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(54) **CLEANER UNIT AND IMAGE FORMING APPARATUS INCLUDING THE SAME**

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(57) **ABSTRACT**

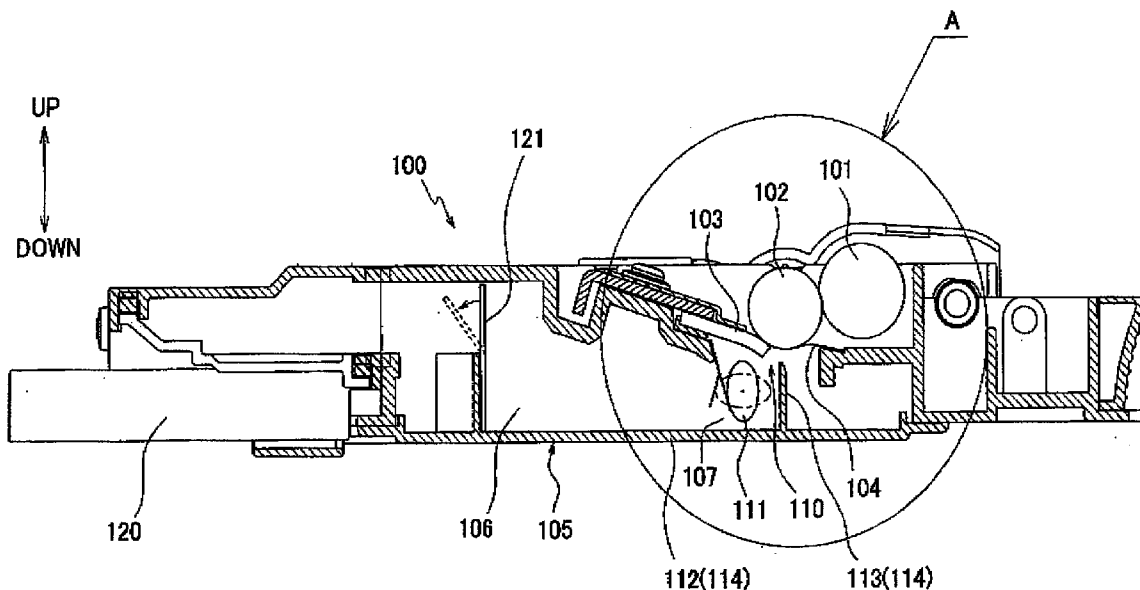
A cleaner unit includes a cleaner roller, a cleaner shaft, a blade, a toner container, and a toner squeeze pump. The cleaner roller collects toner adhered to a surface of a belt to a surface of the cleaner roller. The cleaner shaft collects the toner adhered to the surface of the cleaner roller to a surface of the cleaner shaft. The blade scrapes off the toner adhered to the surface of the cleaner shaft. The toner squeeze pump delivers the toner scraped off by the blade toward an opening of a storage space and compresses the toner stored in the storage space. A part of a bottom wall of the toner container which continues from the opening extends in a substantially horizontal direction, when the cleaner unit is attached to an image forming apparatus.

