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(71) Applicant:
MITA INDUSTRIAL CO. LTD.
Osaka-shi Osaka 540 (JP)

(72) Inventors:
• Hazama, Hiroyuki
Tamatsukuri, Chuo-ku, Osaka 540 (JP)
• Hamakawa, Hiroyuki
Tamatsukuri, Chuo-ku, Osaka 540 (JP)

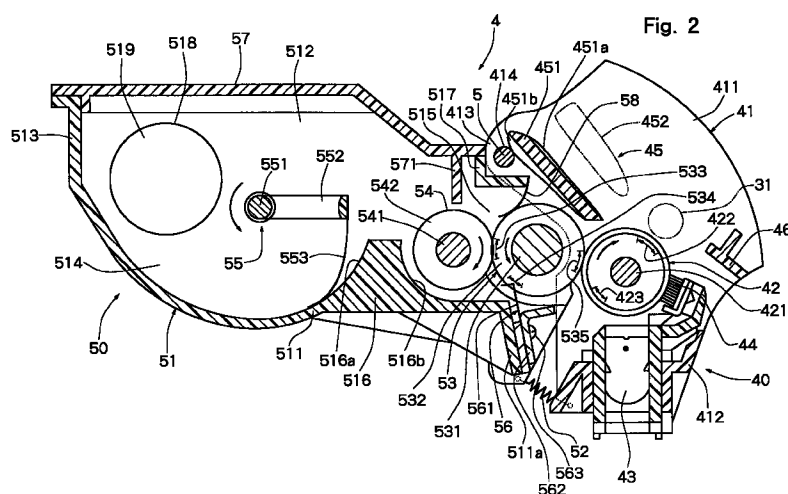
• Watanabe, Masaru
Tamatsukuri, Chuo-ku, Osaka 540 (JP)
• Terada, Takashi
Tamatsukuri, Chuo-ku, Osaka 540 (JP)
• Ogawa, Hirotugu
Tamatsukuri, Chuo-ku, Osaka 540 (JP)
• Maeshima, Masanobu
Tamatsukuri, Chuo-ku, Osaka 540 (JP)

(74) Representative:
Müller-Boré & Partner
Patentanwälte
Grafinger Strasse 2
81671 München (DE)

(54) Latent electrostatic image developing device in image forming machine

(57) A latent electrostatic image developing device of an image forming machine, comprising a developing roller (53) disposed in a development housing (51) for applying in a developing zone a developer to a latent electrostatic image formed on a photoconductor drum (42), a makeup roller (54) for supplying a developer to the peripheral surface of the developing roller (53) in a developer holding zone, and a developer regulating means (56) for regulating the amount of the developer,

held on the peripheral surface of the developing roller (53), in a developer regulating zone. The developing roller (53) is rotationally driven from below to above in the developing zone. The developing roller (53) and the makeup roller (54) are both rotationally driven from above to below in the developer holding zone. The developer regulating means (56) is disposed below the developing roller (53).



Description

Field of the Invention

The present invention relates to a latent electrostatic image developing device for developing a latent electrostatic image to a toner image in an image forming machine such as an electrostatic copier or a laser printer.

Description of the Prior Art

Wide use has been made of a latent electrostatic image developing device of the type which develops a latent electrostatic image, formed on the peripheral surface of a photoconductor drum in an image forming machine, to a toner image by use of a developer comprising a one-component toner. This type of latent electrostatic image developing device is disclosed, for example, in Japanese Laid-Open Patent Publication No. 36277/95. The latent electrostatic image developing device disclosed in this publication has a development housing; a developing roller disposed in the development housing, and adapted to hold a developer on its peripheral surface in a developer holding zone and to convey the held developer to a developing zone opposite a photoconductor drum for applying the developer to a latent electrostatic image; a makeup roller disposed in the development housing, and adapted to supply a developer to the peripheral surface of the developing roller in the developer holding zone; and a developer regulating means for regulating the amount of the developer, held on the peripheral surface of the developing roller, in a developer regulating zone positioned between the developer holding zone and the developing zone. The developing roller is adapted to be rotationally driven from above to below in the developing zone. Thus, the developer regulating zone is positioned above the developer holding zone, so that the developer regulating means is disposed above the developing roller.

Generally, the developing roller is composed of a synthetic rubber material such as urethane rubber. Thus, the peripheral surface of the developing roller is shaved in an upper region by the developer regulating means pressed against this surface. Its shavings are conveyed to the developing zone to damage the photosensitive layer of the photoconductor drum. When the developer regulating means is composed of a rubber blade, on the other hand, the rubber blade is shaven, and the shavings are carried to the developing zone, similarly damaging the photosensitive layer of the photoconductor drum.

To solve these problems, an idea would be to rotationally drive the developing roller from below to above in the developing zone, and to position the developer regulating zone below the developer holding zone. This constitution would pose the following problem: The developer stuck to the peripheral surface of the developing roller in the developer holding zone and scraped off

in the developer regulating zone is accumulated on the bottom wall of the development housing. The accumulation of the developer below the nip between the developing roller and the makeup roller causes malfunction of the developer regulating means. As a result, a uniform, thin layer of developer cannot be formed on the peripheral surface of the developing roller.

Summary of the Invention

A principal technical challenge for the present invention is to provide a latent electrostatic image developing device capable of preventing damage to the photosensitive layer of the photoconductor drum by shavings formed by the friction between the developing roller and the developer regulating means, while preventing the malfunction of the developer regulating means.

