concentration (a mixture ratio of the toner T to the magnetic carrier C in the developer; T/C) by detecting a change of the magnetic permeability of a two-component developer. The magnetic permeability changes with the ratio of the toner to the magnetic carrier in the developer inside the first conveyance chamber **412**, and in response to such changes, the toner concentration sensor **46** outputs different signals.

[0044] In connection with later-described toner conveyance performed by using a plurality of toner replenishment paths, the control portion **8** controls starting and stopping of developer (toner and

carrier) replenishment for the developing device **40**, based on an output signal received from the toner concentration sensor **46**. That is, the toner concentration sensor **46** is a developing toner amount detection portion that detects a toner amount by detecting a toner concentration inside the developing device **40**, and is also a toner conveyance detection portion for detecting a toner conveyance error.

[0045] The toner inside the development container **41** is charged by being stirred and circulated by the first stirring conveyance member **42** and the second stirring conveyance member **43**, and is caused by the second stirring conveyance member **43** to be carried on the outer circumferential surface of the developing roller **44**. The developer carried on the outer circumferential surface of the developing roller **44** has a layer thickness thereof regulated by the regulation member **45**, and is then conveyed, by the rotation of the developing roller **44**, to the facing area between the developing roller **44** and the photosensitive drum **21**. When a predetermined developing voltage is applied to the developing roller **44**, due to a potential difference between the developing roller **44** and the surface (outer circumferential surface) of the photosensitive drum **21**, the toner in the developer carried on the outer circumferential surface of the developing roller **44** moves, in the facing region, onto the outer circumferential surface of the photosensitive drum **21**. In this manner, the electrostatic latent image on the outer circumferential surface of the photosensitive drum **21** is developed with the toner.

[0046] In connection with the replenishment of the toner for the developing device **40**, the image forming apparatus **1** includes a container **50** and a toner replenishment device **60** (see FIG. **4**). The container **50** includes a first container **51** and a second container **52**. The image forming apparatus **1** includes a plurality of the containers **50** (the first container **51**, the second container **52**) containing toner of the same color. Note that, in the following descriptions, the first container **51** and the second container **52** may sometimes be collectively referred to as "the container **50**."

[0047] The first container **51**, the second container **52**, and the toner replenishment device **60** are disposed above the developing device **40**. The first container **51**, the second container **52**, and the toner replenishment device **60** are each provided one for each of the four colors of yellow, cyan, magenta, and black.

[0048] Next, configurations of the container **50** and the toner replenishment device **60** will be described with reference to FIG. **4** to FIG. **9**. FIG. **4** is a perspective view of and around the toner replenishment device **60** of the image forming apparatus **1** shown in FIG. **1**. FIG. **5** and FIG. **6** are respectively a front view and a side view of the toner replenishment device **60** shown in FIG. **4**. FIG. **7** and FIG. **8** are respectively a perspective view and a plan view of the toner replenishment device **60** shown in FIG. **4**. FIG. **9** is a perspective view of a first conveyance pipe **65** and a second conveyance pipe **66** of the toner replenishment device **60** shown in FIG. **7**.

[0049] The first container **51**, the second container **52**, and the toner replenishment device **60** include the following: a first container **51**Y, a second container **52**Y, and a toner replenishment device **60**Y for yellow; a first container **51**C, a second container **52**C, and a toner replenishment device **60**C for cyan; a first container **51**M, a second container **52**M, and a toner replenishment device **60**M for magenta; and a first container **51**B, a second container **52**B, and a toner replenishment device **60**B for black. The first containers **51** for the four different colors are identical in basic configuration, and the same applies to the second containers **52** and the toner replenishment devices **60** for the four different colors. Thus, in the following description, unless specific distinction is necessary, the color identification symbols "Y," "C," "M," and "B" may be omitted.