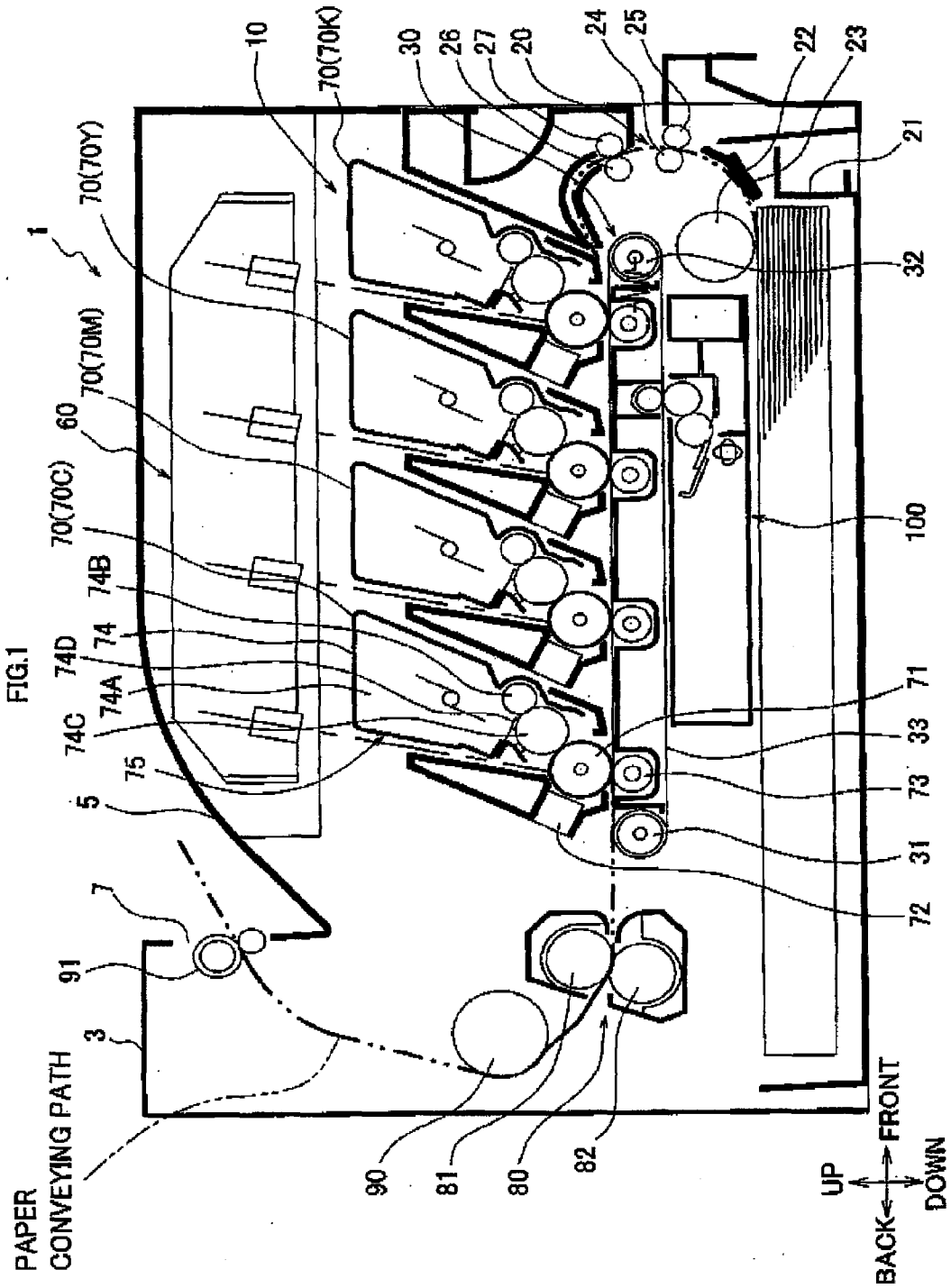
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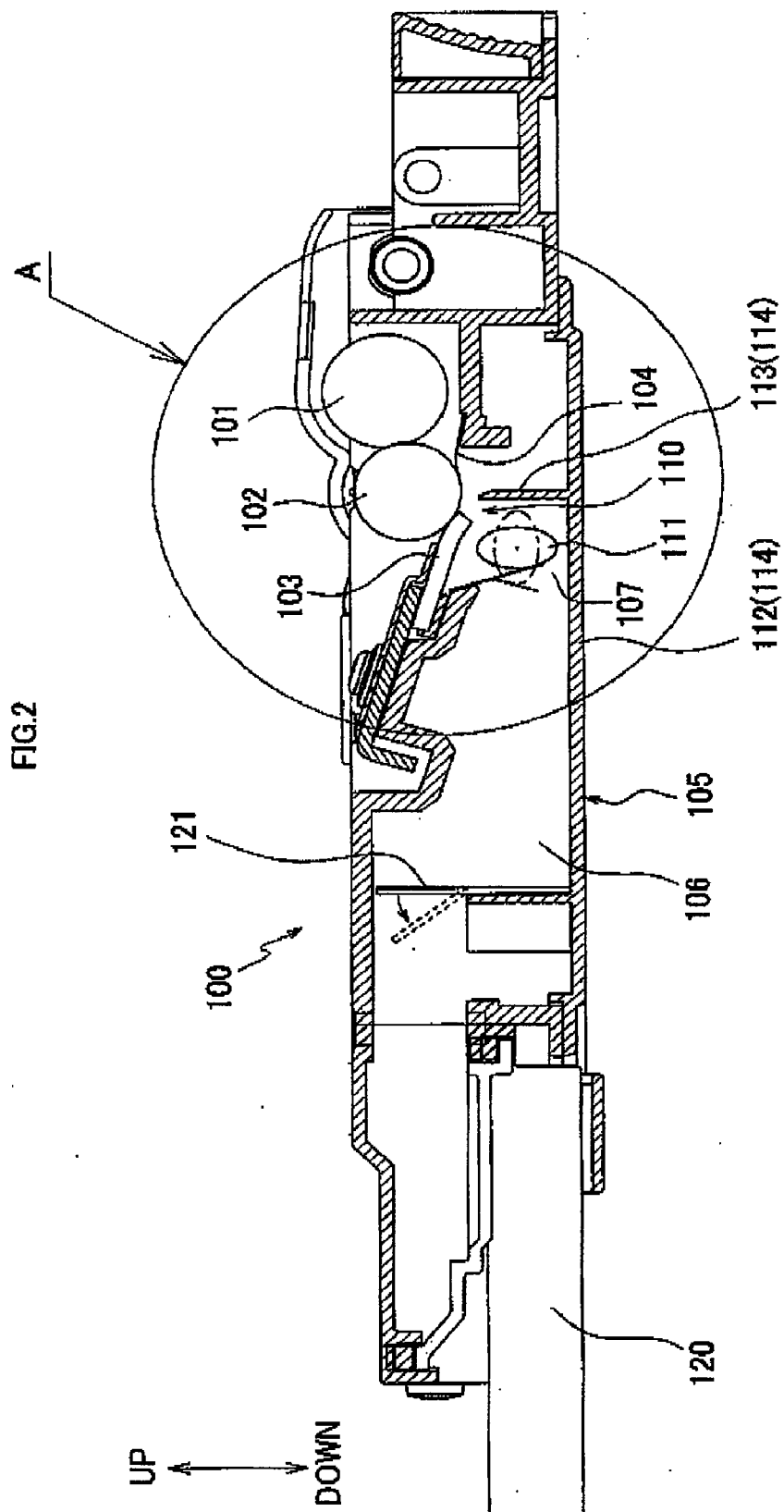