To solve this principal technical challenge, the present invention provides a latent electrostatic image developing device of an image forming machine, which comprises a development housing; a developing roller disposed in the development housing, and adapted to hold a developer on its peripheral surface in a developer holding zone and to convey the held developer to a developing zone opposite a photoconductor drum for applying the developer to a latent electrostatic image; a makeup roller disposed in the development housing, and adapted to supply a developer to the peripheral surface of the developing roller in the developer holding zone; and a developer regulating means for regulating the amount of the developer, held on the peripheral surface of the developing roller, in a developer regulating zone positioned between the developer holding zone and the developing zone; wherein

the developing roller is rotationally driven from below to above in the developing zone, and the developing roller and the makeup roller are both rotationally driven from above to below in the developer holding zone, and the developer regulating means is disposed below the developing roller.

The present invention also provides a latent electrostatic image developing device of an image forming machine in which the peripheral speed of the makeup roller is set to be higher than the peripheral speed of the developing roller.

Brief Description of the Drawings

Fig. 1 is a front view schematically showing a printer having mounted thereon a process unit including an embodiment of a latent electrostatic image developing device constructed in accordance with the present invention; and

Fig. 2 is a sectional view of the process unit including the latent electrostatic image developing device

of Fig. 1.

Detailed Description of the Preferred Embodiments

An embodiment of a latent electrostatic image developing device of an image forming machine constructed in accordance with the present invention will be described in detail with reference to the accompanying drawings. In the illustrated embodiment, a printer will be taken as an example of the image forming machine equipped with the latent electrostatic image developing device constructed in accordance with the invention.

Fig. 1 schematically shows a printer 2 which has mounted thereon an embodiment of a process unit equipped with the latent electrostatic image developing device constructed in accordance with the invention. In this embodiment, the printer 2 is a compact, slow-speed laser printer for use as a printer for a word processor, and has a machine housing 20 molded from a plastic material. This machine housing 20 includes an upwardly open box-shaped housing body 21, and a cover 23 mounted turnably on a shaft 22 disposed at the top of the housing body 21. At nearly the center of the machine housing 20 so constructed, a process unit 4 is mounted detachably.

The process unit 4, as shown in Fig. 2, has a photoconductor unit 40, and a developing unit 50, as a latent electrostatic image developing device, pivotably supported at an upper part of the photoconductor unit 40 via a support shaft 5. The photoconductor unit 40 has a photoconductor support means 41. The photoconductor support means 41 has a pair of side wall members 411 arranged with spacing in the back-and-forth direction (the direction perpendicular to the sheet face of Fig. 2) (only the rear side wall member is shown in Fig. 2), and a connecting member 412 which connects together lower parts of the pair of side wall members 411. The so constructed photoconductor support means 41 is integrally molded from a plastic material. At the upper end parts, on the developing unit 50 side, of the pair of side wall members 411 constituting the photoconductor support means 41, support portions 413 having mounting holes 414 are provided. By inserting the support shaft 5 made of a metal bar material, which is disposed in a development housing (to be described later on) of the developing unit 50, into the mounting holes 414 provided in the support portions 413, the photoconductor unit 40 and the developing unit 50 are supported so as to be pivotable relative to each other.

The photoconductor unit 40 has a photoconductor drum 42 having a photosensitive layer on its peripheral surface. The photoconductor drum 42 has its rotating shaft 421 rotatably supported by the pair of side wall members 411 constituting the photoconductor support means 41, and rotationally driven by a drive means (not shown) in the direction of an arrow, i.e., from below to above in a developing zone, the site of contact (the site of nip) with a developing roller (to be described later on) of the developing unit 50. On the connecting member

412 of the photoconductor support means 41, a charging corona discharger 43 is disposed opposite the lower peripheral surface of the photoconductor drum 42. Upstream from the charging corona discharger 43 in the direction of rotation of the photoconductor drum 42, a paper dust removing brush 44 is disposed in contact with the peripheral surface of the photoconductor drum 42.

Between the pair of side wall members 411 constituting the photoconductor support means 41, there is disposed a lower guide plate 451 constituting one of a pair of pre-transfer guide plates 45 for guiding a transfer sheet, which is fed from upper left in Fig. 2, toward a transfer zone 422 on the peripheral surface of the photoconductor drum 42. This lower guide plate 451 is molded integrally with the pair of side wall members 411. On the top surface of the lower guide plate 451, a plurality of guide ribs 451a are integrally molded with spacing in the longitudinal direction (the direction perpendicular to the sheet face of Fig. 2). On the bottom surface of the lower guide plate 451, too, a plurality of reinforcing ribs 451b are integrally molded with spacing in the longitudinal direction (the direction perpendicular to the sheet face of Fig. 2). These reinforcing ribs 451b are adapted to contact the support shaft 5. Thus, the lower guide plate 451 can be prevented from deflecting because of the contact of the reinforcing ribs 451b with the support shaft 5, even when a pressing force acts on the top surface of the lower guide plate 451 in an attempt to cause its deflection. The lower guide plate 451 can also function as a connecting member for connecting together the upper parts of the pair of side wall members 411 constituting the photoconductor support means 41, thereby improving the rigidity and strength of the photoconductor support means 41. In the illustrated embodiment, moreover, the lower guide plate 451 is molded integrally with the pair of side wall members 411, so that it can maintain a highly precise positional relationship with the photoconductor drum 42 supported rotatably on the pair of side wall members 411.

