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DEVELOPING DEVICE AND IMAGE FORMING APPARATUS

Abstract

A developing device includes a developer container, a conveying member, and a developer carrying member. The conveying member has a rotation shaft, a conveying blade, a cut portion, and a dispersing portion. In the cut portion, the conveying blade is partly cut off along the longitudinal direction of the developer container. The dispersing portion is formed on an outer circumferential part of the rotation shaft, so as to face the cut portion, and extends along the radial direction of the rotation shaft. The dispersing portion has a dispersing surface having an area larger than the sectional area of the conveying blade.

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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. 2024-021009 filed on Feb. 15, 2024, the contents of which are hereby incorporated by reference.

BACKGROUND

[0002] The present disclosure relates to a developing device and an image forming apparatus.

[0003] In image forming apparatuses employing an electrophotographic system, such as copiers and printers, it is common to supply toner to an electrostatic latent image formed on the outer circumferential surface of an image carrying member such as a photosensitive drum to develop it into a toner image that will subsequently be transferred to a sheet. The image forming apparatus conveys developer containing toner stored in a developer container while stirring it there, to continue to uniformly form an image.

SUMMARY

[0004] According to one aspect of the present disclosure, a developing device includes a developer container, a conveying member, and a developer carrying member. The developer container stores developer containing toner to be supplied to an image carrying member. The conveying member is rotatably supported on the developer container and conveys the developer while stirring it. The developer carrying member is rotatably supported on the developer container so as to face the image carrying member and supplies the toner in the developer container to the image carrying member. The conveying member has a rotation shaft, a conveying blade, a cut portion, and a dispersing portion. The rotation shaft extends along the longitudinal direction of the developer container. The conveying blade is helically formed on an outer circumferential part of the rotation shaft. In the cut portion, the conveying blade is partly cut off along the longitudinal direction. The dispersing portion has a dispersing surface that is formed on an outer circumferential part of the rotation shaft, so as to face the cut portion, and that extends along the radial direction of the rotation shaft. The dispersing surface has an area larger than the sectional area of the conveying blade.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

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

[0006] FIG. **2** is a schematic sectional front view around an image forming portion in the image forming apparatus in FIG. **1**.

[0007] FIG. **3** is a plan view, on a horizontal section, of a developing device of the image forming portion in FIG. **2**.

[0008] FIG. **4** is a side part view of a first conveying member in the developing device in FIG. **3**.

[0009] FIG. **5** is a side part view of the first conveying member as seen from the far side of FIG. **4**.

[0010] FIG. **6** is a perspective partial view of the first conveying member in FIG. **4**.

[0011] FIG. **7** is a side part view of a first conveying member in Modified Example 1.

[0012] FIG. **8** is a side part view of the first conveying member of Modified Example 1 as seen from the far side of FIG. **7**.

[0013] FIG. **9** is a side part view of a first conveying member in Modified Example 2.

[0014] FIG. **10** is a side part view of the first conveying member in Modified Example 2 as seen from the far side of FIG. **9**.

[0015] FIG. **11** is a side part view of a first conveying member in Modified Example 3.

DETAILED DESCRIPTION

[0016] Now, an embodiment of the present disclosure will be described with reference to the drawings. Note that the description below is not meant to limit the scope of the present disclosure.

[0017] FIG. **1** is a schematic sectional front view of an image forming apparatus **1** according to the embodiment. FIG. **2** is a schematic sectional front view around an image forming portion **20** in the image forming apparatus **1** in FIG. **1**. One example of the image forming apparatus **1** according to the embodiment is a tandem color printer that transfers a toner image to a sheet S using an intermediate transfer belt **31**. The image forming apparatus **1** can be what is called a multifunction peripheral having functions of, for example, printing, scanning (image reading), facsimile transmission, and the like.

[0018] As shown in FIGS. **1** and **2**, the image forming apparatus **1** includes, inside its body **2**, a sheet feeding portion **3**, a sheet conveying portion **4**, an exposure portion **5**, an image forming portion **20**, a transferring portion **30**, a fixing portion **6**, a sheet ejection portion **7**, and a control portion **8**.

[0019] The sheet feeding portion **3** is disposed in a bottom part of the body **2**. The sheet feeding portion **3** stores a plurality of unprinted sheets S and separates and feeds out one sheet S after another for printing. The sheet conveying portion **4** extends along the top-bottom direction along a side wall of the body **2**. The sheet conveying portion **4** conveys the sheet S fed from the sheet feeding portion **3** to a secondary transfer portion **33** and the fixing portion **6**, and ejects the sheet S after fixing through a sheet ejection port **4***a* to the sheet ejection portion **7**. The exposure portion **5** is disposed above the sheet feeding portion **3**. The exposure portion **5** exposes the image forming portion **20** to laser light controlled based on image data.

[0020] The image forming portion **20** is disposed above the exposure portion **5**, 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, an image forming portion **20**B for black. These four image forming portions **20** have basically the same configuration. Thus, in the following description, except when distinction is needed, the suffixes distinguishing the colors, “Y,” “C,” “M,” and “B,” are sometimes omitted.