FIG.3

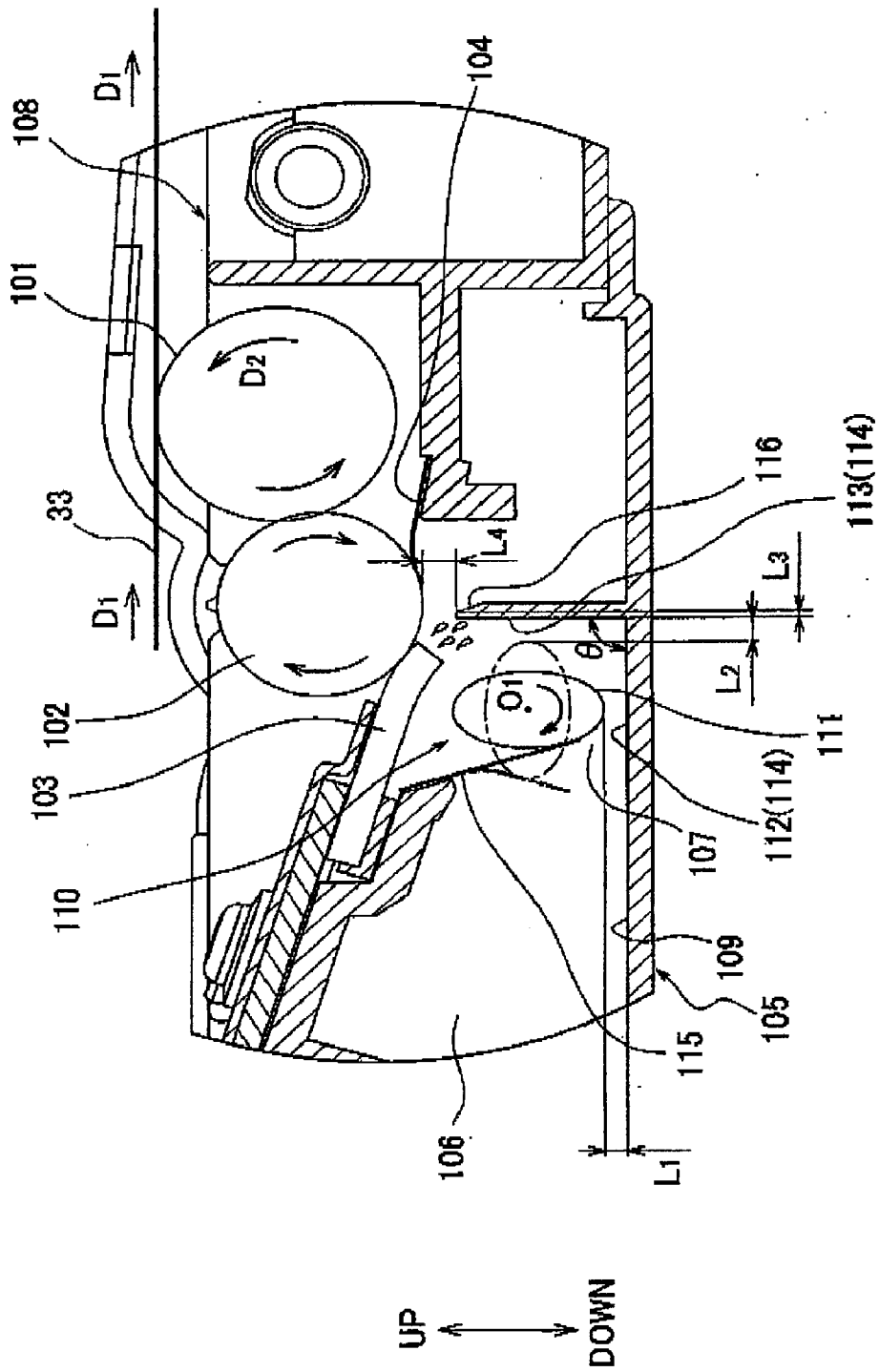


FIG.4

EXP NO	DIAMETER OF ELLIPTIC ROTOR	θ	L1	L2	
1	10 mm	90°	3 mm	1.5 mm	WASTE TONER UNCONVEYABLE
2	10 mm	90°	2 mm	1.5 mm	WASTE TONER CONVEYABLE
3	10 mm	90°	1 mm	1.5 mm	WASTE TONER CONVEYABLE
4	10 mm	90°	0.5 mm	1.5 mm	WASTE TONER CONVEYABLE BUT LARGE ROTARY TORQUE IN ELLIPTIC ROTOR
5	10 mm	135°	2 mm	1 mm	WASTE TONER HEAPED UP ON WALL AND UNCONVEYABLE
6	10 mm	135°	1 mm	1 mm	WASTE TONER HEAPED UP ON WALL AND UNCONVEYABLE
7	10 mm	135°	0.5 mm	1 mm	WASTE TONER HEAPED UP ON WALL AND UNCONVEYABLE

FIG.5

EXP NO	DIAMETER OF ELLIPTIC ROTOR	θ	
2	10 mm	90°	WASTE TONER CONVEYABLE
8	8 mm	135°	WASTE TONER HEAPED UP ON WALL AND UNCONVEYABLE
9	8 mm	110°	WASTE TONER HEAPED UP ON WALL AND UNCONVEYABLE

FIG.6

EXP NO	DIAMETER OF ELLIPTIC ROTOR	θ	L2	L3	L4	
10	10 mm	90°	3.4 mm	1 mm	L4	WASTE TONER HEAPED UP BETWEEN ROTOR AND WALL AND UNCONVEYABLE / WASTE TONER ACCUMULATES IN L4 PART (TONER ACCUMULATED IN L4 PART RUNS ON TO TONER ON WALL)
11	10 mm	90°	2.4 mm	1 mm		WASTE TONER HEAPED UP BETWEEN ROTOR AND WALL AND UNCONVEYABLE / WASTE TONER ACCUMULATES IN L4 PART (TONER ACCUMULATED IN L4 PART RUNS ON TO TONER ON WALL)
12	10 mm	90°	1.9 mm	1 mm		WASTE TONER HEAPED UP BETWEEN ROTOR AND WALL AND UNCONVEYABLE / WASTE TONER ACCUMULATES IN L4 PART (TONER ACCUMULATED IN L4 PART RUNS ON TO TONER ON WALL)
13	10 mm	90°	1.4 mm	1 mm		WASTE TONER HEAPED UP BETWEEN ROTOR AND WALL AND UNCONVEYABLE / WASTE TONER ACCUMULATES IN L4 PART (TONER ACCUMULATED IN L4 PART RUNS ON TO TONER ON WALL)
14	10 mm	90°		0.1 mm	1.5 mm	SUBTLE LEAK OF WASTE TONER TO OPPOSITE SIDE OF WALL / NO ACCUMULATION OF WASTE TONER IN L4 PART
15	10 mm	90°		0.1 mm	2.5 mm	LEAK OF WASTE TONER TO OPPOSITE SIDE OF WALL / NO ACCUMULATION OF WASTE TONER IN L4 PART

CLEANER UNIT AND IMAGE FORMING APPARATUS INCLUDING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Japanese Patent Application No. 2006-95015 filed Mar. 30, 2006 in the Japan Patent Office, the disclosure of which is incorporated herein by reference.

BACKGROUND

[0002] This invention relates to an electrophotographic image forming apparatus.

[0003] Electrophotographic image forming apparatus are known to transfer toner (developer) onto a recording medium such as a recording sheet and an OHP sheet to form an image onto the recording medium. During the transfer, however, part of the supplied toner is likely to adhere to a photosensitive drum and a conveyor mechanism belt to form waste toner.

[0004] If printing (image formation) is performed with the photosensitive drum and the conveyor mechanism belt to which the waste toner adhered, the waste toner is retransferred onto the reverse side of the recording medium. An undesirable image may be formed onto the recording medium.

[0005] A conventional electrophotographic image forming apparatus is therefore provided with a waste toner container that collects the waste toner so as to avoid forming an undesirable image onto the recording medium.

SUMMARY

[0006] The larger the capacity of the waste toner container, the more of the waste toner can be collected in the container. As a result, exchange frequency of the container can be reduced. Utility for a user is improved. However, in order to include a large container in an image forming apparatus, the image forming apparatus has to be undesirably increased in size. The size of the image forming apparatus may be larger than preferred.

[0007] In the aforementioned image forming apparatus, the waste toner container may be formed to be flat so that the height of the container remains short but the capacity of the container can be expanded in a horizontal direction. A conveying roller may be also provided at the entrance of the container for the purpose of conveying the collected toner to the waste toner container. However, it is difficult to convey the waste toner to the inner part of the container even in use of the conveying roller. A dead space is created in the container in which the waste toner can never be stored.

[0008] In the aforementioned image forming apparatus, volumetric efficiency is small between the waste toner container and the waste toner actually stored. Thus, the waste toner container has to be elongated in a vertical direction so as to store a sufficient amount of waste toner.