Between the pair of side wall members 411 constituting the photoconductor support means 41, a post-transfer guide plate 46 is disposed for guiding the transfer sheet, undergoing transfer in the transfer zone 422, to a fixing means to be described later on. The post-transfer guide plate 46 is molded integrally with the pair of side wall members 411. Thus, the post-transfer guide plate 46 can function as a connecting member for connecting together the pair of side wall members 411 constituting the photoconductor support means 41, thereby improving the rigidity and strength of the photoconductor support means 41.

Next, the developing unit 50 as a latent electrostatic image developing device will be described. The developing unit 50 in the illustrated embodiment has a development housing 51 accommodating a developer comprising a one-component toner. The development housing 51 is composed of a bottom wall 511, a front side wall 512 and a rear side wall 512 (only the rear side

wall is shown in Fig. 2) erected upright from the front and rear ends of the bottom wall 511 (the ends in the direction perpendicular to the sheet face of Fig. 2), and a left side wall 513. These walls are integrally molded from a plastic material, defining an agitation chamber 514 and a development chamber 515. On the bottom wall 511 constituting the development housing 51, a partition wall 516 provided in the back-and-forth direction (the direction perpendicular to the sheet face in Fig. 2) is integrally molded between the agitation chamber 514 and the development chamber 515. The left and right surfaces of the partition wall 516 are formed as arcuate guide surfaces 516a and 516b. Between the front and rear side walls 512 constituting the development housing 51, a connecting member 517 disposed in an upper part on the development chamber 515 side is provided integrally with the front and rear side walls 512. In the rear side wall 512 constituting the development housing 51, a toner supply hole 518 is formed. The toner supply hole 518 is fitted with a cap 519. In an upper end part, on the development chamber 515 side, of the so constructed development housing 51, the support shaft 5 is disposed so as to pass through the front and rear side walls 512. By fitting both end parts of the support shaft 5 into the mounting holes 414 provided in the support portions 413 of the pair of side wall members 411 constituting the photoconductor support means 41 of the photoconductor unit 40, the photoconductor unit 40 and the developing unit 50 are supported so as to be pivotable relative to each other. Between a front end site of a lower end part of the photoconductor support means 41 of the photoconductor unit 40 and a rear end site of a lower end part of the development housing 51, coiled springs 52 are interposed as spring means. These coiled springs 52 urge the photoconductor support means 41 and the development housing 51 toward each other about the support shaft 5. The development housing 51 is open upwards and rightwards, i.e., on the photoconductor unit 40 side.

Inside the development housing 51, a developing roller 53, a makeup roller 54, an agitating means 55 and a developer regulating means 56 are disposed.

The developing roller 53 is disposed in the development chamber 515 of the development housing 51, and includes a rotating shaft 531 mounted rotatably on the front and rear side walls 512 constituting the development housing 51, and a solid synthetic rubber roller 532 secured to the outer peripheral surface of the rotating shaft 531. The rotating shaft 531 may be formed of a suitable metallic material such as stainless steel. The solid synthetic rubber roller 532 is composed of a relatively flexible and conductive material, e.g., conductive solid synthetic rubber such as urethane rubber. In the illustrated embodiment, the surface roughness of the peripheral surface of the solid synthetic rubber roller 532, i.e., the 10-point average roughness R_z defined in JIS B 0601, is set at 5.0 to 12.0. The volume resistivity of the solid synthetic rubber roller 532 is set at about 10^4 to $10^9 \Omega \cdot \text{cm}$. The roller hardness of the solid synthetic

rubber roller 532 is set at an Asker hardness of 60 to 80 in the illustrated embodiment. The so constructed roller 532 of the developing roller 53 is exposed through the right-hand opening formed in the development housing 51, and positioned opposite the photoconductor drum 42. The peripheral surface of the roller 532 constituting the developing roller 53 is pressed against the peripheral surface of the photoconductor drum 42 in the developing zone. At the nip in this pressed condition, the peripheral surface of the roller 532 is compressed slightly elastically. The rotating shaft 531 of the developing roller 53 is rotationally driven by a drive means (not shown) in the direction of an arrow, i.e., from below to above in the developing zone, the site of contact between the roller 532 and the photoconductor drum 42. In accordance with this rotation of the rotating shaft 531, the roller 532 is also rotationally driven in the direction of the arrow, so that the peripheral surface of the roller 532 is sequentially moved through a developer holding zone 533, a developer regulating zone 534, and a developing zone 535. In the illustrated embodiment, a constant voltage of 300V is applied to the rotating shaft 531 of the developing roller 53.

