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Inventor(s)	Adams; Emily Stefano et al.

Toner container having a shutter lock mechanism

Abstract

A toner container for use in an image forming device according to one example embodiment includes a body having a reservoir for holding toner, a toner port on the body in fluid communication with the reservoir, and a shutter translatable along a first dimension between a closed position blocking the toner port and an open position unblocking the toner port. A lock is translatable along a second dimension orthogonal to the first dimension between a locked position blocking the shutter from moving from the closed position to the open position and an unlocked position unblocking the shutter permitting the shutter to move from the closed position to the open position.

Inventors: **Adams; Emily Stefano (Lexington, KY), Boettcher; Brian Lester (Versailles, KY), Hawes; Brian Lee (Versailles, KY), Sexton; Brittany Nicole (Lexington, KY), Reidhaar; Glen Alan (Lexington, KY), Triplett; Edward Lynn (Lexington, KY)**

Applicant: **LEXMARK INTERNATIONAL, INC.** (Lexington, KY)

Family ID: **1000008767359**

Assignee: **Lexmark International, Inc. (Lexington, KY)**

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Primary Examiner: Chen; Sophia S

Background/Summary

CROSS REFERENCES TO RELATED APPLICATIONS (1) This application claims priority to U.S. Provisional Patent Application Ser. No. 63/449,643, filed Mar. 3, 2023, entitled “Toner Cartridge and Developer Unit Shutter Interface,” U.S. Provisional Patent Application Ser. No. 63/465,062, filed May 9, 2023, entitled “Toner Container Having a Shutter Lock,” and U.S. Provisional Patent Application Ser. No. 63/532,245, filed Aug. 11, 2023, entitled “Toner Container Having a Shutter Lock Mechanism,” the contents of which are hereby incorporated by reference in their entirety.

BACKGROUND

1. Field of the Disclosure

(1) The present disclosure relates generally to image forming devices and more particularly to a toner container having a shutter lock mechanism.

2. Description of the Related Art

(2) During the electrophotographic printing process, an electrically charged rotating photoconductive drum is selectively exposed to a laser beam. The areas of the photoconductive drum exposed to the laser beam are discharged, creating an electrostatic latent image of a page to be printed on the photoconductive drum. Toner particles are then electrostatically picked up by the latent image on the photoconductive drum, creating a toned image on the drum. The toned image is transferred to the print media (e.g., paper) either directly by the photoconductive drum or indirectly by an intermediate transfer member. The toner is then fused to the media using heat and pressure to complete the print.

(3) The image forming device's toner supply is typically stored in one or more replaceable units having a shorter lifespan than the image forming device. It is important to prevent the unwanted release of toner from these replaceable units. Some image forming devices include a first replaceable unit in the form of a toner cartridge that holds a main toner supply of the image forming device and feeds toner through an outlet port of the toner cartridge to an inlet port of a second replaceable unit, sometimes referred to as an imaging unit. The toner cartridge may include a shutter that seals the outlet port when the toner cartridge is not installed in the image forming device. The shutter may be biased toward a closed position in order to prevent the undesired release of toner. As the toner cartridge is inserted into the image forming device and the outlet port of the toner cartridge mates with the corresponding inlet port, an engagement feature in the image forming device opens the shutter so that toner may be delivered through the outlet port. Toner leakage may be experienced if the shutter opens when the outlet port is not mated with the corresponding inlet port, such as if the shutter opens prematurely during insertion of the toner cartridge into the image forming device or if a user unintentionally opens the shutter or intentionally opens the shutter without appreciating its purpose. Leaked toner may cause uncleanliness, which customers disfavor, and in some instances, contamination of electrophotographic components and print defects. Accordingly, it will be appreciated that a mechanism that prevents the unwanted release of toner from the outlet port of the toner cartridge is desired.

SUMMARY

(4) A toner container for use in an image forming device according to one example embodiment includes a body having a reservoir for holding toner, a toner port on the body in fluid communication with the reservoir, and a shutter translatable along a first dimension between a closed position blocking the toner port and an open position unblocking the toner port. A lock is translatable along a second dimension orthogonal to the first dimension between a locked position blocking the shutter from moving from the closed position to the open position and an unlocked position unblocking the shutter permitting the shutter to move from the closed position to the open position. In one embodiment, the first dimension is a horizontal dimension, and the second dimension is a vertical dimension. In some embodiments, the lock moves upward when the lock

moves from the locked position to the unlocked position, and the lock moves downward when the lock moves from the unlocked position to the locked position.

(5) Embodiments include those wherein the lock includes a locking arm having a blocking surface. The locking arm is movable between the locked position where the blocking surface is positioned in a path of the shutter blocking the shutter from moving from the closed position to the open position and the unlocked position where the blocking surface is positioned clear from the path of the shutter permitting the shutter to move from the closed position to the open position. In some embodiments, the locking arm is spaced from the shutter when the lock is in the unlocked position and the shutter is in the open position. In some embodiments, the locking arm contacts the shutter when the lock is in the unlocked position and the shutter is in the open position. Embodiments also include those wherein the lock includes a camming surface positioned to receive a force from a corresponding surface in the image forming device that causes the lock to move from the locked position to the unlocked position during installation of the toner container into the image forming device.

(6) A toner container for use in an image forming device according to another example embodiment includes a body having a reservoir for holding toner, a toner port on the body in fluid communication with the reservoir, and a shutter translatable along a horizontal dimension between a closed position blocking the toner port and an open position unblocking the toner port. A lock is movable upward and downward between a locked position blocking the shutter from moving from the closed position to the open position and an unlocked position permitting the shutter to move from the closed position to the open position. In one embodiment, the lock is translatable upward and downward between the locked position and the unlocked position. In some embodiments, the lock moves upward when the lock moves from the locked position to the unlocked position, and the lock moves downward when the lock moves from the unlocked position to the locked position. In some embodiments, the lock is translatable along a vertical dimension orthogonal to the horizontal dimension.