[0009] Accordingly, in the aforementioned image forming apparatus, there is a problem that the waste toner container, that is, the image forming apparatus, may be increased in size.

[0010] It would be desirable that an image forming apparatus can be reduced in size in a vertical direction while allowing to store a sufficient amount of waste toner.

[0011] A cleaner unit may be detachable from an electrophotographic image forming apparatus provided with a belt. It would be desirable that the cleaner unit includes a cleaner roller, a cleaner shaft, a blade, a toner container, and a toner squeeze pump. The cleaner roller is brought into contact with the belt. The cleaner shaft is brought into contact with the cleaner roller. The blade is brought into contact with the cleaner shaft. The toner container includes a storage space storing toner and an opening allowing toner to be delivered to the storage space. The toner squeeze pump is provided outside the storage space. The cleaner roller collects toner adhered to a surface of the belt to a surface of the cleaner roller. The cleaner shaft collects the toner adhered to the surface of the cleaner roller to a surface of the cleaner shaft. The blade scrapes off the toner adhered to the surface of the cleaner shaft. The toner squeeze pump delivers the toner scraped off by the blade toward an opening of the storage space and compresses the toner stored in the storage space. A part of a bottom wall of the toner container which continues from the opening extends in a substantially horizontal direction, when the cleaner unit is attached to the image forming apparatus.

[0012] The cleaner roller may be made of polyurethane foam or silicone rubber foam. The cleaner shaft may be made of metal. The blade may be made of polyurethane.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The invention will now be described below, by way of example, with reference to the accompanying drawings, in which:

[0014] FIG. 1 is a sectional side view showing main parts of a laser printer according to an embodiment;

[0015] FIG. 2 is an enlarged view of a belt cleaner according to the embodiment;

[0016] FIG. 3 is an enlarged view of a portion A in FIG. 2;

[0017] FIG. 4 is a table showing test results of conveying state of waste toner when minimum gap sizes between an elliptic rotor and a rotor housing and an angle between a first wall and a second wall are used as testing parameters;

[0018] FIG. 5 is a table showing test results of conveying state of waste toner when the angle between the first wall and the second wall is used as a testing parameter; and

[0019] FIG. 6 is a table showing test results of conveying state of waste toner when a width size of an apex of the second wall and a distance from the apex of the second wall to a peripheral surface of a cleaning shaft are used as testing parameters.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020] In the present embodiment, an electrophotographic image forming apparatus according to the invention is applied to a laser printer which is used connected to a computer.

[0021] 1. External Structure of Laser Printer

[0022] FIG. 1 shows main parts of a laser printer 1 of the present embodiment. In FIG. 1, the upper side in FIG. 1 is regarded as upward in the direction of gravity. The right side in FIG. 1 is normally regarded as the front side.

[0023] A housing 3 of the laser printer 1 is formed into a substantially box-like (e.g., square) shape. A discharge tray 5 is provided on the top of the housing 3 so as to receive a

printed sheet or an OHP sheet (hereinafter, simply referred to as "paper") discharged from the housing 3.

[0024] In the present embodiment, the housing 3 is provided with a not shown frame member made of metal or resin therein. Component members such as a developer toner cartridge 70 and a fixing unit 80 are detachably attached to the frame member.

[0025] 2. Internal Structure of Laser Printer

[0026] The laser printer 1 includes an image forming portion 10, a feeder portion 20, and a conveyer 30. The image forming portion 10 forms an image on paper. The feeder portion 20 feeds the paper to the image forming portion 10. The conveyer 30 conveys the paper to four developing toner cartridges 70K, 70Y, 70M, and 70C composing the image forming portion 10.

[0027] The paper to which image formation is completed at the image forming portion 10 is turned around so that a conveying direction of the paper is rotated upward by approximately 180° at an intermediate conveying roller 90 and a not shown discharge chute. Then, the paper is discharged from a discharge portion 7 onto the discharge tray 5 by a discharge roller 91.

[0028] 2.1. Feeder Portion

[0029] The feeder portion 20 includes a feed tray 21, a feed roller 22, and a separation pad 23. The feed tray 21 is provided at the bottom of the housing 3. The feed roller 22 is provided at the upper front of the feed tray 21. The feed roller 22 feeds (conveys) paper placed on the feed tray 21 to the image forming portion 10. The separation pad 23 applies a predetermined conveying resistance to the paper fed by the feed roller 22 so as to separate the paper one by one.

[0030] The paper on the feed tray 21 is conveyed to the image forming portion 10 disposed in a substantially middle part of the housing 3 as if to make a U-turn at the front side of the housing 3. For this purpose, a conveying roller 24 that applies a conveying force to the paper is provided at a region making a U-turn in a paper conveying path between the feed tray 21 and the image forming portion 10.

[0031] A pressure roller 25 is disposed to face the conveying roller 24 across the paper conveying path to press paper onto the conveying roller 24. The pressure roller 25 is pressed against the conveying roller 24 by a not shown resilient member such as a coil spring.

[0032] Registration rollers 26 and 27 are provided downstream of the conveying roller 24 in the paper conveying direction. The registration roller 26 abuts the front end of the paper conveyed by the conveying roller 24 so as to correct orientation of the paper. The registration roller 26 then conveys the paper toward the image forming portion 10. The registration roller 27 is provided to face the registration roller 26. The registration roller 27 is pressed against the registration roller 26 by a not shown resilient member such as a coil spring.

[0033] 2.2. Conveyer

[0034] The conveyer 30 includes a drive roller 31, a driven roller 32, and a conveyor belt 33. The drive roller 31 rotates in conjunction with the operation of the image forming portion 10. The driven roller 32 is rotatably disposed at a distance from the drive roller 31. The conveyor belt 33 runs between the drive roller 31 and the driven roller 32.

[0035] Paper conveyed from the feed tray 21 is sequentially conveyed toward the vicinity of the four developer toner cartridges 70K, 70Y, 70M, and 70C, as the conveyor belt 33 rotates with the paper positioned thereon.

[0036] A belt cleaner 100 removes toner adhered to the surface of the conveyor belt 33. From now on, details of the belt cleaner 100 will be described.

[0037] 2.2.1. Details of Belt Cleaner 100

[0038] FIG. 2 is an enlarged view of the belt cleaner 100. FIG. 3 is an enlarged view of a portion A of FIG. 2. For example, the belt cleaner 100 is detachably installed inside the housing 3 on the lower side of the conveyor belt 33. Particularly, the belt cleaner 100 may be designed to be capable of being attached to and detached from the frame member provided in the housing 3.