[0050] The first containers **51** are disposed above the second containers **52**. The second containers **52** are disposed below the first containers **51**. The first containers **51** are disposed, as seen from the front, to be deviated from the second containers **52** in an array direction of the image forming portions **20** and the toner replenishment devices **60**. The first containers **51** and the second containers **52** are attachable to and detachable from the main body **2**, and contain toner to be

replenished to the developing devices **40**.
[0051] The first containers **51** and the second containers **52** are each formed in an elongated cylindrical shape extending along the axis direction Dx of the photosensitive drum **21**, and each disposed with a longitudinal direction thereof aligned horizontally. On circumferential walls of the first and second containers **51** and **52**, helical protrusion portions **51***s* and **52***s* are formed, respectively, so as to protrude inward in a radial direction and to extend in the longitudinal direction.
[0052] The first and second containers **51** and **52** are each closed at one end (front side) thereof and each have an opening (not shown) at the other end (rear side) thereof in the axis direction Dx. The first and second containers **51** and **52** are, at the rear side, which is the open side, respectively connected to a first container connecting portion **61** and a second container connecting portion **62** in the toner supply device **60**. The first and second containers **51** and **52** are supported on the toner supply device **60** so as to be rotatable about their axes that extend parallel to the axial direction Dx of the photosensitive drum **21**.
[0053] The first and second containers **51** and **52** are caused by a driver (not shown) in the toner replenishment device **60** to rotate about their respective axes extending parallel to the axis direction Dx of the photosensitive drum **21**. As the first and second containers **51** and **52** rotate, the toner inside is conveyed by the helical protrusion portions **51***s* and **52***s*, respectively, toward the rear side, which is the open side. As a result, the toner inside the first and second containers **51** and **52** flows into the toner replenishment device **60** through the opening.
[0054] The toner replenishment device **60** is disposed at the rear side of the first and second containers **51** and **52**. The four toner replenishment devices **60** are arranged in a row in the same order as the four image forming portions **20**. The toner replenishment devices **60** cause the first and second containers **51** and **52** to rotate to thereby convey and replenish the toner inside the first and second containers **51** and **52** to the developing device **40**.
[0055] The toner replenishment devices **60** each include the first container connection portion **61**, the second container connection portion **62**, a first vertical pipe **63**, a second vertical pipe **64**, the first conveyance pipe **65**, the second conveyance pipe **66**, a first conveyance member **67**, a second conveyance member **68**, a confluence portion **69**, a conveyance driving portion **70**, an intermediate toner amount detection portion **71**, and a rotation detection portion **80**.
[0056] Note that the toner replenishment devices **60** each include a plurality of toner replenishment paths for conveying and replenishing the toner inside the container **50** to the developing device **40**. Specifically, the toner replenishment devices **60** each include a first toner replenishment path R**1** through which the toner is conveyed from the first container **51** toward the developing device **40**, and a second toner replenishment path R**2** through which the toner is conveyed from the second container **52** toward the developing device **40**. The first toner replenishment path R**1** includes the first container connection portion **61**, the first vertical pipe **63**, the first conveyance pipe **65**, and the first conveyance member **67**. The second toner replenishment path R**2** includes the second container connection portion **62**, the second vertical pipe **64**, the second conveyance pipe **66**, and the second conveyance member **68**.
[0057] The first container connection portion **61** is disposed in an upper part of the toner replenishment device **60** so as to be above the second container connection portion **62**. The first container connection portion **61** includes a toner flow path (not shown) provided inside thereof. The first container connection portion **61** is connected to the open side of the first container **51**, and rotatably supports the first container **51**. A downstream end of the first container connection portion **61** in a toner flow direction is connected to the first vertical pipe **63**. To replenish the developing device **40** with the toner from the first container **51**, the toner flows from the first container **51** into the first container connection portion **61**, then through it, and out toward the first vertical pipe **63**.
[0058] The second container connection portion **62** is disposed in an upper part of the toner replenishment device **60** so as to be below the first container connection portion **61**. The second

container connection portion **62** includes a toner flow path (not shown) provided inside thereof. The second container connection portion **62** is connected to the open side of the second container **52**, and rotatably supports the second container **52**. A downstream end of the second container connection portion **62** in the toner flow direction is connected to the second vertical pipe **64**. To replenish the developing device **40** with the toner from the second container **52**, the toner flows from the second container **52** into the second container connection portion **62**, then through it, and out toward the second vertical pipe **64**.

[0059] The first vertical pipe **63** is disposed between the first container connection portion **61** and the first conveyance pipe **65**. The first vertical pipe **63** is formed in a cylindrical shape extending in the up-down direction. An upper end of the first vertical pipe **63** is connected to the first container connection portion **61**. A lower end of the first vertical pipe **63** is connected to the first conveyance pipe **65**. To replenish the developing device **40** with the toner from the first container **51**, the toner flows through the first container connection portion **61** into the first vertical pipe **63**, then through it, and out toward the first conveyance pipe **65**.