(7) A toner container for use in an image forming device according to another example embodiment includes a body having a top, a bottom, a first side and a second side positioned between a first longitudinal end and a second longitudinal end of the body. A longitudinal dimension of the toner container that is orthogonal to a vertical dimension of the toner container extends between the first longitudinal end of the body and the second longitudinal end of the body. The first longitudinal end of the body leads during insertion of the toner container into the image forming device and the second longitudinal end of the body trails during insertion of the toner container into the image forming device. The body has a reservoir for holding toner. An outlet port is disposed on the bottom of the body for exiting toner from the reservoir. A shutter is movable along the longitudinal dimension of the body between a closed position blocking the outlet port and an open position unblocking the outlet port. The shutter moves in a direction away from the first longitudinal end of the body and toward the second longitudinal end of the body when the shutter moves from the closed position to the open position and the shutter moves in a direction away from the second longitudinal end of the body and toward the first longitudinal end of the body when the shutter moves from the open position to the closed position. A lock is positioned on the first side of the body and is movable along the vertical dimension of the body between a locked position blocking the shutter from moving from the closed position to the open position and an unlocked position permitting the shutter to move from the closed position to the open position.

(8) In some embodiments, the lock is translatable along the vertical dimension of the body between the locked position and the unlocked position. In some embodiments, the shutter is translatable along the longitudinal dimension of the body between the closed position and the open position. In some embodiments, the lock moves upward when the lock moves from the locked position to the unlocked position, and the lock moves downward when the lock moves from the unlocked position to the locked position.

(9) Embodiments include those wherein the lock includes a locking arm having a blocking surface. The locking arm is movable between the locked position where the blocking surface is positioned in a path of the shutter blocking the shutter from moving from the closed position to the open position and the unlocked position where the blocking surface is positioned clear from the path of the shutter permitting the shutter to move from the closed position to the open position. Embodiments also include those wherein the lock includes a camming surface for contacting a corresponding surface in the image forming device during insertion of the toner container into the image forming device and receiving an actuation force from the corresponding surface in the image forming device to move the lock from the locked position to the unlocked position. In some embodiments, the camming surface is positioned on an engagement arm of the lock spaced apart from the locking arm. In some embodiments, the engagement arm and the locking arm extend downward from the lock.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The accompanying drawings incorporated in and forming a part of the specification, illustrate several aspects of the present disclosure, and together with the description serve to explain the principles of the present disclosure.

(2) FIG. **1** is a schematic view of an image forming device according to one example embodiment.

(3) FIGS. **2**A and **2**B are perspective views of a toner cartridge according to one example embodiment.

(4) FIGS. **3**A and **3**B are perspective views of the toner cartridge shown in FIGS. **2**A and **2**B showing a shutter lock of the toner cartridge in a locked position and an unlocked position, respectively, and a shutter of the toner cartridge in a closed position and an open position, respectively, according to one example embodiment.

(5) FIG. **4** is a perspective view of a developer unit according to one example embodiment.

(6) FIGS. **5**A-**5**E are sequential side views showing the operation of the shutter lock shown in FIGS. **3**A and **3**B during insertion of the toner cartridge into the image forming device according to one example embodiment.

(7) FIG. **6** is a side view showing the shutter lock in an unlocked position according to another example embodiment.

(8) FIG. **7** is a side view showing a shutter lock in an unlocked position according to another example embodiment.

DETAILED DESCRIPTION

(9) In the following description, reference is made to the accompanying drawings where like numerals represent like elements. The embodiments are described in sufficient detail to enable those skilled in the art to practice the present disclosure. It is to be understood that other embodiments may be utilized and that process, electrical, and mechanical changes, etc., may be made without departing from the scope of the present disclosure. Examples merely typify possible variations. Portions and features of some embodiments may be included in or substituted for those of others. The following description, therefore, is not to be taken in a limiting sense, and the scope of the present disclosure is defined only by the appended claims and their equivalents.

(10) FIG. **1** illustrates a schematic view of the interior of an example image forming device **20**. Image forming device **20** includes a housing **22**. Housing **22** includes one or more input trays **28** positioned therein. Each tray **28** is sized to contain a stack of media sheets. As used herein, the term media is meant to encompass not only paper but also labels, envelopes, fabrics, photographic paper and any other desired substrate. Trays **28** are preferably removable for refilling. A control panel may be located on housing **22**. Using the control panel, a user is able to enter commands and

generally control the operation of image forming device **20**. For example, a user may enter commands to switch modes (e.g., color mode, monochrome mode), view the number of images printed, etc. A media path **32** extends through image forming device **20** for moving the media sheets through the image transfer process. Media path **32** includes a simplex path **34** and may include a duplex path **36**. A media sheet is introduced into simplex path **34** from tray **28** by a pick mechanism **38**. In the example embodiment shown, pick mechanism **38** includes a roll positioned to move the media sheet from tray **28** and into media path **32**. The media sheet is then moved along media path **32** by various transport rollers. Media sheets may also be introduced into media path **32** by a manual feed **46** having one or more rolls **48** or by additional media trays.