[0021] The image forming portion **20** includes a photosensitive drum (an image carrying member) **21** that is supported so as to be rotatable in a predetermined direction (clockwise in FIGS. **1** and **2**). The image forming portion **20** further includes a charging portion **22**, a developing device **40**, and a drum cleaning portion **23** that are disposed around the photosensitive drum **21** along its rotational direction. Note that a primary transfer portion **32** is disposed between the developing device **40** and the drum cleaning portion **23**.

[0022] The photosensitive drum **21** is formed in the shape of a cylinder extending along a horizontal direction and has, on its outer circumferential surface, a photosensitive layer formed with, for example, an amorphous silicon photosensitive member. The charging portion **22** electrostatically charges the surface (outer circumferential surface) of the photosensitive drum **21** to a predetermined surface potential. The exposure portion **5** exposes the outer circumferential surface of the photosensitive drum **21** electrostatically charged by the charging portion **22** to light to form an electrostatic latent image based on a document image on the outer circumferential surface of the photosensitive drum **21**. The developing device **40** supplies toner to and thereby develops the electrostatic latent image to form a toner image. The four image forming portions **20** form toner images of different colors. The drum cleaning portion **23** performs cleaning by removing the residual toner and the like left on the outer circumferential surface of the photosensitive drum **21** after the primary transfer of the toner images to the outer circumferential surface of the intermediate transfer belt **31**. In this way, the image forming portion **20** forms the image (toner image) that will be subsequently transferred to the sheet S.

[0023] The transferring portion **30** includes the intermediate transfer belt **31**, the 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 so as to be rotatable in a predetermined direction (counterclockwise in FIG. **1**) and to which the toner images formed at the four image forming portions **20** are primarily transferred sequentially so as to be overlayed on each other. The four image forming portions **20** are disposed in what is called a tandem arrangement, in which they are arrayed in a row from upstream to downstream in the rotational direction of the intermediate transfer belt **31**.

[0024] The primary transfer portions **32**Y, **32**C, **32**M, and **32**B are disposed, across the intermediate transfer belt **31**, above the image forming portions **20**Y, **20**C, **20**M, and **20**B of the corresponding colors. The secondary transfer portion **33** is disposed upstream of the fixing portion **6** with respect to the sheet conveyance direction of the sheet conveying portion **4**, downstream of the four image forming portions **20**Y, **20**C, **20**M, and **20**B with respect to the rotational 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 rotational direction of the intermediate transfer belt **31**.

[0025] The primary transfer portion **32** transfers the toner image formed on the outer circumferential surface of the photosensitive drum **21** to the intermediate transfer belt **31**. In other words, the toner image is primarily transferred to the outer circumferential surface of the intermediate transfer belt **31** at the primary transfer portions **32**Y, **32**C, **32**M, and **32**B of the corresponding colors. Then as the intermediate transfer belt **31** rotates, with predetermined timing, the toner images of the four image forming portions **20** are transferred to the intermediate transfer belt **31** sequentially so as to be overlayed on each other to form a color toner image having the toner images of four colors, namely yellow, cyan, magenta, and black, overlayed on each other on the outer circumferential surface of the intermediate transfer belt **31**.

[0026] The color toner image on the outer circumferential surface of the intermediate transfer belt **31** is transferred to the sheet S synchronously fed by the sheet conveying portion **4** at a secondary transfer nip portion formed in the secondary transfer portion **33**. The belt cleaning portion **34** performs cleaning by removing foreign matter such as residual toner left on the outer circumferential surface of the intermediate transfer belt **31** after secondary transfer. In this way, the transferring portion **30** transfers (records) the toner image formed on the outer circumferential surface of the photosensitive drum **21** to the sheet S.

[0027] The fixing portion **6** is disposed above the secondary transfer portion **33**. The fixing portion **6** heats and presses the sheet S having the toner image transferred to it to fix the toner image to the sheet S.

[0028] The sheet ejection portion **7** is disposed above the transferring portion **30**. The sheet S having the toner image fixed to it and having undergone printing is conveyed to the sheet ejection portion **7**. In the sheet ejection portion **7**, the printed sheet (printed matter) can be retrieved upward.

[0029] The control portion **8** includes a CPU, an image processing portion, a memory, and other electronic circuits and components (none of which is shown). The CPU controls the operation of different components in the image forming apparatus **1** based on programs and data for control stored in the memory to perform processes related to the functions of the image forming apparatus **1**. The sheet feeding portion **3**, the sheet conveying portion **4**, the exposure portion **5**, the image forming portion **20**, the transferring portion **30**, and the fixing portion **6** individually receive instructions from the control portion **8** and operate together to perform printing on the sheet S. The memory is configured with a combination of a non-volatile memory device, such as a program ROM (read only memory) and a data ROM, and a volatile memory device, such as a RAM (random access memory).