[0060] The second vertical pipe **64** is disposed between the second container connection portion **62** and the second conveyance pipe **66**. The second vertical pipe **64** is formed in a cylindrical shape extending in the up-down direction. An upper end of the second vertical pipe **64** is connected to the second container connection portion **62**. A lower end of the second vertical pipe **64** is connected to the second conveyance pipe **66**. To replenish the developing device **40** with the toner from the second container **52**, the toner flows through the second container connection portion **62** into the second vertical pipe **64**, then through it, and out toward the second conveyance pipe **66**.

[0061] Due to the first container **51** and the first container connection portion **61** being disposed above the second container **52** and the second container connection portion **62**, the first vertical pipe **63** is longer than the second vertical pipe **64** in the up-down direction. Due to the second container **52** and the second container connection portion **62** being disposed below the first container **51** and the first container connection portion **61**, the second vertical pipe **64** is shorter than the first vertical pipe **63** in the up-down direction. The first vertical pipe **63** and the second vertical pipe **64** are disposed at the same position in the axis direction Dx of the photosensitive drum **21**. In other words, the first vertical pipe **63** and the second vertical pipe **64** are arranged side by side on a straight line that is orthogonal to the axis direction Dx.

[0062] The first conveyance pipe **65** is arranged between the first vertical pipe **63** and the confluence portion **69** in the up-down direction. The first conveyance pipe **65** is formed in a horizontally extending cylindrical shape. To one end of the first conveyance pipe **65** in its extending direction, the first vertical pipe **63** is connected. The other end of the first conveyance pipe **65** in its extending direction is connected to the confluence portion **69**. To replenish the developing device **40** with the toner from the first container **51**, the toner flows through the first vertical pipe **63** into the first conveyance pipe **65**, then through it, and out toward the confluence portion **69**. In other words, the first conveyance pipe **65** is connected between the first container **51** and the confluence portion **69**, and the toner is conveyed from the first container **51** side toward the confluence portion **69** side.

[0063] The second conveyance pipe **66** is disposed between the second vertical pipe **64** and the confluence portion **69** in the up-down direction. The second conveyance pipe **66** is formed in a horizontally extending cylindrical shape. To one end of the second conveyance pipe **66** in its extending direction, the second vertical pipe **64** is connected. The other end of the second conveyance pipe **66** in its extending direction is connected to the confluence portion **69**. To replenish the developing device **40** with the toner from the second container **52**, the toner flows through the second vertical pipe **64** into the second conveyance pipe **66**, then through it, and out toward the confluence portion **69**. In other words, the second conveyance pipe **66** is connected between the second container **52** and the confluence portion **69**, and the toner is conveyed from the second container **52** side toward the confluence portion **69** side.

[0064] The first conveyance pipe **65** and the second conveyance pipe **66** are arranged side by side in a direction (horizontal direction) intersecting with their respective extending directions so as to join together at the confluence portion **69**, to which a replenishment pipe **69***a* is connected. In other words, the first conveyance pipe **65** and the second conveyance pipe **66** are disposed such that their respective extension lines intersect with each other at their sides close to the confluence portion **69** in their extending directions. The first conveyance pipe **65** and the second conveyance pipe **66** are disposed such that an angle between their extending directions is an acute angle in the horizontal direction, that is, they are arranged in a V-shape as seen from the up-down direction.

[0065] The first conveyance member **67** is disposed inside the first conveyance pipe **65**. The first conveyance member **67** includes a rotation shaft that is provided between opposite ends of the cylindrical first conveyance pipe **65** in the axis direction, and a first conveyance blade that is formed on an outer circumferential surface of the rotation shaft so as to extend in a helical shape along the axis direction. The first conveyance member **67** is supported inside the first conveyance pipe **65** so as to be rotatable about an axis extending in the horizontal direction. Note that one end part of the first conveyance member **67** in the axis direction is located inside the confluence portion **69**.

[0066] The first conveyance member **67** rotates about its axis, thereby stirring and conveying the toner in the first conveyance pipe **65** along a toner conveyance direction f**1** (see FIG. **8** and FIG. **9**) that is parallel to the rotation axis. The first conveyance member **67** conveys the toner in the first conveyance pipe **65** from the first vertical pipe **63** side toward the confluence portion **69** side. In other words, the first conveyance member **67** conveys the toner from the first container **51** side toward the confluence portion **69** side.