[0039] In FIG. 3, a cleaning roller 101 removes toner adhered to the surface of the conveyor belt 33. A cleaning shaft 102 conveys the toner adhered to the cleaning roller 101 toward a waste toner container 105.

[0040] The cleaning roller 101 may be, for example, made of polyurethane foam or silicone rubber foam. The cleaning shaft 102 may be, for example, made of metal.

[0041] In the present embodiment, the cleaning roller 101 is brought into contact with the conveyor belt 33 while rotating in reverse of a rotation direction D1 of the conveyor belt 33. In this manner, the toner adhered to the conveyor belt 33 is scraped off to be removed.

[0042] An electric charge (negative charge in the present embodiment) opposite to an electric charge of the toner is applied to the cleaning shaft 102. The cleaning shaft 102 is then brought into contact with the external surface of the cleaning roller 101 while being rotated. In this manner, the toner adhered to the surface of the cleaning roller 101 is transferred to the cleaning shaft 102 to be removed from the cleaning roller 101.

[0043] The waste toner adhered to the surface of the cleaning shaft 102 is scraped off by a release blade 103. The release blade 103 is formed into a thin plate. The waste toner is then conveyed to the waste toner container 105 by the waste toner squeeze pump mechanism 110.

[0044] The blade 103 may be, for example, made of polyurethane.

[0045] An antiscattering blade 104 prevents scattering of waste toner scraped off from the cleaning shaft 102 to the side of the cleaning roller 101. One end of the antiscattering blade 104 is secured to the inner wall of a casing 108. The other end of the antiscattering blade 104 is formed into a flexible film which slidably abuts on the outer surface of the cleaning shaft 102.

[0046] The waste toner container 105 constitutes a storage space 106 in which the waste toner is collected. The waste toner squeeze pump mechanism 110 is provided on the outer side of the storage space 106 across an entrance 107 of the storage space 106 (waste toner container 105). The waste toner squeeze pump mechanism 110 is capable of compressing the waste toner collected in the storage space 106.

[0047] The waste toner squeeze pump mechanism 110 includes an elliptic rotor 111, a rotor housing 114, and a lead bulb 115. The elliptic rotor 111 pushes the waste toner scraped off from the cleaning shaft 102 toward the entrance 107 by rotating. The rotor housing 114 is provided to enclose the elliptic rotor 111. The lead bulb 115 prohibits the waste toner delivered into the storage space 106 from flowing backward to the outside of the storage space 106.

[0048] The elliptic rotor 111 has a substantially elliptic cross section. The elliptic rotor 111 rotates around a rotation axis orthogonal to the cross section. The rotor housing 114 is composed of a first wall 112 and a second wall 113. The

first wall **112** extends in a horizontal direction continuing from the entrance **107** of the toner container **105**. The second wall **113** extends substantially orthogonal to the first wall **112**.

[0049] The lead bulb **115** is formed into an elastic thin plate which slidably abuts on the peripheral surface of the elliptic rotor **111** from the side of the entrance **107** toward a rotation center **O1** of the elliptic rotor **111**.

[0050] Due to the above structure, when a force from the inside toward the outside of the storage space **106** acts on the lead bulb **115** in the waste toner squeeze pump mechanism **110** of the present embodiment, contact surface pressure between the lead bulb **115** and the elliptic rotor **111** is increased.

[0051] Accordingly, even if a force to open the lead bulb **115** acts on the lead bulb **115** by increased pressure inside the storage space **106** due to compressed waste toner, the lead bulb **115** is reliably prohibited from being open. Thus, the waste toner would not leak out of the storage space **106**.

[0052] As shown in FIG. 2, a waste toner measurement sensor **120** is provided on the back side (left side in FIG. 2) in a horizontal direction of the waste toner container **105**. The waste toner measurement sensor **120** determines whether the waste toner stored in the storage space **106** has reached to a predetermined amount. The waste toner measurement sensor **120** generates signal when a not shown switch is depressed by the pressure of the compressed waste toner provided inside the storage space **106**.

[0053] An elastic film door **121** is provided on the side of the entrance **107** of the waste toner measurement sensor **120** in such a manner as to partition the storage space **106** into the entrance **107** side and the waste toner measurement sensor **120** side. The film door **121** is designed to be opened by pressure of the waste toner stored on the entrance **107** side when the pressure has reached to a predetermined level.

[0054] Accordingly, in the present embodiment, the waste toner measurement sensor **120** does not operate simply by filling the storage space **106** with waste toner. The waste toner measurement sensor **120** operates when the inner pressure inside the storage space **106** has exceeded the predetermined level.

[0055] 2.3. Image Forming Portion

[0056] Referring to FIG. 1, the image forming portion **10** includes a scanner portion **60**, a developer toner cartridge **70**, and a fixation unit **80**.

[0057] The image forming portion **10** of the present embodiment is of a so-called direct tandem type which allows color printing. In the present embodiment, four toner cartridges **70K**, **70Y**, **70M**, and **70C** corresponding to four colors of toner (developer), that is black, yellow, magenta, and cyan, are arranged in series from the upstream side along the paper conveying direction.

[0058] The four developer toner cartridges **70K**, **70Y**, **70M**, and **70C** are only different in color of ink stored therein, and identical in structure. Accordingly, the four developer toner cartridges **70K**, **70Y**, **70M**, and **70C** are collectively called developer toner cartridges **70**.

[0059] 2.3.1. Scanner Portion

[0060] The scanner portion **60** forms an electrostatic latent image on the surface of a photosensitive drum **71**. The photosensitive drum **71** is provided in the upper portion in the housing **3**. The photosensitive drum **71** is respectively provided for each of the four developer toner cartridges **70K**,

70Y, **70M**, and **70C**. Particularly, the scanner portion **60** includes a laser source, a polygon mirror, f θ lens and a reflector.

[0061] A laser beam emitted from the laser source based on image data is biased by the polygon mirror. After passing the f θ lens, the beam is reflected and bent downward by the reflector. As a result, the beam is radiated on the surface of the photosensitive drum **71** to form an electrostatic latent image.

[0062] 2.3.2. Developer Toner Cartridge

[0063] Hereinafter, the structure of the developer toner cartridge **70C** is explained as an example by way of FIG. 1.

[0064] The developer toner cartridge **70** is detachably arranged inside the housing **3** on the down side of the scanner portion **60**. The developer toner cartridge **70** is provided with a casing **75** which accommodates the photosensitive drum **71**, a charger **72**, and a toner container **74**.

[0065] A transfer roller **73** is rotatably supported to the frame member on the side opposite to the photosensitive drum **71** across the conveyer belt **33**.