[0030] Now, the configuration of the developing device **40** will be described with reference to FIG. **3** in addition to FIG. **2**. FIG. **3** is a plan view, on a horizontal section, of the developing device **40** of the image forming portion **20** in FIG. **2**. Note that the developing devices **40** for different colors

have basically the same configuration and thus, for their components, the suffixes distinguishing the colors will be omitted and no overlapping description will be repeated. In addition, in the following description, "axial direction" means the direction (the depth direction of the plane of FIG. **2**, the lateral, left-right direction in FIG. **3**) of the rotation axes of the photosensitive drum **21**, a first conveying member **42**, a second conveying member **43**, and a developing roller **44**, which extend parallel to each other.

[0031] The developing device **40** supplies toner to the outer circumferential surface of the photosensitive drum **21**. The developing device **40** is removably mounted in, for example, the body **2** of the image forming apparatus **1**. The developing device **40** includes a developer container **50**, the first conveying member **42**, the second conveying member **43**, the developing roller (developer carrying member) **44**, a regulation blade **45**, a toner concentration sensor **46**, a scraper **47**, and a holding portion (dispersing portion) **42***c*.

[0032] The developer container **50** is in an elongated shape extending along the axial direction of the photosensitive drum **21** and is disposed with its longitudinal direction horizontal. In other words, the longitudinal direction of the developer container **50** is parallel to the axial direction of the photosensitive direction **21**. The developer container **50** stores, as developer containing toner supplied to the photosensitive drum **21**, two-component developer containing toner and magnetic carrier, for example.

[0033] The developer container **50** has a partition portion **51**, a first conveyance chamber **52**, a second conveyance chamber **53**, a first communication portion **54**, and a second communication portion **55**.

[0034] The partition portion **51** is provided in a bottom part inside the developer container **50**. The partition portion **51** is disposed substantially in a middle part of the developer container **50** along a direction (the lateral, left-right direction in FIG. **2**, the top-bottom direction in FIG. **3**) intersecting its longitudinal direction. The partition portion **51** is formed substantially in the shape of a plate extending along the longitudinal and top-bottom directions of the developer container **50**. The partition portion **51** divides the inside of the developer container **50** into two parts lying beside each other along a direction intersecting the longitudinal direction.

[0035] The first and second conveyance chambers **52** and **53** are provided inside the developer container **50**. The first and second conveyance chambers **52** and **53** are formed as a result of the partition portion **51** dividing the developer container **50**. The first and second conveyance chambers **52** and **53** are disposed side by side at substantially the same height.

[0036] The second conveyance chamber **53** is disposed, in the developer container **50**, so as to include a space around the developing roller **44**, adjacent to the photosensitive drum **21**. The first conveyance chamber **52** is disposed, in the developer container **50**, in a region away from the photosensitive drum **21** across the second conveyance chamber **53**. The first conveyance chamber **52** has an opening as a developer supply port **52***a*, through which developer is supplied into the developer container **50**. The first conveyance chamber **52** has a first conveying member **42**, which conveys the developer in a first direction f**1**. The second conveyance chamber **53** has a second conveying member **43**, which conveys the developer in a second direction f**2**, that is, the direction opposite to the first direction f**1**.

[0037] The first and second communication portions **54** and **55** are disposed one beyond each end of the partition portion **51** along its longitudinal direction. Through the first and second communication portions **54** and **55**, the first and second conveyance chambers **52** and **53** communicate with each other in a direction intersecting the longitudinal direction of the partition portion **51** (lateral, left-right direction in FIG. **2**, top-bottom direction in FIG. **3**), that is., the thickness direction of the partition portion **51** substantially in the shape of a plate. In other words, through the first and second communication portions **54** and **55**, the first and second conveyance chambers **52** and **53** communicate with each other in opposite end parts of them in their longitudinal directions.