[0067] The second conveyance member **68** is disposed inside the second conveyance pipe **66**. The second conveyance member **68** includes a rotation shaft that is provided between opposite ends of the cylindrical second conveyance pipe **66** in the axis direction, and a second conveyance blade that is formed on an outer circumferential surface of the rotation shaft so as to extend in a helical shape along the axis direction. The second conveyance member **68** is supported inside the second conveyance pipe **66** so as to be rotatable about an axis extending in the horizontal direction. Note that one end part of the second conveyance member **68** in the axis direction is located inside the confluence portion **69**.

[0068] The second conveyance member **68** rotates about the axis, thereby stirring and conveying the toner in the second conveyance pipe **66** along a toner conveyance direction f**2** (see FIG. **8** and FIG. **9**) that is parallel to the rotation axis. The second conveyance member **68** conveys the toner in the second conveyance pipe **66** from the second vertical pipe **64** side toward the confluence portion **69** side. In other words, the second conveyance member **68** conveys the toner from the second container **52** side toward the confluence portion **69** side.

[0069] As mentioned previously, the first conveyance pipe **65** and the second conveyance pipe **66** are arranged in a V-shape as seen from the up-down direction. That is, the rotation shaft of the first conveyance member **67** and the rotation shaft of the second conveyance member **68** are arranged with a predetermined shaft angle α formed between them.

[0070] The confluence portion **69** is disposed at downstream ends of the first conveyance pipe **65** and the second conveyance pipe **66** in their respective toner conveyance directions. The confluence portion **69** allows the toner in the first conveyance pipe **65** and in the second conveyance pipe **66** to join together at the downstream ends in their respective toner conveyance directions. The confluence portion **69** also allows the joined toner to flow into the developing device **40**. The confluence portion **69** includes the replenishment pipe **69***a*.

[0071] The replenishment pipe **69***a*, which is a lower part of the confluence portion **69**, is disposed in a lower part of the toner replenishment device **60**. The toner replenishment devices **60** each include the single replenishment pipe **69***a*. The replenishment pipe **69***a* is formed in a cylindrical shape extending in the up-down direction. An upper end of the replenishment pipe **69***a* is connected

to a part at which the first conveyance pipe **65** and the second conveyance pipe **66** join together. A lower end of the replenishment pipe **69***a* is connected to the replenishment pipe connection portion **412***a* of the developing device **40**. To replenish the developing device **40** with the toner from the first container **51** and the second container **52**, the toner flows into the replenishment pipe **69***a* in the confluence portion **69**, and then flows through the replenishment pipe **69***a* into the developing device **40**.

[0072] That is, the confluence portion **69** is disposed at downstream ends of the first toner replenishment path R**1** and the second toner replenishment path R**2** in their respective toner conveyance directions so as to allow the toner to join together to flow into the developing device **40**.

[0073] The conveyance driving portion **70** is disposed, in a rear part of the toner replenishment device **60**, so as to be upstream of the first conveyance pipe **65** and the second conveyance pipe **66** in their toner conveyance directions. The conveyance driving portion **70** includes a motor **70***m* and a gear group **70***g* composed of a plurality of gears. The motor **70***m* is coupled via the gear group **70***g* to each of the first conveyance member **67** and the second conveyance member **68**. The conveyance driving portion **70** causes the motor **70***m* to rotate either forward or backward, and thereby selectively causes one of the first conveyance member **67** and the second conveyance member **68** to rotate.

[0074] The intermediate toner amount detection portion **71** includes a first intermediate toner amount detection portion **71**A and a second intermediate toner amount detection portion **71**B. The first intermediate toner amount detection portion **71**A is disposed at a lower part of the first vertical pipe **63**. The second intermediate toner amount detection portion **71**B is disposed at a lower part of the second vertical pipe **64**. The first intermediate toner amount detection portion **71**A and the second intermediate toner amount detection portion **71**B are, similarly to the toner concentration sensor **46**, each constituted of a sensor of a type that detects magnetic permeability. The first intermediate toner amount detection portion **71**A, at the lower part of the first vertical pipe **63**, detects a change in magnetic permeability of the two-component developer, and outputs a detection signal. The second intermediate toner amount detection portion **71**B, at the lower part of the second vertical pipe **64**, detects a change in magnetic permeability of the two-component developer, and outputs a detection signal.