[0066] The photosensitive drum **71** carries an image to be transferred onto paper. The photosensitive drum **71** has a cylindrical shape, the outmost surface of which is formed by a positively charged photosensitive layer, for example, made of polycarbonate.

[0067] The charger **72** charges the surface of the photosensitive drum **71**. The charger **72** is disposed obliquely upward at the back of the photosensitive drum **71**. The charger **72** is disposed at a predetermined distance from the photosensitive drum **71** so as not to contact the photosensitive drum **71**.

[0068] The charger **72** according to the present embodiment employs a scorotron charger which positively charges the surface of the photosensitive drum **71** substantially evenly by using corona discharge from charging wire, for example, made of tungsten.

[0069] The transfer roller **73** is disposed to face with the photosensitive drum **71** and rotates in conjunction with rotation of the transfer belt **33**. When the paper passes near the photosensitive drum **71**, the transfer roller **73** applies an electric charge (negative charge in the present embodiment) opposite to the electric charge of the photosensitive drum **71** to the paper from the surface side opposite to a print surface of the paper, so as to transfer the toner adhered to the surface of the photosensitive drum **71** onto the print surface.

[0070] The toner container **74** includes a toner chamber **74A**, a toner supply roller **74B** and a developer roller **74C**. The toner chamber **74A** stores toner. The toner supply roller **74B** and the developer roller **74C** supply toner to the photosensitive drum **71**.

[0071] The toner stored in the toner chamber **74A** is supplied to the developer roller **74C** by the rotation of the toner supply roller **74B**. The toner supplied to the developer roller **74C** is carried onto the surface of the developer roller **74C**. The carried toner is adjusted to have a predetermined thickness (to be even) on the surface of the developer roller **74C** by a layer thickness control blade **74D**. The toner is then supplied to the surface of the photosensitive drum **71** exposed by the scanner portion **60**.

[0072] 2.3.3. Fixation Unit

[0073] The fixation unit **80** is disposed downstream of the photosensitive drum **71** in the paper conveying direction. The fixation unit **80** heats and melts the toner transferred

onto the paper to be fixed. The fixation unit **80** is detachably attached to the aforementioned frame member.

[0074] Particularly, the fixation unit **80** includes a beating roller **81**, and a pressure roller **82**. The heating roller **81** is disposed on the side of the print surface of the paper. The heating roller **81** applies a conveying force to the paper while heating the toner. The pressure roller **82** is disposed to face the heating roller **81** across the paper. The pressure roller **82** presses the paper toward the side of the heating roller **81**.

[0075] The heating roller **81** is rotationally driven in synchronization with the developer roller **74C** and the conveyer belt **33**. The pressure roller **82** is rotated by a rotational force of the heating roller **81** via the paper contacting the heating roller **81**.

[0076] 2.3.4. Outline of Image Forming Operation

[0077] In the image forming portion **10**, an image is formed onto the paper as follows.

[0078] That is, the surface of the photosensitive drum **71**, along with the rotation thereof, is positively and uniformly charged by the charger **72**. Then, the surface of the photosensitive drum **71** is exposed by rapid scanning of a laser beam emitted from the scanner portion **60**. Thereby, an electrostatic latent image corresponding to an image to be formed on the paper is formed on the surface of the photosensitive drum **71**.

[0079] Next, the positively charged toner carried onto the developer roller **74C** by the rotation thereof is supplied to the electrostatic latent image formed on the surface of the photosensitive drum **71**, that is, a part of the surface of the uniformly and positively charged photosensitive drum **71** which is exposed by a laser beam and where the electric potential is lowered, when brought into contact with the photosensitive drum **71**. Thereby, the electrostatic latent image on the photosensitive drum **71** is visualized. A toner image by reversal development is carried on the surface of the photosensitive drum **71**.

[0080] Thereafter, the toner image on the photosensitive drum **71** is transferred onto the paper by a transfer bias applied to the transfer roller **73**. The paper to which the toner image is transferred is conveyed to the fixation unit **80** and heated. The toner transferred as the toner image is fixed on the paper to complete image formation.

[0081] 3. Characteristics of Laser Printer According to Present Embodiment

[0082] In the belt cleaner **100** according to the present embodiment, the waste toner inside the storage space **106** can be compressed by the waste toner squeeze pump mechanism **110**. Therefore, the waste toner can be accumulated in the waste toner container **105** while being compressed inside the storage space **106**.

[0083] Accordingly, as shown in FIGS. 2 and 3, even though the portion of a bottom wall **109** (see FIG. 3) of the waste toner container **105** continuing from the entrance **107** of the waste toner container **105** extends in a substantially horizontal direction to form the storage space **106** extending in the horizontal direction, sufficient amount of waste toner can be stored in the waste toner container **105**. Therefore, in the present embodiment, miniaturization of the laser printer **1** in a vertical direction can be achieved while a sufficient amount of waste toner can be stored.

[0084] In the belt cleaner **100** of the present embodiment, even if the pressure inside the storage space **106** is increased by the compressed waste toner, the lead bulb **115** remains

closed as mentioned above. Therefore, it is difficult for the waste toner to leak out of the storage space **106**. Accordingly, even if the capacity and the vertical size of the storage space **106** are reduced, much waste toner can be stored.

[0085] In the elliptic rotor **111** of the waste toner squeeze pump mechanism **110** of the present embodiment, the waste toner is pumped as if pushed by two edges of a major axial portion of the elliptic rotor **111**. Thus, when the elliptic rotor **111** is rotated once, the waste toner is pumped twice.

[0086] On the other hand, for example, a rolling piston pump which rotates an eccentric round rotor may be adopted instead of the elliptic rotor **111**. In this case, however, when the round rotor rotates once, the waste toner is pumped once. Therefore, the rolling piston pump has lower efficiency than the waste toner squeeze pump mechanism **110** of the present embodiment.

[0087] Accordingly, the belt cleaner **100** of the present embodiment allows efficient collection of the waste toner.

[0088] As shown in FIG. 3, the waste toner scraped off from the cleaning shaft **102** by the release blade **103** falls into a gap between the elliptic rotor **111** and the second wall **113** to be conveyed toward the entrance **107** along with rotation of the elliptic rotor **111**. Therefore, if minimum gap sizes **L1** and **L2** between the rotor housing **114** and the elliptic rotor **111**, that is, the minimum gap size **L1** between the first wall **112** and the elliptic rotor **111**, and the minimum gap size **L2** between the second wall **113** and the elliptic rotor **111**, become too large, the amount of waste toner capable of being conveyed is decreased. The amount of waste toner remaining in the gap between the rotor housing **114** and the elliptic rotor **111** is increased. As a result, pumping efficiency of the waste toner squeeze pump mechanism **110** becomes low.