(11) Image forming device **20** includes an image transfer section that includes one or more imaging stations **50**. Each imaging station **50** includes a toner cartridge **100**, a developer unit **200** and a photoconductive unit (PC unit) **300**. Each toner cartridge **100** includes a reservoir **102** for holding toner and an outlet port in communication with an inlet port of a corresponding developer unit **200** for transferring toner from reservoir **102** to developer unit **200** as discussed in greater detail below. In the example embodiment illustrated, developer unit **200** utilizes what is commonly referred to as a single component development system. In this embodiment, each developer unit **200** includes a toner reservoir **202** and a toner adder roll **204** that moves toner from reservoir **202** to a developer roll **206**. In another embodiment, developer unit **200** utilizes what is commonly referred to as a dual component development system. In this embodiment, toner in toner reservoir **202** is mixed with magnetic carrier beads. The magnetic carrier beads may be coated with a polymeric film to provide triboelectric properties to attract toner to the carrier beads as the toner and the magnetic carrier beads are mixed in the toner reservoir. In this embodiment, developer roll **206** attracts the magnetic carrier beads having toner thereon to developer roll **206** through the use of magnetic fields. Each PC unit **300** includes a charging roll **304** and a photoconductive (PC) drum **302** for each imaging station **50**. PC drums **302** are mounted substantially parallel to each other. For purposes of clarity, developer unit **200** and PC unit **300** are labeled on only one of the imaging stations **50** in FIG. **1**. In the example embodiment illustrated, each imaging station **50** is substantially the same except for the color or type of toner contained therein.

(12) Each charging roll **304** forms a nip with the corresponding PC drum **302**. During a print operation, charging roll **304** charges the surface of PC drum **302** to a specified voltage. A laser beam from a printhead **52** associated with each imaging station **50** is then directed to the surface of PC drum **302** and selectively discharges those areas it contacts to form a latent image. Developer roll **206** then transfers toner to PC drum **302** to form a toner image. A metering device, such as a doctor blade **208**, may be used to meter toner on developer roll **206** and apply a desired charge to the toner prior to its transfer to PC drum **302**. Toner is attracted to the areas of PC drum **302** surface discharged by the laser beam from printhead **52**.

(13) In the example embodiment illustrated, an intermediate transfer mechanism (ITM) **54** is disposed adjacent to imaging stations **50**. In this embodiment, ITM **54** is formed as an endless belt trained about a drive roll **56**, a tension roll **58** and a back-up roll **60**. During print operations, ITM **54** moves past imaging stations **50** in a counterclockwise direction as viewed in FIG. **1**. One or more of PC drums **302** apply toner images in their respective colors to ITM **54** at a first transfer nip **62**. ITM **54** rotates and collects the one or more toner images from imaging stations **50** and then conveys the toner images to a media sheet advancing through simplex path **34** at a second transfer nip **64** formed between a transfer roll **66** and ITM **54**, which is supported by back-up roll **60**. In other embodiments, the toner image is transferred to the media sheet directly by the PC drum(s) **302**.

(14) The media sheet with the toner image is then moved along the media path **32** and into a fuser area **68**. Fuser area **68** includes fusing rolls or belts **70** that form a nip **72** to adhere the toner image to the media sheet. The fused media sheet then passes through transport rolls **74** located downstream from fuser area **68**, which move the media sheet to an output area **76** of image forming

device **20** or to duplex path **36** for image formation on a second side of the media sheet, as desired.
(15) A monocolor image forming device **20** may include a single imaging station **50**, as compared to a color image forming device **20** that may include multiple imaging stations **50**.
(16) FIGS. **2**A and **2**B show toner cartridge **100** according to one example embodiment. Toner cartridge **100** includes a body **104** housing toner reservoir **102** therein. Body **104** includes a top **105**, a bottom **106**, a front end **107**, a rear end **108** and a pair of sides **109**, **110**. Body **104** has a height measured along a vertical dimension **112** of toner cartridge **100** between top **105** and bottom **106**, a length measured along a longitudinal dimension **114** of toner cartridge **100** orthogonal to vertical dimension **112** between front end **107** and rear end **108**, and a width measured along a side-to-side dimension **116** of toner cartridge **100** orthogonal to vertical dimension **112** and longitudinal dimension **114** between side **109** and side **110**. In the example embodiment illustrated, each end **107**, **108** of body **104** includes a respective end cap **117**, **118** mounted on a corresponding end wall, such as by suitable fasteners (e.g., screws, rivets, etc.) or by a snap-fit engagement. In this embodiment, an end wall **119** at front end **107** and an end wall (not shown) at rear end **108** along with top **105**, bottom **106** and sides **109**, **110** form toner reservoir **102**. In the example embodiment illustrated, toner cartridge **100** is inserted into image forming device **20** generally along longitudinal dimension **114** in the direction indicated by arrow A in FIGS. **2**A and **2**B with front end **107** of body **104** leading and rear end **108** of body **104** trailing.
(17) As used herein, the terms “front” and “rear” correspond to the direction of travel of toner cartridge **100** during insertion of toner cartridge **100** into image forming device **20** rather than any particular orientation of image forming device **20**. For example, in one embodiment, image forming device **20** is primarily operated, for example, accessing a user interface, media tray(s), supply item(s) (such as toner cartridge **100**, developer unit **200**, and PC unit **300**) and other features of image forming device **20**, at a side proximate to rear end **108** of body **104** of toner cartridge **100**.
(18) Toner cartridge **100** includes an outlet port **122** for exiting toner from reservoir **102**, such as when transferring toner to an inlet port of developer unit **200**. In the example embodiment illustrated, outlet port **122** is formed as a downward facing opening on bottom **106** of body **104**, next to front end **107** of body **104**, such as next to an inner side of end wall **119**. A shutter **150** is positioned at outlet port **122** to regulate whether toner is permitted to flow from reservoir **102** out of outlet port **122**. Shutter **150** may be referred to herein as cartridge shutter **150**. Cartridge shutter **150** is positioned on bottom **106** of body **104** and is translatable between a closed position blocking outlet port **122** to prevent toner from escaping toner cartridge **100** and an open position unblocking outlet port **122** to permit toner to flow from outlet port **122** of toner cartridge **100**. In this embodiment, cartridge shutter **150** moves in a front-to-rear direction **115***a* relative to body **104** as shutter moves from the closed position to the open position and in a rear-to-front direction **115***b* relative to body **104** as cartridge shutter **150** moves from the open position to the closed position. In the embodiment illustrated, cartridge shutter **150** includes a blocking portion **157** and a window **159**. Blocking portion **157** blocks outlet port **122** when cartridge shutter **150** is in the closed position as shown in FIG. **2**B. When cartridge shutter **150** is in the open position, such as after moving in the front-to-rear direction **115***a* from the closed position, window **159** aligns with outlet port **122** to allow toner to exit outlet port **122**.
(19) Cartridge shutter **150** is biased toward the closed position blocking outlet port **122**. In the embodiment illustrated, one or more biasing springs, such as extension springs **176**, **177** bias cartridge shutter **150** towards the closed position. In the embodiment illustrated, each spring **176**, **177** has one end connected to a portion of body **104** and another end connected to cartridge shutter **150**. While the example embodiment illustrated includes extension springs **176**, **177**, it will be appreciated that cartridge shutter **150** may be biased relative to body **104** by any suitable biasing member as desired, including, for example, one or more compression springs, torsion springs, leaf springs, or other materials having resilient properties.
(20) Cartridge shutter **150** includes a first engagement feature that contacts and pushes open a