[0075] In connection with toner conveyance performed by using the plurality of toner replenishment paths, the control portion **8** controls starting and stopping of developer replenishment for the developing device **40**, based on the output signals received from the first intermediate toner amount detection portion **71**A and the second intermediate toner amount detection portion **71**B. That is, the first intermediate toner amount detection portion **71**A is a toner amount detection portion that detects a toner amount on the first toner replenishment path R**1**. The second intermediate toner amount detection portion **71**B is a toner detection portion that detects a toner amount on the second toner replenishment path R**2**. Further, the first intermediate toner amount detection portion **71**A and the second intermediate toner amount detection portion **71**B are toner conveyance detection portions for detecting toner conveyance errors.

[0076] The rotation detection portion **80** is disposed, in a rear part of the toner replenishment device **60**, so as to be upstream of the conveyance driving portion **70** in the toner conveyance direction. The rotation detection portion **80** includes a container toner amount detection portion **81** and light-shielding plates (not shown) that individually rotate respectively with the first conveyance member **67** and the second conveyance member **68**.

[0077] The container toner amount detection portion **81** is a light transmissive sensor, for example, including a light emitter and a light receiver, and has an optical path extending from the light emitter toward the light receiver. The light-shielding plates move into, and withdraw from, the optical path of the light transmissive sensor. The container toner amount detection portion **81** detects rotation of each of the first conveyance member **67** and the second conveyance member **68**,

and outputs a detection signal.
[0078] In connection with toner conveyance performed by using the plurality of toner replenishment paths, the control portion **8** detects a toner amount in each of the first container **51** and the second container **52** based on the output signal received from the container toner amount detection portion **81**. Specifically, the control portion **8** counts the number of rotations of the first and second conveyance members **67** and **68** based on the output signal form the container toner amount detection portion **81**, and detects, based on the counted number of rotations, a toner amount in the first and second containers **51** and **52**. That is, the container toner amount detection portion **81** is a toner conveyance detection portion that detects a toner amount in the container **50** to thereby detect a conveyance error in the toner conveyance performed by using the plurality of toner replenishment paths.
[0079] Further, in a case where the toner conveyance detection portion (the toner concentration sensor **46**, the intermediate toner amount detection portion **71**, and the container toner amount detection portion **81**) has detected a toner conveyance error in one of the toner replenishment paths that is in use, the control portion **8** switches to another one of the toner replenishment paths to convey the toner. That is, in a case where a toner conveyance error has been detected in one of the first toner replenishment path R**1** and the second toner replenishment path R**2** that is in use, the control portion **8** switches to the other toner replenishment path to convey the toner.
[0080] According to the above-described configuration, which detects a conveyance error in toner conveyance performed by using the plurality of toner replenishment paths, no matter in which one of the toner replenishment paths a conveyance error occurs, it is possible to continue toner conveyance and replenishment by switching to another replenishment path. Thus, it is possible, in the image forming apparatus **1**, to suppress interruptions in toner replenishment for the developing device **40** and to continue appropriate image formation.
[0081] Further, as described previously, the toner conveyance detection portion is a toner amount detection portion that includes the toner concentration sensor **46**, the intermediate toner amount detection portion **71**, and the container toner amount detection portion **81**. The control portion **8** detects, based on results of detection performed by these three toner amount detection portions, a toner conveyance error in one of the toner replenishment paths that is in use. In this manner, it is possible to detect toner conveyance errors in accordance with respective characteristics of the developing device **40**, the toner replenishment device **60**, and the container **50**. That is, it becomes possible to appropriately detect a toner conveyance error in the first toner replenishment path R**1** and in the second toner replenishment path R**2**. Thus, it is possible, in the image forming apparatus **1**, to suppress interruptions in toner replenishment for the developing device **40**, and thus to continue appropriate image formation.
[0082] Further, the toner replenishment device **60** includes the first toner replenishment path R**1**, the second toner replenishment path R**2**, and the confluence portion **69**, and also includes the first intermediate toner amount detection portion **71**A and the second intermediate toner amount detection portion **71**B. This enables the image forming apparatus **1** to perform toner conveyance by using two toner replenishment paths. And, even when a conveyance error occurs in one of the two toner replenishment paths in the image forming apparatus **1**, it is possible to switch to the other replenishment path to continue the conveyance and replenishment of the toner.
[0083] Next, a description will be given of an outline of a flow in toner conveyance error detection processing with respect to the plurality of toner replenishment paths. FIG. **10** is a flowchart schematically showing an example of processing in toner conveyance error detection performed with respect to the plurality of toner replenishment paths. In the present embodiment, the image forming apparatus **1** includes two toner replenishment paths, namely, the first toner replenishment path R**1** and the second toner replenishment path R**2**.
[0084] When the image forming apparatus **1** is started to operate (“START” in FIG. **10**), the control portion **8** starts toner conveyance and replenishment for the developing device **40** by using the first