[0038] Through the first communication portion **54**, the downstream end of the first conveyance chamber **52** in the first direction f**1** communicates with the upstream end of the second conveyance chamber **53** in the second direction f**2**. In the first communication portion **54**, developer is conveyed from the first conveyance chamber **52** to the second conveyance chamber **53**. Through the second communication portion **55**, the downstream end of the second conveyance chamber **53** in the second direction f**2** communicates with the upstream end of the first conveyance chamber **52** in the first direction f**1**. In the second communication portion **55**, developer is conveyed from the second conveyance chamber **53** to the first conveyance chamber **52**.
[0039] The first conveying member **42** is disposed in the first conveyance chamber **52**. The second conveying member **43** is disposed in the second conveyance chamber **53**. The first and second conveying members **42** and **43** are disposed side by side substantially at the same height. The second conveying member **43** is disposed close to and extends parallel to the developing roller **44**. The first and second conveying members **42** and **43** are supported on the developer container **50** so as to be rotatable about axes extending in a horizontal direction, parallel to the developing roller **44**.
[0040] The first and second conveying members **42** and **43** have basically the same configuration. The first conveying member **42** has a first conveying blade **42***b* helically formed on an outer circumferential part of a rotation shaft **42***a* extending along the longitudinal direction of the developer container **50**. In the embodiment, the first conveying member **42** has two first conveying blades **42***b*. The second conveying member **43** has a second conveying blade **43***b* helically formed on an outer circumferential part of a rotation shaft **43***a* extending along the longitudinal direction of the developer container **50**. In the embodiment, the second conveying member **43** has two second conveying blades **43***b*.
[0041] In the first conveyance chamber **52**, the first conveying member **42** conveys developer while stirring it in the first direction f**1**, which points from the second communication portion **55** to the first communication portion **54** along the axis of rotation. In the second conveyance chamber **53**, the second conveying member **43** conveys developer while stirring it in the second direction f**2**, which points from the first communication portion **54** to the second communication portion **55** along the axis of rotation. Accordingly, the first and second conveying members **42** and **43** convey developer while stirring it in directions opposite to each other along their longitudinal direction to circulate the developer in a predetermined circulation direction.
[0042] The developing roller **44** is disposed, in the developer container **50**, above the second conveying member **43** so as to face the photosensitive drum **21**. The developing roller **44** is supported on the developer container **50** so as to be rotatable about an axis which extends parallel to the axis of the photosensitive drum **21**.
[0043] The developing roller **44** has a part of its outer circumferential surface exposed through the developer container **50** so as to face and lie close to the photosensitive drum **21**. The developing roller **44** carries, on its outer circumferential surface, toner to be supplied to the outer circumferential surface of the photosensitive drum **21** in a region where the developing roller **44** faces the photosensitive drum **21**. The developing roller **44** carries the toner in the second conveyance chamber **53** of the developer container **50** to supply it to the photosensitive drum **21**. In other words, the developing roller **44** makes the toner in the second conveyance chamber **53** adhere to an electrostatic latent image on the outer circumferential surface of the photosensitive drum **21** to form a toner image.
[0044] The regulation blade **45** is disposed upstream, in the rotation direction of the developing roller **44**, of the region where the developing roller **44** faces the photosensitive drum **21**. The regulation blade **45** is disposed close to and opposite the developing roller **44** with a predetermined gap between the tip of the regulation blade **45** and the outer circumferential surface of the developing roller **44**. The regulation blade **45** extends over the entire region of the developing roller **44** along its axial direction. The regulation blade **45** regulates the layer thickness of the developer carried on the outer circumferential surface of the developing roller **44** that passes through the gap

between the tip of the regulation blade **45** and the outer circumferential surface of the developing roller **44**.

[0045] The toner concentration sensor **46** is disposed in a wall portion of the first conveyance chamber **52** along its longitudinal direction (the first direction f**1**). The toner concentration sensor **46** is disposed opposite the first conveying member **42**. In the embodiment, the toner concentration sensor **46** is implemented with a headless sensor. The headless sensor as the toner concentration sensor **46** has its sensing surface embedded in the inner wall of the first conveyance chamber **52**. The toner concentration sensor **46** senses the concentration of toner in developer.

[0046] Specifically, the toner concentration sensor **46** is a sensor of a magnetic permeability sensing type that senses the change of the magnetic permeability of two-component developer to find toner concentration (the mixture ratio of toner T to carrier C in developer, i.e., T/C). As the ratio of toner to carrier in the developer in the first conveyance chamber **52** changes, the magnetic permeability also changes so that the output signal from the toner concentration sensor **46** changes accordingly. Based on the output signal from the toner concentration sensor **46**, the control portion **8** controls the starting and stopping of the supply of the developer (toner and carrier) to the developing device **40**.

[0047] In relation to the toner concentration sensor **46**, the first conveying member **42** has a scraper **47** fitted to it. The scraper **47** is fixed to the rotation shaft **42***a* of the first conveying member **42** via a holding portion **42***e* in the region opposite the toner concentration sensor **46**. The scraper **47** and its surroundings will be described in detail later.

[0048] As the first and second conveying members **42** and **43** rotates, the developer in the developer container **50** circulates between the first and second conveyance chambers **52** and **53** through the first and second communication portions **54** and **55** in the predetermined circulation direction. Meanwhile, the toner in the developer container **50** is stirred and electrostatically charged so as 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 its layer thickness regulated by the regulation blade **45** and is subsequently conveyed, as the developing roller **44** rotates, to the region where the developing roller **44** faces the photosensitive drum **21**. When a predetermined developing voltage is applied to the developing roller **44**, under the potential difference relative to the potential on 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 to the outer circumferential surface of the photosensitive drum **21** in the facing region. In this way, the electrostatic latent image on the outer circumferential surface of the photosensitive drum **21** is developed with toner.

[0049] The developer container **50** further has a discharging portion **56**. The discharging portion **56** is provided further downstream of the downstream end of the second conveyance chamber **53** in the second direction f**2**. The discharging portion **56** is connected to the second conveyance chamber **53**. The insides of the discharging portion **56** and the second conveyance chamber **53** communicate with each other. The inner diameter of the discharging portion **56** is smaller than that of the second conveyance chamber **53**. The discharging portion **56** has a developer discharge port **561**.