second shutter of a toner port that is configured to mate with outlet port **122** of toner cartridge **100** during insertion of toner cartridge **100** into image forming device **20**. In the embodiment illustrated, cartridge shutter **150** includes a projection **174** projecting downward near a surface of blocking portion **157**. In the embodiment illustrated, outlet port **122** is positioned closer to front end **107** of body **104** than projection **174** is to front end **107** of body **104**. In addition, window **159** is positioned closer to front end **107** of body **104** than projection **174** is to front end **107** of body **104**. Projection **174** has a front face **175** that faces toward front end **107** of body **104**. In this embodiment, front face **175** of projection **174** is unobstructed such that front face **175** of projection **174** contacts at least a portion of the second shutter positioned along the insertion path of projection **174** in order for projection **174** to contact and push open the second shutter in direction of insertion A of toner cartridge **100** into image forming device **20** during insertion of toner cartridge **100** into image forming device **20**, as discussed below.

(21) Cartridge shutter **150** also includes a second engagement feature that engages a corresponding surface in image forming device **20** to open cartridge shutter **150** when toner cartridge **100** is inserted into image forming device **20**. In the embodiment illustrated, cartridge shutter **150** includes an extension **180** that protrudes from a front end **152** of cartridge shutter **150** toward and beyond front end **107** of body **104** along longitudinal dimension **114** for contacting a corresponding surface in image forming device **20** during insertion of toner cartridge **100** into image forming device **20**. In one embodiment, the corresponding surface in image forming device **20** may be a portion of a basket or tray that holds developer unit **200** in image forming device **20**. In another embodiment, the corresponding surface may be an inner wall or frame within image forming device **20**. Extension **180** is positioned to receive an actuation force from the corresponding surface in image forming device **20** to move cartridge shutter **150** along longitudinal dimension **114** in front-to-rear direction **115***a* of body **104** from the closed position to the open position. Extension **180** extends forward, for example, in a cantilevered manner, from front end **152** of cartridge shutter **150** along longitudinal dimension **114** in the direction of insertion A of toner cartridge **100** into image forming device **20**. When cartridge shutter **150** is in the closed position, extension **180** extends further forward along longitudinal dimension **114** than front end **107** and/or drive coupler **124** of toner cartridge **100** in order to contact the corresponding surface in image forming device **20**. In the embodiment illustrated, window **159** is positioned between extension **180** and projection **174** of cartridge shutter **150**.

(22) Toner cartridge **100** includes a shutter lock **130** that prevents cartridge shutter **150** from opening unless toner cartridge **100** is installed in image forming device **100**. In the embodiment illustrated, shutter lock **130** is positioned on side **109** of body **104** of toner cartridge **100** adjacent to cartridge shutter **150**. Shutter lock **130** is translatable along vertical dimension **112** between a lowered position blocking cartridge shutter **150** to prevent cartridge shutter **150** from moving from the closed position to the open position and a raised position unblocking cartridge shutter **150** to permit cartridge shutter **150** to move from the closed position to the open position, as discussed in greater detail below.

(23) Toner cartridge **100** also includes a drive coupler **124** that mates with and receives rotational power from a corresponding drive coupler in image forming device **20** when toner cartridge **100** is installed in image forming device **20** in order to provide rotational power to various rotatable components of toner cartridge **100**, such as toner agitators positioned within reservoir **102** for moving toner to outlet port **122**. In the example embodiment illustrated, drive coupler **124** is positioned on front end **107** of body **104**, for example, higher than outlet port **122**. In the embodiment illustrated, drive coupler **124** is positioned on an outer surface of end wall **119** and exposed through an opening **126** in end cap **117** such that drive coupler **124** is unobstructed to mate with the corresponding drive coupler in image forming device **20** when toner cartridge **100** is installed in image forming device **20**.

(24) In the example embodiment illustrated, toner cartridge **100** includes a pair of guide rails **160**,

162 that extend along longitudinal dimension **114** of toner cartridge **100** at top **105** of body **104**. In this embodiment, guide rails **160**, **162** are formed as cantilevered extensions that extend outward in opposite directions along side-to-side dimension **116** of toner cartridge **100** at top **105** of body **104**. Specifically, guide rail **160** extends along side-to-side dimension **116** toward side **109** of body **104**, and guide rail **162** extends along side-to-side dimension **116** toward side **110** of body **104**. Each guide rail **160**, **162** includes a bottom contact surface **161** that is positioned to contact and ride along the top surface of a corresponding guide rail positioned at an entrance of toner cartridge **100** to image forming device **20** during insertion of toner cartridge **100** into image forming device **20** in order to guide insertion of toner cartridge **100** into image forming device **20** in the direction indicated by arrow A in FIGS. **2**A and **2**B with front end **107** of body **104** leading and rear end **108** of body **104** trailing. In the example embodiment illustrated, guide rails **160**, **162** run along nearly the entire length of body **104** of toner cartridge **100** along longitudinal dimension **114** of toner cartridge **100**, from end wall **119** at front end **107** of body **104** to an inner end of end cap **118** at rear end **108** of body **104**.