The makeup roller 54 is disposed parallel to the developing roller 53 inside the development chamber 515 of the development housing 51. The makeup roller 54 includes a rotating shaft 541 mounted rotatably on the front and rear side walls 512 constituting the development housing 51, and a roller 542 secured to the outer peripheral surface of the rotating shaft 541. The rotating shaft 541, like the rotating shaft 531 of the developing roller 53, may be formed of a suitable metallic material, such as stainless steel. The roller 542 is composed of a foam such as silicone foam or urethane foam. The roller 542 is pressed against the roller 532 of the developing roller 53 in the developer holding zone 533, the nip between the roller 542 and the developing roller 53. The hardness of the foam constituting the roller 542 of the makeup roller 54 is much smaller than the hardness of the roller 532 constituting the developing roller 53 (for example, an Asker hardness of about 35), and it is desirable that by being pressed against the roller 532 of the developing roller 53, the roller 542 be elastically compressed in the nip region by about 0.1 to 0.6 mm. The roller 542 also has conductivity, and its volume resistivity is set at about 10^2 to $10^6 \Omega \cdot \text{cm}$. The rotating shaft 541 of the developing roller 54 is rotationally driven by a drive means (not shown) in the direction of an arrow, i.e., from above to below in the developer holding zone 533, the nip between the roller 542 and the roller 532 of the developing roller 53. In accordance with this rotation of the rotating shaft 541, the roller 542 is also rotationally driven in the direction of the arrow. In the illustrated embodiment, a constant voltage of 450V, a higher voltage than the voltage applied to the developing roller 53, is applied to the rotating shaft 541 of the makeup roller 54.

The peripheral speed V1 of the photoconductor drum 42, the peripheral speed V2 of the developing

roller 53, and the peripheral speed V3 of the makeup roller 54 are set in the relationship $V1 < V2 < V3$. In the illustrated embodiment, the relation between the peripheral speed V1 of the photoconductor drum 42 and the peripheral speed V2 of the developing roller 53 is set to be $1.2V1 \leq V2 \leq 2.5V1$, while the relation between the peripheral speed V2 of the developing roller 53 and the peripheral speed V3 of the makeup roller 54 is set to be $1.0V2 \leq V3 \leq 2.0V2$. If the peripheral speed V2 of the developing roller 53 is less than $1.2V1$, the supply of a developer to the photoconductor drum 42 will be insufficient, and the density of an image may lower. If the peripheral speed V2 of the developing roller 53 is less than $1.2V1$, moreover, there will be a decline in the scraping action of the developing roller 53 on the non-transferred developer that adheres to the photoconductor drum 42 after transfer. Thus, the non-transferred developer cannot be removed from the photoconductor drum 42, potentially causing a so-called offset fog. If the peripheral speed V2 of the developing roller 53 is more than $2.5V1$, on the other hand, the drive torque of the developing roller 53 will increase, possibly causing a scatter of the developer by a centrifugal force. Besides, if the peripheral speed V3 of the makeup roller 54 is less than $1.0V2$, the supply of a developer to the developing roller 53 will be insufficient, and image density may lower. If the peripheral speed V3 of the makeup roller 54 is less than $1.0V2$, moreover, there will be a weak scraping action of the makeup roller 54 on the peripheral surface of the developing roller 53. In case the non-transferred developer adhering to the photoconductor drum 42 after transfer adheres to the developing roller 53, therefore, this adherent developer will be difficult to remove. The adherent developer may generate a ghost in a subsequent development. If the peripheral speed V3 of the makeup roller 54 is more than $2.0V2$, on the other hand, the drive torque of the makeup roller 54 will increase. Simultaneously, the developer will strongly tend to rest above the nip between the makeup roller 54 and the developing roller 53, possibly causing an insufficient supply of the developer to the developing roller 53.

In the agitation chamber 514 of the development housing 51, an agitating means 55 is disposed. The agitating means 55 is disposed parallel to the makeup roller 54, and includes a rotating shaft 551 mounted rotatably on the front and rear side walls 512 constituting the development housing 51, an agitating member 552 fixed to the rotating shaft 551, and an elastic agitating sheet member 553 mounted to the agitating member 552. The agitating member 552 is formed of a plastic material, and has a plurality of openings in the longitudinal direction (the direction perpendicular to the sheet face of Fig. 2). The agitating sheet member 553 is formed of a flexible, elastic material, such as polyethylene terephthalate (PETP), and is secured by an adhesive or the like to the front edge of the agitating member 552. The so constructed agitating means 55 is rotationally driven continuously by a drive means (not shown) in

the direction of an arrow in Fig. 2.

The developer regulating means 56 has a flexible, elastic blade 561 to be pressed against the peripheral surface of the roller 532 constituting the developing roller 53. The blade 561 is composed of, say, a stainless steel plate or a spring steel plate about 0.1 to 0.2 mm thick, and has nearly the same longitudinal dimension as the length of the roller 532 constituting the developing roller 53. The blade 561 has a base end part mounted on a blade mounting portion 511a provided at the open end, on the photoconductor unit 40 side, of the bottom wall 511 constituting the development housing 51. That is, the base end part of the blade 561 is sandwiched between the blade mounting portion 511a and a press plate 562, and is fixed thereto by means of a machine screw 563. A front end part of the blade 561 is bent, and this bend is pressed against the peripheral surface of the roller 532 constituting the developing roller 53 in the developer regulating zone 534.

On the development housing 51, a closure 57 is mounted which covers the open top of the development housing 51 and constitutes part of the development housing 51. The closure 57 is composed of a plastic material, and is secured by an adhesive to the top surfaces of the front and rear side walls 512, the left side wall 513 and the connecting member 517 that constitute the development housing 51. On the inner surface of the closure 57, a regulating portion 571 is integrally molded which extends in the back-and-forth direction (the direction perpendicular to the sheet face of Fig. 2) at a position opposite the makeup roller 54, and which protrudes on the development chamber 515 side. Between the lower end of the regulating portion 571 and the outer peripheral surface of the roller 542 constituting the makeup roller 54, a predetermined spacing is provided. In the illustrated embodiment, the connecting member 517 constituting the development housing 51 is mounted with a sheet-like seal member 58. The sheet-like seal member 58 is composed of a flexible, elastic sheet member of, say, polyethylene terephthalate (PETP), and has nearly the same length as the axial length of the roller 532 constituting the developing roller 53. The sheet-like seal member 58 has one end part secured to the connecting member 517 by a securing means such as an adhesive, and has the other end part curved and elastically contacted with the peripheral surface of the roller 532 constituting the developing roller 53. The so constructed sheet-like seal member 58 prevents a scatter of the developer from the opening, on the photoconductor unit 40 side, of the development housing 51 in cooperation with the blade 561 of the developer regulating means 56.