[0050] Note that the rotation shaft **43***a* of the second conveying member **43** extends continuously into the discharging portion **56**. One end of the rotation shaft **43***a* along its axial direction is rotatably supported on the developer container **50** at the downstream end of the discharging portion **56** with respect to the second direction f**2** along the second conveyance chamber **53**.

[0051] The developer discharge port **561** is disposed at the downstream end of the discharging portion **56** with respect to the second direction f**2** along the second conveyance chamber **53**. The developer discharge port **561** is open, for example, below the rotation shaft **43***a* of the second conveying member **43**. Through the developer discharge port **561**, excess developer in the developer container **50** is discharged out of it.

[0052] The second conveying member **43** further includes, along with the second conveying blade

43*b*, a regulation blade **43***c* and a discharging blade **43***d*. These three blades are provided in the order of, from the second conveyance chamber **53** to the discharging portion **56**, the second conveying blade **43***b*, the regulation blade **43***c*, and the discharging blade **43***d*. Like the second conveying blade **43***b*, the regulation blade **43***c* and the discharging blade **43***d* are provided integrally with the rotation shaft **43***a* and are helically formed along the axial direction of the rotation shaft **43***a* on its outer circumferential part.

[0053] The regulation blade **43***c* is disposed, in the second conveyance chamber **53**, downstream of the second conveying blade **43***b* with respect to the second direction f**2** along the second conveyance chamber **53**. The regulation blade **43***c* faces a connecting portion of the second conveyance chamber **53** with the discharge portion **56** along the axial direction of the rotation shaft **43***a*.

[0054] The regulation blade **43***c* winds in the opposite direction to the second conveying blade **43***b*. This allows regulation blade **43***c* to block the developer conveyed to around the downstream end of the second conveyance chamber **53** and thereby restrict the movement of the developer to the discharging portion **56**. Note that the pitch of the regulation blade **43***c* is smaller than that of the second conveying blade **43***b*.

[0055] An outer circumferential part of the regulation blade **43***c* forms a predetermined gap (clearance) with the inner surface of the developer container **50**. The developer exceeding a predetermined amount in the second conveyance chamber **53** is conveyed, as excess developer, toward the discharging portion **56** through the gap between the outer circumferential part of the regulation blade **43***c* and the inner surface of the developer container **50**.

[0056] The discharging blade **43***d* is disposed, in the discharging portion **56**, downstream of the regulation blade **43***c* with respect to the second direction f**2** along the second conveyance chamber **53**. The discharging blade **43***d* winds in the same direction as the second conveying blade **43***b*. In other words, the conveyance direction of developer in the discharging portion **56** is the same as the second direction f**2** along the second conveyance chamber **53**. Accordingly, the discharging blade **43***d* conveys excess developer in the discharging portion **56** toward the developer discharge port **561**. Note that the outer diameter of the discharging blade **43***d* is smaller than those of the second conveying blade **43***b* and the regulation blade **43***c*. The pitch of the discharging blade **43***d* is smaller than that of the second conveying blade **43***b*.

[0057] Now, the configuration of the developing device **40** will be described in more detail with reference to FIGS. **4**, **5**, and **6** in addition to FIG. **3**. FIG. **4** is a side part view of the first conveying member **42** in the developing device **40** in FIG. **3**. FIG. **5** is a side part view of the first conveying member **42** as seen from the far side of FIG. **4**. FIG. **6** is a perspective partial view of the first conveying member **42** in FIG. **4**.

[0058] As shown in FIGS. **4**, **5**, and **6**, the first conveying member **42** has a cut portion **42***c*. As shown in FIG. **3**, the cut portion **42***c* is formed in a region opposite the toner concentration sensor **46**. In the cut portion **42***c* located in the region opposite the toner concentration sensor **46**, the first conveying blade **42***b* is partly cut off along the longitudinal direction (the first direction f**1**). Note that, in the embodiment, in the cut portion **42***c*, two first conveying blades **42***b*A and **42***b*B are cut off over different lengths from each other along the axial direction of the rotation shaft **42***a* (the lateral, left-right directions in FIGS. **4** and **5**).

[0059] With the above configuration, since the first conveying blade **42***b* has the cut portion **42***c* in the region opposite the toner concentration sensor **46**, even at an increased developer conveyance speed, developer easily stagnates near the toner concentration sensor **46**. This helps stabilize the sensing value of toner concentration and makes it possible to maintain an adequate amount of toner in the developer container **50**.

[0060] The scraper **47** is, in the cut portion **42***c*, fixed to the rotation shaft **42***a* of the first conveying member **42** via a fitting portion **42***d*. As shown in FIG. **6**, the scraper **47** is formed in the shape of a fan as seen from the axial direction of the rotation shaft **42***a*. The scraper **47** is disposed

substantially at the same inclination as the first conveying blade **42***b*, which is helical with respect to the axial direction of the rotation shaft **42***a*.