(25) In the example embodiment illustrated, respective guide pins or posts **164**, **166** project outward in opposite directions along side-to-side dimension **116** of toner cartridge **100** at a front end of each guide rail **160**, **162**. Specifically, guide post **164** extends along side-to-side dimension **116** toward side **109** of body **104**, and guide post **166** extends along side-to-side dimension **116** toward side **110** of body **104**. Guide posts **164**, **166** extend further outward along side-to-side dimension **116** of toner cartridge **100** than guide rails **160**, **162**. In this embodiment, guide posts **164**, **166** are positioned at end wall **119** at front end **107** of body **104**. Each guide post **164**, **166** includes a bottom contact surface **165** that is positioned to contact and ride along the top surface of a corresponding guide rail that runs along the length of a guide slot that receives toner cartridge **100** in image forming device **20** during insertion of toner cartridge **100** into image forming device **20** in order to further guide insertion of toner cartridge **100** into image forming device **20** in the direction indicated by arrow A in FIGS. **2**A and **2**B.

(26) Contact between bottom contact surfaces **161** of guide rails **160**, **162** of toner cartridge **100** and the top surfaces of corresponding guide rails positioned at an entrance to image forming device **20** and between bottom contact surfaces **165** of guide posts **164**, **166** of toner cartridge **100** and the top surfaces of corresponding guide rails that run along the length of a guide slot that receives toner cartridge **100** in image forming device **20** controls the position of toner cartridge **100** along vertical dimension **112** during insertion of toner cartridge **100** into image forming device **20** and removal of toner cartridge **100** from image forming device **20** and may aid in positioning toner cartridge **100** along vertical dimension **112** when toner cartridge **100** is in its final installed position in image forming device **20**. Contact between guide rails **160**, **162** and guide posts **164**, **166** of toner cartridge **100** and their corresponding guide rails in image forming device **20** may also aid in controlling the position of toner cartridge **100** along side-to-side dimension **116** and limiting rotation of toner cartridge **100** during insertion of toner cartridge **100** into image forming device **20** and removal of toner cartridge **100** from image forming device **20**.

(27) FIGS. **3**A and **3**B show shutter lock **130** in greater detail according to one example embodiment. In the embodiment illustrated, shutter lock **130** is positioned on side **109** of body **104** and is movable, such as translatable, between a lowered position shown in FIG. **3**A and a raised position shown in FIG. **3**B. In the lowered position, shutter lock **130** blocks cartridge shutter **150**, shown in FIG. **3**A in the closed position, from moving in front-to-rear direction **115***a* towards the open position. In the raised position, shutter lock **130** unblocks cartridge shutter **150** to allow cartridge shutter **150** to move in front-to-rear direction **115***a* towards the open position as shown in FIG. **3**B. In this embodiment, shutter lock **130** moves in a bottom-to-top direction **131** relative to body **104** as shutter lock **130** moves from the lowered position to the raised position and in a top-to-bottom direction **132** relative to body **104** as shutter lock **130** moves from the raised position to the lowered position.

(28) In the embodiment illustrated, shutter lock **130** includes a lock body **135** having an engagement arm **137** and a locking arm **139**. Side **109** of body **104** includes opposed retaining ribs **141** forming a channel **142** therebetween within which lock body **135** translates on side **109** of body **104**. Retaining arms **143** extend inwardly from retaining ribs **141** into channel **142** to retain lock body **135** within channel **142** to support the sliding motion of lock body **135** in directions **131**, **132**. Engagement arm **137** and locking arm **139** are spaced apart from each other by an intermediate edge portion **145** that is positioned to contact a portion **125** of a ledge **127** formed on side **109** of body **104**. In the embodiment illustrated, ledge **127** includes slits **128**, **129** for receiving engagement arm **137** and locking arm **139**, respectively, in order to further support the sliding motion of lock body **135** in directions **131**, **132** along side **109** of body **104**. Portion **125** of ledge **127** provides a downward stop for intermediate edge portion **145** of lock body **135** to engage for limiting the downward movement of lock body **135**.
(29) Locking arm **139** of lock body **135** is movable between a locked position preventing cartridge shutter **150** from opening and an unlocked position permitting cartridge shutter **150** to open. In the embodiment illustrated, locking arm **139** is in the locked position when shutter lock **130** is in the lowered position and is in the unlocked position when shutter lock **130** is in the raised position. In the example embodiment illustrated, lock body **135** of shutter lock **130** is biased in top-to-bottom direction **132**, such as by one or more springs, such that locking arm **139** is biased toward the locked position. In the embodiment illustrated, an extension spring **147** is connected between a first spring mount **149** on lock body **135** and a second spring mount **123** on side **109** of body **104** to continuously bias lock body **135** in top-to-bottom direction **132** and locking arm **139** towards the locked position. Intermediate edge portion **145** of lock body **135** contacts portion **125** of ledge **127** when locking arm **139** is in the locked position. The biasing force of spring **147** is overcome when lock body **135** moves upward in bottom-to-top direction **131** when engagement arm **137** of lock body **135** receives an upward force from a feature in image forming device **20**, such as from a feature on developer unit **200**, causing locking arm **139** to move from the locked position to the unlocked position. In other embodiments, lock body **135** may be pulled down and biased towards the locked position by gravity without extension spring **147**.
(30) Locking arm **139** of lock body **135** includes a blocking surface **140** that is in the path of cartridge shutter **150** when locking arm **139** is in the locked position to prevent cartridge shutter **150** from opening. In the embodiment illustrated, blocking surface **140** of locking arm **139** is positioned at a downstream location from cartridge shutter **150** relative to the front-to-rear direction **115***a* of body **104** when cartridge shutter **150** is in the closed position. In this manner, blocking surface **140** prevents cartridge shutter **150** from sliding toward rear end **108** from the closed position to the open position when locking arm **139** is in the locked position. When locking arm **139** is in the unlocked position, blocking surface **140** of locking arm **139** clears the path of cartridge shutter **150** permitting cartridge shutter **150** to slide toward rear end **108** from the closed position to the open position.
(31) Engagement arm **137** of lock body **135** includes a camming surface **138** that is tapered upward from a bottom end of engagement arm **137** in a direction toward front end **107**. Engagement arm **137** is unobstructed such that camming surface **138** contacts a feature positioned along the insertion path of engagement arm **137** in order for lock body **135** to move from the lowered position to the raised position during insertion of toner cartridge **100** into image forming device **20**, as discussed below. In one embodiment, engagement arm **137** is positioned to contact a feature of developer unit **200** when toner cartridge **100** is inserted into image forming device **20** to receive an actuation force and cause lock body **135** to move upward in bottom-to-top direction **132** and, consequently, locking arm **139** to move upward from the locked position to the unlocked position with blocking surface **140** of locking arm **139** clear of the sliding path of cartridge shutter **150** in order to permit cartridge shutter **150** to move from the closed position to the open position.
(32) It will be appreciated that lock body **135** and the mounting configuration of lock body **135** on