toner replenishment path R**1** (step S**101**). Note that, in a case where the first container **51** has already become empty by then, for example, the control portion **8** may sometimes start toner conveyance and replenishment for the developing device **40** by using the second toner replenishment path R**2**.

[0085] Next, the control portion **8** determines, by means of the toner conveyance detection portion (the toner concentration sensor **46**, the first intermediate toner amount detection portion **71**A, and the container toner amount detection portion **81**), whether or not a conveyance error has been detected in the toner conveyance performed by using the first toner replenishment path R**1** (step S**102**). If no toner conveyance error has been detected (No in step S**102**), the flow returns to step S**101**, where the toner conveyance and replenishment for the developing device **40** is continued by using the first toner replenishment path R**1**.

[0086] In a case where the toner conveyance detection portion has detected a toner conveyance error in the first toner replenishment path R**1** in use (Yes in step S**102**), the control portion **8** switches to the second toner replenishment path R**2** to convey the toner (step S**103**).

[0087] Next, the control portion **8** determines, by means of the toner conveyance detection portion, whether or not a conveyance error has been detected in the toner conveyance performed by using the second toner replenishment path R**2** (step S**104**). In a case where no toner conveyance error has been detected (No in step S**104**), the flow returns to step S**103**, where the toner conveyance and replenishment for the developing device **40** is continued by using the second toner replenishment path R**2**.

[0088] In a case where the toner conveyance detection portion has detected a toner conveyance error in the second toner replenishment path R**2** in use (Yes in step S**104**), the control portion **8** ends the processing shown in FIG. **10**.

[0089] Note that, in a case where the image forming apparatus **1** includes more toner replenishment paths such as third, fourth, fifth . . . , and nth toner replenishment paths, the control portion **8** sequentially switches to another toner replenishment path every time a toner conveyance error is detected in one of the toner replenishment paths that is in use. Further, in the present embodiment, when a toner conveyance error is detected in the second toner replenishment path R**2** in use, if a conveyance error in the toner conveyance performed by using the first toner replenishment path R**1** has been cleared, the control portion **8** switches to the first toner replenishment path R**1** to convey the toner.

[0090] Next, a description will be given of a first processing example which is a detailed flow in the toner conveyance error detection processing performed with respect to the plurality of toner replenishment paths. FIG. **11** is a flowchart showing the first example of the processing in the toner conveyance error detection performed with respect to the plurality of toner replenishment paths. Similarly to the case shown in FIG. **10**, in the present embodiment, the image forming apparatus **1** includes two toner replenishment paths, namely, the first toner replenishment path R**1** and the second toner replenishment path R**2**.

[0091] When the image forming apparatus **1** is started to operate (“START” in FIG. **11**), the control portion **8** starts toner conveyance and replenishment for the developing device **40** by using the first toner replenishment path R**1** (step S**201**).

[0092] Next, the control portion **8** determines, by means of the first intermediate toner amount detection portion **71**A, whether or not the toner amount on the first toner replenishment path R**1** is smaller than a predetermined value (step S**202**). In a case where the toner amount on the first toner replenishment path R**1** is larger than the predetermined value (No in step S**202**), that is, in a case where no toner conveyance error has been detected, the flow returns to step S**201**, where the toner conveyance and replenishment for the developing device **40** is continued by using the first toner replenishment path R**1**.