[0089] On the other hand, if the minimum gap sizes **L1** and **L2** between the rotor housing **114** and the elliptic rotor **111** become too small, solidified waste toner or foreign bodies may be easily stuck in the gap between the elliptic rotor **111** and the rotor housing **114**. There is high risk of stopping the rotation of the elliptic rotor **111**.

[0090] Thus, in the present embodiment, the minimum gap **L1** between the first wall **112** and the elliptic rotor **111** is set to be 0.3 mm to 2 mm, as later explained. In this manner, occurrence of deficiency is avoided to the waste toner squeeze pump mechanism **110** while decrease in the pumping efficiency is restricted.

[0091] Similarly, the minimum gap **L2** between the second wall **113** and the elliptic rotor **111** is set to be 0.3 mm or above and below 1.4 mm, as later explained. In this manner, occurrence of deficiency is avoided to the waste toner squeeze pump mechanism **110** while decrease in the pumping efficiency is restricted.

[0092] The conveyor belt **33** and the cleaning shaft **102** are disposed above the second wall **113**. Thus, there is a fear that the waste toner may be heaped up at the apex of the second wall **113**.

[0093] The heaped waste toner may fall on the side facing away from the elliptic rotor **111** over the second wall **113**. The fallen waste toner may not be conveyed into the storage space **106**.

[0094] In the present embodiment, a width size **L3** at the apex of the second wall **113** is set to be below 1 mm, as later explained. Thereby, the waste toner is prohibited from falling on the side facing away from the elliptic rotor **111**

over the second wall 113. The waste toner can be conveyed into the storage space 106. Efficient collection of the waste toner can be achieved.

[0095] The narrower the width size L3 of the apex of the second wall 113, the better the waste toner is prevented from being heaped up at the apex of the second wall 113.

[0096] However, in the present embodiment, the first and the second walls 112 and 113 are integrally formed by die molding such as injection resin molding. Thus, it is difficult to form the overall second wall 113 from the apex to the base to be thin due to manufacturing constraints.

[0097] To overcome the above constraints, the apex of the second wall 113 may be separately manufactured. Thereby, the separately manufactured apex may be attached to an apex portion of the second wall 113 so as to reduce the width size L3 of the apex of the second wall 113. However, this would increase the number of parts and assembling steps of the belt cleaner 100, resulting in increase in manufacturing costs of the laser printer 1.

[0098] In the present embodiment, a taper portion 116 where the width size L3 is tapered toward the apex is provided at least on the apex portion of the second wall 113, as shown in FIG. 3. Therefore, the first and the second walls 112 and 113 can be integrally molded by die molding while reducing the width size L3 of the apex of the second wall 113.

[0099] Accordingly, in the present embodiment, efficient collection of the waste toner can be achieved without increasing the manufacturing costs of the belt cleaner 100 (rotor housing 114).

[0100] If the second wall 113 is bent away from the elliptic rotor 111 so that an angle θ (see FIG. 3) between the first and the second walls 112 and 113 is more than 90°, a lump of waste toner heaped as if leaning on the second wall 113 does not fall apart even if the elliptic rotor 111 is rotated, as later explained. Thus, the waste toner cannot be efficiently collected.

[0101] In order to efficiently collect the waste toner, the second wall 113 may be bent toward the elliptic rotor 111 so that the angle θ is less than 90°. However, in the case of integral die molding of the first and the second walls 112 and 113, the second wall 113 cannot be simply cut out in a vertical direction if the second wall 113 is bent toward the elliptic rotor 111. Thus, a die structure may become complicated. The manufacturing costs of the rotor housing 114 may be increased.

[0102] In the present embodiment, the second wall 113 is orthogonal to the first wall 112. Thus, the second wall 113 is substantially parallel to a perpendicular direction. Accordingly, collection efficiency of the waste toner is not deteriorated. The second wall 113 can be easily cut out in a vertical direction.

[0103] Accordingly, the waste toner can be efficiently collected without increasing the manufacturing costs of the rotor housing 114.

[0104] In the present embodiment, the waste toner adhered to the surface of the cleaning shaft 102 is scraped off by the release blade 103. The scraped waste toner may be scattered to the side facing away from the elliptic rotor 111 over the second wall 113. The waste toner may be unable to be conveyed into the storage space 106.

[0105] In order to solve the above problem, a distance L4 (see FIG. 3) between the apex of the second wall 113 and the peripheral surface of the cleaning shaft 102 may be reduced.

However, if the distance L4 is extremely reduced, the waste toner heaped at the apex of the second wall 113 may expand to the extent to abut the peripheral surface of the cleaning shaft 102.

[0106] Then, the expanded waste toner may fall on the side facing away from the elliptic rotor 111 over the second wall 113. The waste toner may be unable to be conveyed into the storage space 106.

[0107] In the present embodiment, the distance L4 between the apex of the second wall 113 and the peripheral surface of the cleaning shaft 102 is set to 1.5 mm and above, as later explained. Then, the scraped waste toner is prohibited from being scattered to the side facing away from the elliptic rotor 111 over the second wall 113. The waste toner heaped at the apex of the second wall 113 is prohibited from becoming huge.

[0108] The distance L4 may be any distance as far as equal to 1.5 mm and above. However, the extended distance L4 causes the vertical size of the belt cleaner 100 to be large. Thus, in the present embodiment, the distance L4 is set between 1.5 mm to 2.5 mm, in consideration of the vertical size of the belt cleaner 100 and the variations in size.

[0109] FIG. 4 shows a table of test results of conveying state of waste toner when the minimum gap sizes L1 and L2 between the elliptic rotor 111 and the rotor housing 114 and the angle θ between the first wall 112 and the second wall 113 are used as testing parameters. Whether or not the waste toner has been favorably conveyed was determined by visual observation.

[0110] FIG. 5 shows a table of test results of conveying state of waste toner when the angle θ between the first wall 112 and the second wall 113 is used as a testing parameter. FIG. 6 shows a table of test results of conveying state of waste toner when the width size L3 of the front end of the second wall 113 and the distance L4 from the front end of the second wall 113 to the peripheral surface of a cleaning shaft 102 are used as testing parameters.

[0111] FIGS. 4 to 6, the elliptic rotor 111 having a diameter of 8 mm is a prototype, and the elliptic rotor 111 having a diameter of 10 mm is a mass production prototype. The diameter of the elliptic rotor 111 is not a parameter that affects the sizes L1 to L3 and the distance L4.