body **104** illustrated are intended to serve as examples and that one or more components of shutter lock **130** may be mounted according to any suitable configuration that permit locking arm **139** to move between the locked and unlocked positions. For example, the locations and shapes of retaining ribs **141**, retaining arms **143**, slits **128** and **129**, and/or locking arm **139** may vary as desired. Further, retaining ribs **141** may be provided as separate components attached to body **104**. Lock body **135** may be made of plastic material. In other embodiments, lock body **135** may be made of any suitable material(s) or manufacturing technique(s) known in the art. Engagement arm **137** and locking arm **139** are formed as part of the body of lock body **135** in the example illustrated, but engagement arm **137** and/or locking arm **139** may be separate elements that are attached to the body of lock body **135**. In other alternative embodiments, downward stops for limiting downward movement of lock body **135** may be positioned in other locations. For example, a downward stop engageable by spring mount **149** may be positioned beneath spring mount **149** of lock body **135**.

(33) Body **104** of toner cartridge **100** includes rearward and forward stops that prevent cartridge shutter **150** from overtraveling along front-to-rear direction **115***a* and rear-to-front direction **115***b*, respectively. In the example embodiment illustrated, a forward stop **169** is positioned on body **104** facing front end **152** of cartridge shutter **150**. Contact between front end **152** of cartridge shutter **150** and forward stop **169** limits forward travel of cartridge shutter **150** toward front end **107**. A rearward stop **172** is positioned on body **104** facing a rear end **153** of cartridge shutter **150**. In one embodiment, locking arm **139** is positioned closer to rear end **153** of cartridge shutter **150** than rearward stop **172** is to rear end **153** of cartridge shutter **150** when locking arm **139** is in the locked position. In the embodiment illustrated, rearward stop **172** is positioned in the space between engagement arm **137** and locking arm **139** of shutter lock **130** when locking arm **139** is in the locked position. Contact between rear end **153** of cartridge shutter **150** and rearward stop **172** limits rearward travel of cartridge shutter **150** toward rear end **108**. lock body

(34) FIG. **4** shows developer unit **200** according to one example embodiment. Developer unit **200** includes a housing **212** having reservoir **202** therein. Housing **212** extends generally along longitudinal dimension **114** from a front end **214** to a rear end **216** of housing **212**. In the embodiment illustrated, front end **214** of housing **212** includes an end cap **218** mounted by fasteners, such as screws, to a main body of housing **212**.

(35) Developer unit **200** includes a drive coupler **220** that mates with and receives rotational power from a corresponding drive coupler in image forming device **20** when developer unit **200** is installed in image forming device **20** in order to provide rotational power to various rotatable components of developer unit **200**, such as toner adder roll **204**, developer roll **206** and one or more toner agitators positioned within reservoir **202**. In the example embodiment illustrated, drive coupler **220** is positioned on front end **214** of housing **212**.

(36) Developer unit **200** includes an inlet port **222** positioned to receive toner from outlet port **122** of toner cartridge **100** to replenish reservoir **202** as toner is consumed from reservoir **202** by the printing process. In the example embodiment illustrated, inlet port **222** is positioned on a top **213** of housing **212** near front end **214**. Developer unit **200** includes a shutter **250** that is translatable along longitudinal dimension **114** between a closed position blocking inlet port **222** to prevent toner from escaping inlet port **222** and an open position unblocking inlet port **222** to permit toner to enter inlet port **222**. Shutter **250** may be referred to herein as developer shutter **250**. In the embodiment illustrated, developer shutter **250** moves in a rear-to-front direction **217** relative to housing **212** as developer shutter **250** moves from the closed position to the open position and in a front-to-rear direction **219** relative to housing **212** as developer shutter **250** moves from the open position to the closed position. In this embodiment, developer shutter **250** includes a blocking portion **257** and a window **259**. Blocking portion **257** blocks inlet port **222** when developer shutter **250** is in the closed position as shown in FIG. **4**. When developer shutter **250** is in the open position, such as after moving in the rear-to-front direction **217** from the closed position, window **259** aligns with