[0093] In a case where the toner amount on the first toner replenishment path R**1** is smaller than the predetermined value (Yes in step S**202**), the control portion **8** determines, by means of the container

toner amount detection portion **81**, whether or not the toner amount in the first container **51** is larger than a predetermined value (step S**203**). In a case where the toner amount in the first container **51** is smaller than the predetermined value (No in step S**203**), that is, in a case where no toner conveyance error has been detected, the flow returns to step S**201**, where the toner conveyance and replenishment for the developing device **40** is continued by using the first toner replenishment path R**1**.

[0094] Note that processing of detecting a state where the toner amount in the first container **51** is nearly zero and a state where the toner amount is exactly zero and processing related to dealing with those are performed according to another processing flow, which is different from the flow of processing performed to detect and deal with a toner conveyance error in the present embodiment.

[0095] In a case where the toner amount in the first container **51** is larger than the predetermined value (Yes in step S**203**), that is, in a case where a toner conveyance error has been detected, the control portion **8** determines that a toner conveyance error has occurred in the first toner replenishment path R**1** in use (step S**204**). Then, the control portion **8** causes the display portion **2***d* of the main body **2** to display cautions and messages such as "TONER CONVEYANCE ERROR DETECTED IN FIRST TONER REPLENISHMENT PATH," "MAINTENANCE REQUESTED," and the like (step S**205**).

[0096] Next, the control portion **8** switches to the second toner replenishment path R**2** to convey the toner (step S**206**). Thereafter, in steps from step S**206** through step S**208**, the control portion **8** performs, with respect to the second toner replenishment path R**2**, processing that is similar to the processing performed in steps from step S**201** through step S**204**.

[0097] Then, after determining the conveyance error in the toner conveyance performed by using the second toner replenishment path R**2** (step S**208**), the control portion **8** causes the display portion **2***d* of the main body **2** to display cautions and messages such as "TONER CONVEYANCE ERROR DETECTED IN SECOND TONER REPLENISHMENT PATH/APPARATUS STOPPED," "MAINTENANCE REQUESTED," and the like (step S**209**). Then, the control portion **8** ends the processing shown in FIG. **11**.

[0098] Next, a description will be given of a second processing example which is a detailed flow in the toner conveyance error detection processing performed with respect to the plurality of toner replenishment paths. FIG. **12** is a flowchart showing the second example of the processing in the toner conveyance error detection performed with respect to the plurality of toner replenishment paths. Similarly to the case shown in FIG. **10**, in the present embodiment, the image forming apparatus **1** includes two toner replenishment paths, namely, the first toner replenishment path R**1** and the second toner replenishment path R**2**.

[0099] When the image forming apparatus **1** is started to operate ("START" in FIG. **12**), the control portion **8** starts toner conveyance and replenishment for the developing device **40** by using the first toner replenishment path R**1** (step S**301**).

[0100] Next, the control portion **8** determines, by means of the toner concentration sensor **46**, whether or not a toner amount in the developing device **40** is smaller than a predetermined value (step S**302**). In a case where the toner amount in the developing device **40** is larger than the predetermined value (No in step S**302**), that is, in a case where no toner conveyance error has been detected, the flow returns to step S**301**, where the toner conveyance and replenishment for the developing device **40** is continued by using the first toner replenishment path R**1**.

[0101] In a case where the toner amount in the developing device **40** is smaller than the predetermined value (Yes in step S**302**), the control portion **8** determines, by means of the first intermediate toner amount detection portion **71**A, whether or not the toner amount on the first toner replenishment path R**1** is larger than a predetermined value (step S**303**). In a case where the toner amount on the first toner replenishment path R**1** is smaller than the predetermined value (No in step S**303**), that is, in a case where no toner conveyance error has been detected, the flow returns to step S**301**, where the toner conveyance and replenishment for the developing device **40** is continued by