[0112] The elliptic rotor 111 according to the present embodiment is made of resin. There is no problem in strength (bending rigidity) of the elliptic rotor 111 if the diameter is 8 mm and above. The diameter of the mass production prototype is 10 mm in consideration of safety margin.

[0113] As shown in FIG. 4, when the minimum gap size L1 between the first wall 112 and the elliptic rotor 111 is set to be 0.3 mm to 2 mm as mentioned above, the waste toner can be favorably conveyed. Also as shown in FIG. 6, when the minimum gap size L2 between the second wall 113 and the elliptic rotor 111 is set to be 0.3 mm or above and below 1.4 mm, the waste toner can be favorably conveyed.

[0114] As shown in FIGS. 4 and 5, if the angle θ between the first wall 112 and the second wall 113 is set larger than 90°, a lump of waste toner heaped as if leaning on the second wall 113 does not fall apart, as mentioned above. Regardless of the minimum gap sizes L1 and L2 between the elliptic rotor 111 and the rotor housing 114, the waste toner cannot be smoothly conveyed. Accordingly, it is preferable that the angle θ between the first wall 112 and the second wall 113 is set to be 90° to favorably convey the waste toner.

[0115] Also as shown in FIG. 6, when the width size L3 of the apex of the second wall 113 is set to be below 1 mm as mentioned above, accumulation of waste toner can be avoided at the apex of the second wall 113. The waste toner can be favorably conveyed.

[0116] Also as shown in FIG. 6, when the distance L4 between the apex of the second wall 113 and the peripheral surface of the cleaning shaft 102 is set to be 1.5 mm and above as aforementioned, the waste toner can be favorably conveyed.

Other Embodiments

[0117] In the above embodiment, the elliptic rotor 111 is used in the waste toner squeeze pump mechanism 110. However, for example, a rolling piston pump may be used instead.

[0118] Also in the above embodiment, the first wall 112 and the second wall 113 are connected orthogonal to each other. However, for example, the first wall 112 and the second wall 113 may be connected to form a smooth curve which is substantially parallel to a locus drawn by the top of the major axis of the elliptic rotor 111.

[0119] An embodiment of the present invention is described in the above. However, it should be noted that the present invention can be practiced in various manners without departing from the scope of the present invention.

What is claimed is:

1. A cleaner unit detachable from an electrophotographic image forming apparatus provided with a belt, the cleaner unit comprising:

- a cleaner roller that is brought into contact with the belt;
- a cleaner shaft that is brought into contact with the cleaner roller;
- a blade that is brought into contact with the cleaner shaft;
- a toner container that includes a storage space storing toner and an opening allowing toner to be delivered to the storage space; and
- a toner squeeze pump that is provided outside the storage space, wherein

the cleaner roller collects toner adhered to a surface of the belt to a surface of the cleaner roller,

the cleaner shaft collects the toner adhered to the surface of the cleaner roller to a surface of the cleaner shaft, the blade scrapes off the toner adhered to the surface of the cleaner shaft,

the toner squeeze pump delivers the toner scraped off by the blade toward the opening of the storage space and compresses the toner stored in the storage space,

a part of a bottom wall of the toner container which continues from the opening extends in a substantially horizontal direction, when the cleaner unit is attached to the image forming apparatus.

2. The cleaner unit according to claim 1, wherein the toner squeeze pump includes

an elliptic rotor having a substantially elliptic cross section;

a rotor housing provided to enclose the elliptic rotor; and

a lead bulb formed into an elastic plate, and wherein the elliptic rotor rotates around a rotation axis orthogonal to the elliptic cross section of the elliptic rotor,

the rotor housing has a first wall and a second wall, the first wall continuing from the opening and the second wall extending orthogonal to the first wall,

the lead bulb slidably abuts on a peripheral surface of the elliptic rotor from a side of the opening in the storage space toward a rotation center of the elliptic rotor.

3. The cleaner unit according to claim 2, wherein a part of the rotor housing which has the first wall and the second wall is integrally formed with the toner container.

4. The cleaner unit according to claim 2, wherein a taper portion where a width size is tapered toward an apex of the second wall is provided at least on a side of the apex.

5. The cleaner unit according to claim 3, wherein a surface of the second wall which faces the elliptic rotor is substantially parallel to a perpendicular direction.

6. A cleaner unit comprising:

- a cleaner roller made of silicone rubber foam;
- a cleaner shaft made of metal;
- a blade made of polyurethane;
- a toner container that includes a storage space storing toner and an opening allowing toner to be delivered to the storage space; and
- a toner squeeze pump that is provided outside the storage space, wherein

the cleaner shaft rotates in contact with the cleaner roller and collects toner adhered to a surface of the cleaner roller to be transferred to a surface of the cleaner shaft, the blade is brought into contact with the cleaner shaft and scrapes off the toner adhered to the surface of the cleaner shaft,

the toner squeeze pump delivers the toner scraped off by the blade toward the opening of the storage space and compresses the toner stored in the storage space,

a part of a bottom wall of the toner container which continues from the opening extends in a substantially horizontal direction, when the cleaner unit is attached to an image forming apparatus.

7. The cleaner unit according to claim 6, wherein

the toner squeeze pump includes:

an elliptic rotor having a substantially elliptic cross section;

a rotor housing provided to enclose the elliptic rotor; and

a lead bulb formed into an elastic plate, and wherein the elliptic rotor rotates around a rotation axis orthogonal to the elliptic cross section of the elliptic rotor,

the rotor housing has a first wall and a second wall, the first wall continuing from the opening and the second wall extending orthogonal to the first wall,

the lead bulb slidably abuts on a peripheral surface of the elliptic rotor from a side of the opening in the storage space toward a rotation center of the elliptic rotor.

8. The cleaner unit according to claim 7, wherein

a part of the rotor housing which has the first wall and the second wall is integrally formed with the toner container.

9. The cleaner unit according to claim 7, wherein

a taper portion where a width size is tapered toward an apex of the second wall is provided at least on a side of the apex.

10. The cleaner unit according to claim 8, wherein

a surface of the second wall which faces the elliptic rotor is substantially parallel to a perpendicular direction.

11. The cleaner unit according to claim 1, wherein the toner container is designed as a long member extending in a substantially horizontal direction, when the cleaner unit is attached to the image forming apparatus.

12. The cleaner unit according to claim 6, wherein the toner container is designed as a long member extending in a substantially horizontal direction, when the cleaner unit is attached to the image forming apparatus.

13. An electrophotographic image forming apparatus comprising the cleaner unit according to claim 1 which is detachable from the apparatus.

14. An electrophotographic image forming apparatus comprising the cleaner unit according to claim 6 which is detachable from the apparatus.

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