[0061] The scraper **47** can be implemented with a base member formed of a flexible film (clastic member) such as a PET (polyethylene terephthalate) film of which the surface is laid with a sheet of fabric such as felt or unwoven fabric. The scraper **47**, by rotating together with the rotation shaft **42***a*, moves the developer opposite the toner concentration sensor **46**. New developer is then supplied to the region opposite the toner concentration sensor **46**.

[0062] With the above configuration, since the scraper **47** is provided in the cut portion **42***c*, excessive stagnation of developer near the toner concentration sensor **46** can be avoided. This makes it possible to properly sense the toner concentration in the developer container **50**.

[0063] The fitting portion **42***d* is disposed, like the scraper **47**, substantially at the same inclination as the first conveying blade **42***b*, which is helical with respect to the axial direction of the rotation shaft **42***a*. The fitting portion **42***d* is, in the cut portion **42***c*, provided integrally with an outer circumferential part of the rotation shaft **42***a*. Note that, while in the embodiment, the fitting portion **42***d* is provided integrally with the rotation shaft **42***a*, it can be provided as a member separate from the rotation shaft **42***a*.

[0064] In each end part of the fitting portion **42***d* along the axial direction, a holding portion (dispersing portion) **42***e* that holds the scraper **47** is formed. The holding portion **42***e* grips and holds the scraper **47** substantially along the axial direction of the rotation shaft **42***a*.

[0065] The holding portion (dispersing portion) **42***c* has, in each end part of it in the circumferential direction of the rotation shaft **42***a*, a circumferential end surface (dispersing surface) **42***f* extending in the radial direction of the rotation shaft **42***a*. In other words, the circumferential end surface (dispersing surface) **42***f* is formed on an outer circumferential part of the rotation shaft **42***a*, so as to face the cut portion **42***c* and extends along the radial direction of the rotation shaft **42***a*. As shown in FIG. **5**, the area of the circumferential end surface **42***f* is larger than the sectional area of the first conveying blade **42***b* (**42***b*A).

[0066] With the above configuration, since the area of the circumferential end surface **42***f* as the dispersing surface is larger than the sectional area of the first conveying blade **42***b*, in the holding portion **42***c* as the dispersing portion, developer can be supplied in a direction (e.g., the circumferential direction of the rotation shaft **42***a*) different from the conveyance direction (the first direction f**1**) of developer by the first conveying blade **42***b*. In other words, in the holding portion **42***c*, the dispersion (stirring) of developer can be promoted. This improves the dispersibility of developer in the developer container **50** and makes it possible to uniformly form an image with suppressed uneven density.

[0067] As shown in FIG. **5**, the circumferential end surface **42***f* is formed parallel to the axial direction of the rotation shaft **42***a* and points in a direction substantially orthogonal to the axial direction of the rotation shaft **42***a*. With this configuration, in the holding portion **42***e* as the dispersing portion, developer can be supplied in a direction orthogonal to the conveyance direction (first direction f**1**) of developer by the first conveying blade **42***b*, that is, in the circumferential direction of the rotation shaft **42***a*. This helps more effectively promote the dispersion (stirring) of developer in the holding portion **42***c*.

[0068] The circumferential end surface **42***f* is disposed at the edge, so as to face the cut portion **42***c*, of the holding portion **42***e* that holds the scraper **47**.

[0069] With the above configuration, since the holding portion **42***e* that holds the scraper **47** has the circumferential end surface (dispersing surface) **42***f*, it is possible to enhance the effect of moving the developer near the toner concentration sensor **46** by the action of the circumferential end surface **42***f* moving as the rotation shaft **42***a* rotates. This helps avoid excessive stagnation of developer near the toner concentration sensor **46**. In this way, it is possible to properly sense the toner concentration as well as to improve the dispersibility of developer in the developer container **50**.

[0070] By using the holding portion **42***e* of the scraper **47** as the dispersing portion for improving the dispersibility of developer, it is possible to secure a sufficient area to accommodate the holding portion **42***e*. This helps give the holding of the scraper **47** increased holding strength.

[0071] Now, the effects of the embodiment will be described. Table 1 shows the results of an evaluation of the conveyance speed and the dispersibility of developer in the developing devices of practical and comparative examples. For each of the developing devices **40** of the practical examples and the developing devices of the comparative examples, an evaluation was made of the effect of the area factor of the dispersing surface (assuming that the sectional area of the conveying blade=1.0) on the conveyance speed and the dispersibility of developer.