The so constructed process unit 4 is mounted detachably on the machine housing 20 of the printer 2, as shown in Fig. 1. That is, the cover 23 constituting the machine housing 20 of the printer 2 is turned about the shaft 22 counterclockwise in Fig. 1, whereby the top of the housing body 21 constituting the machine housing 20 is opened. Then, the process unit 4 is mounted

inside the housing body 21 from above. Inside the housing body 21, a positioning means (not shown) capable of placing the photoconductor unit 40 of the process unit 4 at a predetermined position is provided. After the process unit 4 is mounted inside the housing body 21 of the machine housing 20, the cover 22 is turned about the shaft 22 clockwise in Fig. 1 to close the top of the housing body 21.

As shown in Fig. 1, a laser unit 24 is disposed in a lower part of the housing body 21 constituting the machine housing 20 of the printer 2. This laser unit 24 throws laser light, corresponding to print data from, say, a word processor connected to the printer 2, upon the photosensitive layer of the photoconductor drum 42 in an exposure zone 423 of the process unit 4, thereby forming a latent electrostatic image. In the housing body 21 constituting the machine housing 20 of the printer 2, a fixing roller pair 25 is disposed downstream from the post-transfer guide plate 46. Downstream from the fixing roller pair 25, a discharge roller pair 26 is disposed. Furthermore, a copy receiving or discharge tray 27 is disposed downstream from the discharge roller pair 26.

On the cover 23 constituting the machine housing 20 of the printer 2, a feed tray 28 for bearing a transfer sheet is disposed at an upper left part in Fig. 2. Downstream from the feed tray 28, a feed roller 29 is disposed. This feed roller 29 is rotationally driven by a drive means (not shown) in the direction of an arrow in Fig. 2. Opposite the feed roller 29, a friction pad 30 for sheet separation is disposed. In the transfer zone 422, a non-contact transfer roller 31 is disposed opposite the photoconductor drum 42. The transfer roller 31 is formed of a conductive urethane foam, and rotatably supported on the cover 23. The transfer roller 31 has opposite end parts mounted with collars (not shown) which are composed of an insulating material, such as synthetic resin, and each of which has a larger outside diameter than the diameter of the transfer roller 31. These collars are disposed in contact with the peripheral surface of the photoconductor drum 42. Thus, the transfer roller 31 is caused to follow the rotation of the photoconductor drum 42 while slipping. The clearance between the peripheral surface of the transfer roller 31 and the peripheral surface of the photoconductor drum 42 is set at about 0.5 mm. A constant voltage of, say, 10 μ A is applied to the so constructed transfer roller 31. On the cover 23, an upper guide plate 452 constituting the other component of the pre-transfer guide plate pair 45 is disposed.

The printer 2 in the illustrated embodiment is constructed as described above. Its actions will be described below.

Based on a print command from a word processor or the like (not shown), the above-described members start operation, and the photosensitive layer on the surface of the photoconductor drum 42 is charged substantially uniformly to a specific polarity by the charging corona discharger 43. Then, the laser unit 24 throws laser light, corresponding to the print data from the word

processor or the like, upon the surface of the charged photosensitive layer of the photoconductor drum 42, thereby forming a latent electrostatic image there. The latent electrostatic image formed on the photosensitive layer of the photoconductor drum 42 is developed to a toner image by the developing action of the developing unit 50. The developing action of the developing unit 50 will be described in detail later on. Transfer sheets laid on the feed tray 28 are fed one by one by the action of the feed roller 29 and the friction pad 30. The fed transfer sheet is guided by the pre-transfer guide plate pair 45, and conveyed to the transfer zone 422 where the photoconductor drum 42 and the transfer roller 31 are opposite to each other. Thus, the toner image formed on the photoconductor drum 42 is transferred to the surface of the transfer sheet. The transfer sheet, having the toner image transferred thereto in this fashion, is guided by the post-transfer guide plate 46 to be carried to the fixing roller pair 25. The transfer sheet having the toner image heat-fixed by the fixing roller pair 25 is discharged onto the discharge tray 27 by the discharge roller pair 26.

The developing action of the developing unit 50 will be described.

After the start of operation of the developing unit 50, the developing roller 53, makeup roller 54 and agitating means 55 are rotationally driven by drive means (not shown) in the directions of the arrows. In accordance with the rotation of the agitating member 552 and agitating sheet member 553, constituting the agitating means 55, in the direction of the arrow, the developer accommodated in the agitation chamber 514 is passed over the partition wall 516 while being agitated, whereafter the developer is fed into the development chamber 515 from above the makeup roller 54. On this occasion, the amount of the developer fed into the development chamber 515 is controlled by the regulating portion 571 formed on the inner surface of the closure 57 so that this amount will not be excessive. The developer so supplied by the agitating means 55 is borne on the roller 542 of the makeup roller 54, and carried to the nip between the roller 542 and the roller 532 of the developing roller 53, which is also the developer holding zone 533. The makeup roller 54 and the developing roller 53, as described above, rotate in the developer holding zone 533, the nip, in the same direction, from above to below. Thus, the supply of the developer from the makeup roller 54 to the developing roller 53 is adequate, preventing lack of the developer. Since the makeup roller 54 and the developing roller 53, as described above, rotate in the same direction in the developer holding zone 533, the nip, moreover, they can be driven reliably without requiring a great drive force.