using the first toner replenishment path R**1**.
[0102] In a case where the toner amount on the first toner replenishment path R**1** is larger than the predetermined value (Yes in step S**303**), that is, in a case where a toner conveyance error has been detected, the control portion **8** determines that a toner conveyance error has occurred in the first toner replenishment path R**1** in use (step S**304**). Then, the control portion **8** causes the display portion **2***d* of the main body **2** to display cautions and messages such as "TONER CONVEYANCE ERROR DETECTED IN FIRST TONER REPLENISHMENT PATH," "MAINTENANCE REQUESTED," and the like (step S**305**).
[0103] Next, the control portion **8** switches to the second toner replenishment path R**2** to convey the toner (step S**306**). Thereafter, in steps from step S**306** through step S**308**, the control portion **8** performs, with respect to the second toner replenishment path R**2**, processing that is similar to the processing performed in steps from step S**301** through step S**304**.
[0104] Then, after determining the conveyance error in the toner conveyance performed by using the second toner replenishment path R**2** (step S**308**), the control portion **8** causes the display portion **2***d* of the main body **2** to display cautions and messages such as "TONER CONVEYANCE ERROR DETECTED IN SECOND TONER REPLENISHMENT PATH/APPARATUS STOPPED," "MAINTENANCE REQUESTED," and the like (step S**309**). Then, the control portion **8** ends the processing shown in FIG. **12**.
[0105] According to the above-described configuration, it becomes possible to appropriately detect, and make a determination as to, a toner conveyance error in the first toner replenishment path R**1** and the second toner replenishment path R**2**. Thus, it is possible, in the image forming apparatus **1**, to suppress interruptions in toner replenishment for the developing device **40** and to continue appropriate image formation. Furthermore, it is also possible, as to the toner conveyance path where a toner conveyance error has been determined, to notify the user of the toner conveyance error. This makes it possible, in the image forming apparatus **1**, to quickly urge the user to deal with the toner conveyance error.
[0106] The above-described embodiment is by no means meant to limit the scope of the present disclosure, and various modifications can be made and implemented within the scope not departing from the gist of the present disclosure.
[0107] For example, although, in the embodiment described above, it is assumed that the image forming apparatus **1** is what is called a tandem type color image forming apparatus in which images in a plurality of colors are formed so as to be sequentially superimposed on one another, the present disclosure is not limited to image forming apparatuses of such a type. The image forming apparatus may also be a non-tandem type color image forming apparatus for color printing or a monochrome image forming apparatus.

Claims

1. An image forming apparatus, comprising: a developing device that supplies toner to an image carrier; a container that contains the toner to be replenished to the developing device; a toner replenishment device that includes a plurality of toner replenishment paths through which the toner in the container is conveyed and replenished to the developing device; a toner conveyance detection portion that detects a toner conveyance error in toner conveyance performed by using the plurality of toner replenishment paths; and a control portion that controls operations of the developing device and the toner replenishment device, wherein in a case where the toner conveyance detection portion has detected the toner conveyance error in one of the toner replenishment paths that is in use, the control portion switches to another one of the toner replenishment paths to convey the toner.
2. The image forming apparatus according to claim 1, wherein the toner conveyance detection portion includes a toner amount detection portion that detects a toner amount in the developing

device, in the container, and in the plurality of toner conveyance paths, and the control portion detects, based on a result of detection performed by the toner amount detection portion, the toner conveyance error in one of the toner replenishment paths that is in use.

3. The image forming apparatus according to claim 2, wherein the toner amount detection portion includes an intermediate toner amount detection portion that detects the toner amount on the toner replenishment paths, and a container toner amount detection portion that detects the toner amount in the container, and in a case where the control portion has detected that the toner amount is smaller than a predetermined value by means of the intermediate toner amount detection portion and has also detected that the toner amount is larger than a predetermined value by means of the container toner amount detection portion, the control portion determines that the toner conveyance error has occurred.

4. The image forming apparatus according to claim 2, wherein the toner amount detection portion includes a developing toner amount detection portion that detects the toner amount by detecting a toner concentration in the developing device, and an intermediate toner amount detection portion that detects the toner amount on the toner replenishment paths, and in a case where the control portion has detected that the toner amount is smaller than a predetermined value by means of the developing toner amount detection portion and has also detected that the toner amount is larger than a predetermined value by means of the intermediate toner amount detection portion, the control portion determines that the toner conveyance error has occurred.

5. The image forming apparatus according to claim 2, wherein the container includes a first container and a second container, the toner in the first container and the toner in the second container being of a same color, and the toner replenishment device includes a first toner replenishment path through which the toner is conveyed from the first container toward the developing device, a second toner replenishment path through which the toner is conveyed from the second container toward the developing device, a confluence portion that is disposed at downstream ends of the first toner replenishment path and the second toner replenishment path in respective toner conveyance directions thereof so as to allow the toner to join together to flow into the developing device, a first intermediate toner amount detection portion that detects the toner amount on the first toner replenishment path, and a second intermediate toner amount detection portion that detects the toner amount on the second toner replenishment path.