TABLE-US-00001 TABLE 1 AREA FACTOR OF DISPERSING SURFACE (WITH SECTIONAL AREA OF CONVEYANCE DISPERS- CONVEYING SPEED IBILITY BLADE = OF OF 1.0) DEVELOPER DEVELOPER COMPARATIVE 1.0 GOOD POOR EXAMPLE 1 PRACTICAL 1.5 GOOD GOOD EXAMPLE 1 PRACTICAL 3.0 GOOD GOOD EXAMPLE 2 PRACTICAL 6.0 GOOD GOOD EXAMPLE 3 PRACTICAL 9.0 GOOD GOOD EXAMPLE 4 COMPARATIVE 10.0 POOR GOOD EXAMPLE 2

[0072] The area factor of the dispersing surface of the first conveying member in the developing device of Comparative Example 1 was 1.0 as compared with the sectional area of the first conveying blade of the first conveying member, that is, those areas were equal. The area factors of the dispersing surface (the circumferential end surface **42***f*) of the first conveying member **42** in the developing devices **40** of Practical Examples 1, 2, 3, and 4 were respectively 1.5, 3.0, 6.0, and 9.0 as compared with the sectional area of the first conveying blade **42***b* of the first conveying member **42**. The area factor of the dispersing surface of the first conveying member in the developing device of Comparative Example 2 was 10.0 as compared with the sectional area of the first conveying blade of the first conveying member.

[0073] With respect to Table 1, printing was performed with a print ratio of 40% per sheet surface; if the developer conveyance speed exceeded a rate at which a sufficient amount of developer could be supplied, the developer conveyance speed was evaluated as “GOOD”; if the developer conveyance speed was equal to or less than that rate, the developer conveyance speed was evaluated as “POOR”. In addition, a predetermined amount of developer was supplied through the developer supply port **52***a* in the developing device **40**; if the mixture ratio of toner to carrier (T/C) in the developer having reached a downstream part of the first conveying member **42** in the conveyance direction of developer (where the toner concentration sensor **46** is disposed) had a difference within 1% from the T/C obtained after complete dispersion, the developer dispersibility was evaluated as “GOOD”; if it had a difference of 1% or more, the developer dispersibility was evaluated as “POOR.”

[0074] According to Table 1, with the configuration of Comparative Example 1, since the area factor of the dispersing surface of the first conveying member equals to the sectional area of the first conveying blade, while the conveyance speed of developer is sufficient, the dispersibility of developer is unsatisfactory. With the configuration of Comparative Example 2, since the area factor of the dispersing surface of the first conveying member is 10.0 as compared with the sectional area of the first conveying blade, while the dispersibility of developer is sufficient, the conveyance speed of developer is unsatisfactory. This results from the dispersing surface being so configured as to block the gap between the conveying blades adjacent along the axial direction, hampering developer from moving in the conveyance direction, and causing an extreme drop in the conveyance speed of developer.

[0075] With the configurations of Practical Examples 1, 2, 3, and 4, the evaluation results are good both in the conveyance speed and the dispersibility of developer. That is, setting the area of the dispersing surface (the circumferential end surface **42***f*) of the first conveying member **42** to be 1.4 to 9 times the sectional area of the first conveying blade **42***b* helps maintain sufficient dispersibility of developer without adversely affecting the conveyance speed of developer.

[0076] Now, modified examples of a developing device **40** will be described.
[0077] FIG. **7** is a side part view of a first conveying member **42** in Modified Example 1. FIG. **8** is a side part view of the first conveying member **42** of Modified Example 1 as seen from the far side of FIG. **7**. The first conveying member **42** of Modified Example 1 has a holding portion (dispersing portion) **42***e* of a scraper **47** formed only at one side of the scraper **47** with respect to the axial and circumferential directions of the rotation shaft **42***a*, that is, at the right side in FIG. **7** (at the left side in FIG. **8**). In other words, the circumferential end surface (dispersing surface) **42***f* is formed at one place on the rotation shaft **42***a* with respect to its axial direction.
[0078] Also with the above configuration of Modified Example 1, as with the embodiment described previously with reference to FIGS. **4**, **5**, and **6**, the dispersion (stirring) of developer can be promoted in the holding portion **42***e*. This improves the dispersibility of developer in the developer container **50** and makes it possible to uniformly form an image with suppressed uneven density.
[0079] Providing dispersing surfaces (dispersion portions) for developer at three or more places necessitates providing many cut portions **42***c* in the first conveying member **42**, and this requires the first conveying blade **42***b* to be divided at more places. This may lead to difficulty in conveying developer. In order to obtain a suitable conveyance speed combined with a suitable dispersibility of developer, it is preferable to form the dispersing surface (dispersing portion) for developer at one or two places on the rotation shaft **42***a* with respect to its axial direction.
[0080] If the scraper **47** is provided on the conveying member, it is preferable to provide the holding portion (dispersing portion) **42***e* at each end of the scraper **47** along its axial direction. This helps give the holding of the scraper **47** increased holding strength.
[0081] FIG. **9** is a side part view of a first conveying member **42** in Modified Example 2. FIG. **10** is a side part view of the first conveying member **42** in Modified Example 2 as seen from the far side of FIG. **9**. The first conveying member **42** in Modified Example 2 has two first conveying blades **42***b*A and **42***b*B; while one first conveying blades **42***b*B has a cut portion **42***c* and a fitting portion **42***d* (holding portion **42***e*), the other first conveying blade **42***b*A does not. In the region of the first conveying blade **42***b*B where the cut portion **42***c* and the fitting portion **42***d* (holding portion **42***e*) are provided, the first conveying blade **42***b*A extends continuously along the axial direction.
[0082] Also with the above configuration of Modified Example 2, as with the embodiment described previously with reference to FIGS. **4**, **5**, and **6**, the dispersion (stirring) of developer can be promoted in the holding portion **42***e*. This improves the dispersibility of developer in the developer container **50** and makes it possible to uniformly form an image with suppressed uneven density.
[0083] FIG. **11** is a side part view of a first conveying member **42** in Modified Example 3. The first conveying member **42** in Modified Example 3 does not have either a scraper **47** or a fitting portion **42***d* (holding portion **42***e*) like those in the above embodiment. The first conveying member **42** in Modified Example 3 has two first conveying blades **42***b*A and **42***b*B; while one first conveying blades **42***b*A has a cut portion **42***c*; the other first conveying blades **42***b*B does not. The first conveying blade **42***b*B extends continuously along the axial direction.
[0084] The cut portion **42***c* is formed one at two places apart from each other on the first conveying blade **42***b*A along its axial direction. The first conveying blade **42***b*A has two dispersing portions **42***g* that include dispersing surfaces **42***h* disposed so as to face the cut portions **42***c* at those two places respectively. The two dispersing surfaces **42***h* are formed at opposite end parts of a region of the first conveying blade **42***b*A between the two cut portions **42***c* along its axial direction.
[0085] The two dispersing surfaces **42***h* are formed on an outer circumferential part of a rotation shaft **42***a*, extends along the radial direction of the rotation shaft **42***a*, and has an area larger than the sectional area of the other part of the first conveying blade **42***b*A. The dispersing surfaces **42***h* are formed orthogonally to the extension direction of the first conveying blade **42***b*A, which helically extends. In other words, the dispersing surfaces **42***h* are formed so as to incline with