The developer sent to the developer holding zone 533, the nip between the makeup roller 54 and the developing roller 53, is conveyed toward the developer regulating zone 534 while being held on the peripheral surface of the roller 532 constituting the developing roller 53. At this time, the makeup roller 54 and the

developing roller 53 rotate in the same direction, from above to below, in the developer holding zone 533, the nip, as described earlier. The developer also passes through the nip, remains held on the developing roller 53, and moves to the developer regulating zone 534 and the developing zone 535. When passing through the nip, the developer is fully rubbed against the makeup roller 54 and the developing roller 53 and fully charged, thus preventing the occurrence of a fog.

In the developer regulating zone 534, the blade 561 of the developer regulating means 56 acts on the developer held on the peripheral surface of the roller 532 of the developing roller 53 to restrict the developer held on the peripheral surface of the roller 532 to a required amount and form it into a thin layer. The developer, which has been regulated by the blade 561 of the developer regulating means 56 in the developer regulating zone 534 and scraped off onto the bottom wall 511 of the development housing 51, does not remain stationary, but is conveyed along the guide surface 516b of the partition wall 516, because the makeup roller 54 is rotated in the direction of the arrow.

As described above, the developer is held on the peripheral surface of the roller 532 constituting the developing roller 53 in the developer holding zone 533, and formed into a thin layer by the action of the blade 561 of the developer regulating means 56 in the developer regulating zone 534. Then, this developer is conveyed to the developing zone 535 in accordance with the rotation in the direction of the arrow.

In the developing zone 535, the developer is applied to the latent electrostatic image on the electrostatic photoconductor disposed on the peripheral surface of the photoconductor drum 42, whereby the latent electrostatic image is developed to a toner image. For example, the latent electrostatic image has a non-image area charged to about +600V, and an image area charged to about +120V, and a toner as the developer is caused to adhere to the image area (reversal development). The photoconductor drum 42 and the developing roller 53 are rotationally driven in the directions of the arrows in Fig. 2. In the developing zone 535, therefore, the peripheral surface of the photoconductor drum 42 and the peripheral surface of the roller 532 constituting the developing roller 53 are both moved in the same direction, from below to above. Since the peripheral speed V2 of the roller 532 and the peripheral speed V1 of the photoconductor drum 42 are set in the relationship $1.2V1 \leq V2 \leq 2.5V1$, a sufficient amount of the developer is carried to the developing zone 535 by the roller 532 of the developing roller 53. Also, the rubbing action of the peripheral surface of the roller 532 on the peripheral surface of the photoconductor drum 42 properly peels off the developer that has once adhered to the non-image area of the latent electrostatic image. Hence, a satisfactory image having an appropriate development density and free from fog can be obtained. The developer after use that has passed through the developing zone 535 while being held on the peripheral

surface of the roller 532 constituting the developing roller 53, on the other hand, is passed on to the surface of the makeup roller 54 at the nip between the developing roller 53 and the makeup roller 54. The peripheral speed of the makeup roller 54 is set to be greater than the peripheral speed of the developing roller 53. Therefore, as the developer is shifted to the makeup roller 54 at the nip, the non-transferred developer adhering to the developing roller 53 during passage through the developing zone 535 can be decreased in adherence, and recovered. Hence, a ghost ascribed to the non-transferred developer adhering to the developing roller 53 can be prevented.

The latent electrostatic image developing device according to the present invention has been described based on the embodiments in which it is applied to a printer. However, the present invention is in no way limited to the illustrated embodiments. The invention is applicable, for instance, to an electrostatic copier, and various changes or modifications are possible without departing from the scope of the technical concept of the invention.

Since the latent electrostatic image developing device according to the present invention is constructed as described above, it exhibits the following actions and effects:

According to this invention, the developing roller is rotationally driven from below to above in the developing zone; the developing roller and the makeup roller are both rotationally driven from above to below in the developer holding zone; and the developer regulating means is disposed below the developing roller. Thus, shavings of the developing roller or the developer regulating means formed by the friction between the developing roller and the developer regulating means immediately fall, and are not carried to the developing zone positioned upwardly of the developer regulating means. Hence, damage to the photoconductor by such shavings can be prevented, and the occurrence of black dots in the transferred image due to the shavings can be prevented. When the developing roller is rotationally driven from above to below in the developer holding zone, and the developer regulating means is disposed below the developing roller as stated above, the developer scraped off by the developer regulating means may be accumulated on the bottom wall of the development housing. However, the makeup roller is rotationally driven from above to below in the developer holding zone, so that the scraped developer is not accumulated, but conveyed along the bottom wall of the development housing in accordance with the rotation of the makeup roller. Thus, the developer is not stagnant below the nip between the developing roller and the makeup roller. This can prevent the malfunction of the developer regulating means ascribed to the stagnation of the developer below the nip between the developing roller and the makeup roller.