inlet port **222** to allow toner to enter inlet port **222**.
(37) Developer shutter **250** is biased toward the closed position blocking inlet port **222** such as, for example, by one or more extension springs **263**, **264**. Each extension spring **263**, **264** has one end attached to a corresponding spring mount **266**, **267** on developer shutter **250** and another end attached to a corresponding spring mount **230**, **231** on housing **212**. While the example embodiment illustrated includes extension springs **263**, **264**, it will be appreciated that developer shutter **250** may be biased relative to housing **212** by any suitable biasing member as desired, including, for example, one or more compression springs, torsion springs, leaf springs, or other materials having resilient properties.
(38) In the embodiment illustrated, developer shutter **250** includes a seal **261** surrounding window **259**. Seal **261** is fixed to developer shutter **250** and moves with developer shutter **250**. In the embodiment illustrated, seal **261** includes an opening **262** that is aligned and fixed relative to window **259**. Seal **261** is positioned on a top surface of developer shutter **250** near inlet port **222** to capture any toner leaked between outlet port **122** of toner cartridge **100** and inlet port **222** and to provide a sealing force between cartridge shutter **150** and developer shutter **250** when toner cartridge **100** is inserted into image forming device **20**. Although not shown, a seal may be positioned on a bottom surface of developer shutter **250** between base **252** of developer shutter **250** and top **213** of housing **212** of developer unit **200** to help block toner from leaking from inlet port **222**.
(39) Developer shutter **250** includes an actuation tab **270** extending upward from developer shutter **250**. Actuation tab **270** is positioned along the insertion path of projection **174** of cartridge shutter **150** to receive an actuation force from toner cartridge **100** against the biasing force of extension springs **263**, **264** to move developer shutter **250** from the closed position to the open position during insertion of toner cartridge **100** into image forming device **20**, as discussed below.
(40) In the embodiment illustrated, developer unit **200** includes a cam rib **280** extending upward from a top **213** of housing **212** and along a side **203** of housing **212**. In the embodiment illustrated, cam rib **280** is positioned at a downstream location from developer shutter **250** relative to the front-to-rear direction **219** of housing **212**. Cam rib **280** is positioned along the path of insertion of engagement arm **137** of shutter lock **130** to provide an actuation force to engagement arm **137** of shutter lock **130** to move shutter lock **130** from the lowered position to the raised position against the biasing force of spring **147** to thereby move locking arm **139** from the locked position to the unlocked position during insertion of toner cartridge **100** into image forming device **20**. Cam rib **280** includes a cam surface **285**. When engagement arm **137** of shutter lock **130** engages cam rib **280** of developer unit **200** during insertion of toner cartridge **100** into image forming device **20**, engagement arm **137** contacts and slides along cam surface **285** of cam rib **280** as toner cartridge **100** is further inserted into image forming device **20**. To reduce frictional resistance between contact points, engagement arm **137** and cam surface **285** may be made from materials having relatively small coefficients of friction.
(41) FIGS. **5**A-**5**E illustrate the operation of shutter lock **130** during insertion of toner cartridge **100** into image forming device **20** with developer unit **200** in its final installed position in image forming device **20** according to one example embodiment. The direction of insertion of toner cartridge **100** into image forming device **20** is indicated by arrow A in FIGS. **5**A-**5**E. As discussed above, toner cartridge **100** is inserted into image forming device **20** generally along longitudinal dimension **114** of toner cartridge **100** with front end **107** of body **104** leading and rear end **108** of body **104** trailing. In the embodiment shown, guide post **164** of toner cartridge **100** travels along a corresponding guide rail **90** in image forming device **20** to assist with the insertion of toner cartridge **100** into image forming device **20**. In the example embodiment illustrated, guide post **166** of toner cartridge **100** also travels along a corresponding guide rail (not shown) in image forming device **20** to assist with the insertion of toner cartridge **100** into image forming device **20**.
(42) FIG. **5**A shows toner cartridge **100** during insertion into image forming device **20** with shutter

lock **130** of toner cartridge **200** approaching cam rib **280** of developer unit **200** as toner cartridge **100** moves in direction of insertion A. Shutter lock **130** of toner cartridge **100** is in the lowered position with locking arm **139** in the locked position as a result of the bias applied by spring **147**. Blocking surface **140** of locking arm **139** is positioned in the sliding path of cartridge shutter **150**. Cartridge shutter **150** and developer shutter **250** are in their respective closed positions as a result of the bias applied by springs **176**, **263**, respectively. In the embodiment illustrated, guide post **164** moves up a raised section **92** of guide rail **90** causing front end **107** of toner cartridge **100** to move upward relative to developer unit **200** allowing extension **180** of cartridge shutter **150** to lift away from developer shutter **250**.

(43) FIG. **5**B shows toner cartridge **100** advanced forward in the direction of insertion A of toner cartridge **100** from the position shown in FIG. **5**A. In the embodiment illustrated, camming surface **138** of engagement arm **137** of shutter lock **130** initially contacts cam rib **280** of developer unit **200**. Shutter lock **130** of toner cartridge **100** is in the lowered position and locking arm **139** is in the locked position with blocking surface **140** positioned in the sliding path of cartridge shutter **150**. As guide post **164** travels along raised section **92** of guide rail **90**, extension **180** of cartridge shutter **150** moves forward in direction of insertion A above developer shutter **250**, clear of seal **261** in order to avoid damaging seal **261**, which could cause toner leakage or failure of toner to flow through opening **262** of seal **261**.

(44) As toner cartridge **100** advances further forward in the direction of insertion A of toner cartridge **100** from the position shown in FIG. **5**B, engagement arm **137** of shutter lock **130** travels along cam surface **285** of cam rib **280** and extension **180** of cartridge shutter **150** moves past seal **261** of developer shutter **250** as shown in FIG. **5**C. As guide post **164** moves down raised section **92** of guide rail **90**, front end **107** of toner cartridge **100** moves downward allowing cam rib **280** of developer unit **200** to push engagement arm **137** of shutter lock **130** upward against the biasing force of spring **147** causing locking arm **139** of shutter lock **130** to move from the locked position to the unlocked position with blocking surface **140** clear of the sliding path of cartridge shutter **150**. Also, as guide post **164** moves down raised section **92** of guide rail **90** and front end **107** of toner cartridge **100** moves downward, cartridge shutter **150** contacts seal **261** of developer shutter **250**.