respect to the axial direction of the rotation shaft **42***a*.
[0086] Also with the configuration of the above Modified Example 3, as with the embodiment described previously with reference to FIGS. **4**, **5**, and **6**, the dispersion (stirring) of developer is promoted in the dispersing portion **42***g*. This improves the dispersibility of developer in the developer container **50** and makes it possible to uniformly form an image with suppressed uneven density.
[0087] The dispersing portion **42***g* (dispersing surface **42***h*) for developer can be formed only at one side along the axial direction. In the region of the first conveying blade **42***b*A between the two cut portions **42***c* along the axial direction, the other first conveying blades **42***b*B too can have a cut portion formed in it as a region where no part of the first conveying blade **42***b*B lies.
[0088] While an embodiment of the present disclosure is described herein, it is not meant to limit the scope of the present disclosure, which can thus be implemented with various modifications made without departing from the spirit of the present disclosure.

Claims

1. A developing device comprising: a developer container that stores developer containing toner to be supplied to an image carrying member; a conveying member that is rotatably supported on the developer container, the conveying member conveying the developer while stirring the developer; and a developer carrying member that is rotatably supported on the developer container so as to face the image carrying member, the developer carrying member supplying the toner in the developer container to the image carrying member, wherein the conveying member has: a rotation shaft that extends along a longitudinal direction of the developer container; a conveying blade that is helically formed on an outer circumferential part of the rotation shaft; a cut portion in which the conveying blade is partly cut off along the longitudinal direction; and a dispersing portion having a dispersing surface formed on an outer circumferential part of the rotation shaft, so as to face the cut portion, and extending along a radial direction of the rotation shaft, the dispersing surface having an area larger than a sectional area of the conveying blade.
2. The developing device according to claim 1, wherein the area of the dispersing surface is 1.4 to 9 times the sectional area of the conveying blade.
3. The developing device according to claim 1, wherein the dispersing surface is formed on a side surface of the conveying blade so as to face the cut portion.
4. The developing device according to claim 1, wherein the dispersing surface is formed parallel to an axial direction of the rotation shaft.
5. The developing device according to claim 1, wherein the dispersing surface is formed at one or two places on the rotation shaft with respect to an axial direction thereof.
6. The developing device according to claim 1 further comprising: a toner concentration sensor that is disposed in a wall portion of the developer container along a longitudinal direction thereof, opposite the conveying member, the toner concentration sensor sensing a concentration of the toner in the developer, wherein the conveying member has: the cut portion that is formed in a region opposite the toner concentration sensor; a scraper that is fixed to the rotation shaft in the cut portion, the scraper moving the developer opposite the toner concentration sensor; and a holding portion that is formed on the rotation shaft in the cut portion, the holding portion holding the scraper and serving as the dispersing portion, and the holding portion extends along the radial direction of the rotation shaft on each end part of the rotation shaft in a circumferential direction thereof, the holding portion having the dispersing surface disposed at an edge facing the cut portion.
7. An image forming apparatus comprising the developing device according to claim 1.