According to the present invention, moreover, the developing roller and the makeup roller rotate in the

same direction, from above to below, in the developer holding zone, the nip between the two rollers. Thus, the supply of the developer from the makeup roller to the developing roller is adequate, preventing lack of the developer. Besides, this invention permits the developing roller and the makeup roller to rotate in the same direction, from above to below, in the developer holding zone, the nip, as described earlier. The developer also passes through the nip, remains held on the developing roller, and moves to the developer regulating zone and the developing zone. When passing through the nip, the developer is fully rubbed against the makeup roller and the developing roller and fully charged, thus preventing the occurrence of a fog. In addition, the developing roller and the makeup roller rotate in the same direction in the developer holding zone, the nip. Thus, they can be driven reliably without requiring a great drive force.

According to the invention, furthermore, the peripheral speed of the makeup roller is set to be greater than the peripheral speed of the developing roller. Therefore, as the developer is shifted to the makeup roller at the nip, the non-transferred developer adhering to the developing roller during passage through the developing zone can be decreased in adherence, and recovered. Hence, a ghost ascribed to the non-transferred developer adhering to the developing roller can be prevented.

Claims

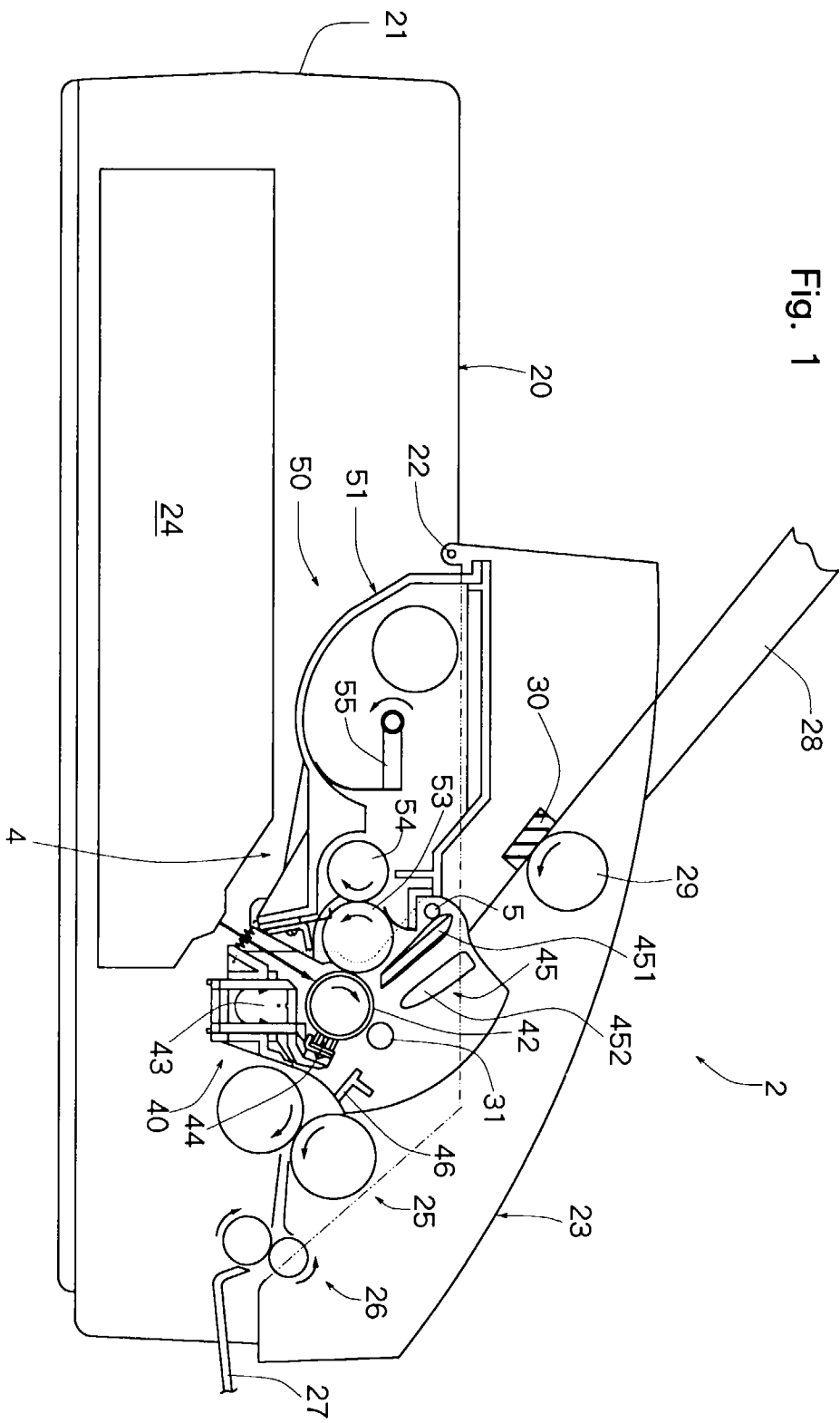
1. A latent electrostatic image developing device of an image forming machine, which comprises a development housing; a developing roller disposed in the development housing, and adapted to hold a developer on its peripheral surface in a developer holding zone and to convey the held developer to a developing zone opposite a photoconductor drum for applying the developer to a latent electrostatic image; a makeup roller disposed in the development housing, and adapted to supply a developer to the peripheral surface of the developing roller in the developer holding zone; and developer regulating means for regulating the amount of the developer, held on the peripheral surface of the developing roller, in a developer regulating zone positioned between the developer holding zone and the developing zone; wherein

the developing roller is rotationally driven from below to above in the developing zone, and the developing roller and the makeup roller are both rotationally driven from above to below in the developer holding zone, and the developer regulating means is disposed below the developing roller.

2. A latent electrostatic image developing device of an image forming machine as claimed in claim 1, wherein the peripheral speed of the makeup roller

is set to be higher than the peripheral speed of the developing roller.

Fig. 1



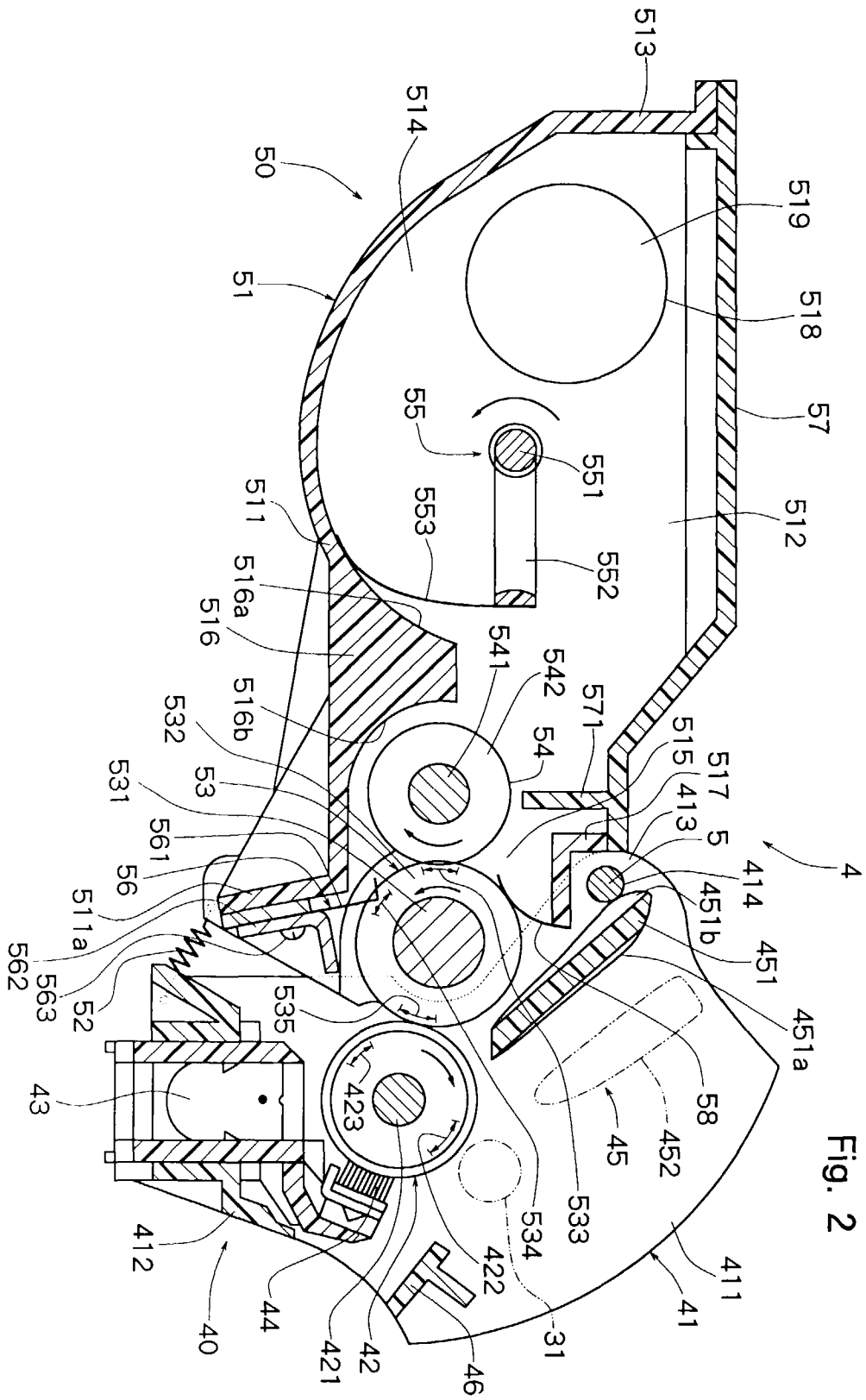


Fig. 2



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 10 8825

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 5 451 713 A (SUZUKI KOJI ET AL) 19 September 1995 * column 14, line 21-48; figure 39 * * column 17, line 65 - column 20, line 2 * ---	1,2	G03G15/08
X	PATENT ABSTRACTS OF JAPAN vol. 095, no. 005, 30 June 1995 & JP 07 044011 A (TOSHIBA CORP), 14 February 1995, * abstract * ---	1	
X	EP 0 451 982 A (JAPAN IMAGING SYST KK) 16 October 1991 * page 4, line 53 - page 6, line 10 * * page 6, line 16-21 * * page 12, line 25 - page 13, line 2; figures 1,2 * ---	1,2	
A	US 4 378 158 A (KANBE JUNICHIRO) 29 March 1983 * column 2, line 36 - column 3, line 39 * * column 4, line 64-67; figures 1,4 * -----	1,2	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			G03G
The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 27 August 1997	Examiner Thirlwell, K
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

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