(45) Further, in the embodiment illustrated, front face **175** of projection **174** of cartridge shutter **150** contacts actuation tab **270** of developer shutter **250** as locking arm **139** moves toward the unlocked position. In the position shown, window **159** of cartridge shutter **150** aligns with window **259** of developer shutter **250** along vertical dimension **112** while cartridge shutter **150** and developer shutter **250** remain in their respective closed positions. In this embodiment, seal **261** of developer shutter **250** contacts cartridge shutter **150** in the area surrounding window **159** of cartridge shutter **150** prior to developer shutter **250** moving from the closed position toward the open position in order to seal the interface between cartridge shutter **150** and developer shutter **250** prior to opening shutters **150**, **250** in order to help contain the toner transferring from outlet port **122** of toner cartridge **100** to inlet port **222** of developer unit **200** and reduce toner leakage.

(46) FIG. **5**D shows toner cartridge **100** advanced forward in the direction of insertion A from the position shown in FIG. **5**C just prior to toner cartridge **100** reaching its final installed position in image forming device **20**. In the embodiment illustrated, locking arm **139** of shutter lock **130** remains in the unlocked position with blocking surface **140** clear of the sliding path of cartridge shutter **150** as engagement arm **137** slides along cam surface **285** of cam rib **280**. While locking arm **139** of shutter lock **130** is held in the unlocked position, cartridge shutter **150** pushes open developer shutter **250**. Specifically, as toner cartridge **100** advances from the position shown in FIG. **5**C with front face **175** of projection **174** of cartridge shutter **150** in contact with actuation tab **270** of developer shutter **250**, the force applied to developer shutter **250** by projection **174** of cartridge shutter **150** overcomes the bias applied to developer shutter **250** by spring **263** allowing projection **174** of cartridge shutter **150** to push developer shutter **250** toward its open position. With locking arm **139** of shutter lock **130** in the unlocked position clear of the sliding path of cartridge

shutter **150** while cartridge shutter **150** pushes open developer shutter **250**, contact between locking arm **139** and cartridge shutter **150** may be avoided in case cartridge shutter **150** moves slightly in front-to-rear direction **115***a* relative to toner cartridge **100** against the biasing force of extension springs **176**, **177** of cartridge shutter **150** while cartridge shutter **150** moves developer shutter **250** in rear-to-front direction **217** (direction of insertion A) against the biasing force of extension springs **263**, **264** of developer shutter **250**. By having locking arm **139** of shutter lock **130** raised in the unlocked position while cartridge shutter **150** pushes open developer shutter **250**, no force from shutter lock **130** may influence the operation between cartridge shutter **150** and developer shutter **250**. Accordingly, in this embodiment, shutter lock **130** may operate independently from the opening and closing operations of cartridge shutter **150** and developer shutter **250**. When projection **174** of cartridge shutter **150** has pushed developer shutter **250** to its open position, window **159** of cartridge shutter **150** and window **259** of developer shutter **250** align with inlet port **222** of developer unit **200**. Further, in the embodiment illustrated, extension **180** of cartridge shutter **150** begins to contact an engagement surface **95** in image forming device **20** as developer shutter **250** reaches the open position.

(47) In one embodiment, the respective biasing forces urging cartridge shutter **150** and developer shutter **250** towards their closed positions are selected such that the biasing force on cartridge shutter **150** prevents the reaction force applied to projection **174** of cartridge shutter **150** by actuation tab **270** from moving cartridge shutter **150** to a position unblocking outlet port **122** of toner cartridge **100** as projection **174** of cartridge shutter **150** pushes open developer shutter **250** during insertion of toner cartridge **100** into image forming device **20**. In one embodiment, extension springs **176**, **177** acting on cartridge shutter **150** may have a combined spring force that holds cartridge shutter **150** in its closed position and/or prevents cartridge shutter **150** from unblocking outlet port **122** while cartridge shutter **150** pushes open developer shutter **250**. For example, the combined spring force of extension springs **176**, **177** that biases cartridge shutter **150** towards its closed position may be greater than the combined spring force of extension springs **263**, **264** that biases developer shutter **250** towards its closed position to allow cartridge shutter **150** to move developer shutter **250** in rear-to-front direction **217** (direction of insertion A) against the biasing force of extension springs **263**, **264** of developer shutter **250** to unblock inlet port **222** of developer unit **200** without causing cartridge shutter **150** to move in front-to-rear direction **115***a* relative to toner cartridge **100** against the biasing force of extension springs **176**, **177** of cartridge shutter **150** to unblock outlet port **122** of toner cartridge **100**.

(48) FIG. **5**E shows toner cartridge **100** in its final installed position in image forming device **20**, advanced forward in the direction of insertion A of toner cartridge **100** from the position shown in FIG. **5**D. In the embodiment illustrated, developer shutter **250** is held by cartridge shutter **150** in the open position while cartridge shutter **150** moves from the closed position to the open position with locking arm **139** of shutter lock **130** held in the unlocked position as engagement arm **137** travels along cam surface **285** of cam rib **280**. Specifically, as toner cartridge **100** advances in direction of insertion A with extension **180** of cartridge shutter **150** in contact with engagement surface **95** in image forming device **20**, the force applied to extension **180** of cartridge shutter **150** by engagement surface **95** overcomes the bias applied to cartridge shutter **150** by springs **176**, **177** allowing engagement surface **95** to hold cartridge shutter **150** in place (i.e., stationary relative to developer unit **200**) against the biasing force of springs **176**, **177** as toner cartridge **100** moves towards its final installed position. In this manner, developer shutter **250** is held in its open position by cartridge shutter **150** while cartridge shutter **150**, although stationary relative to image forming device **20**, moves in front-to-rear direction **115***a* relative to body **104** of toner cartridge **100** toward its open position sliding below locking arm **139** of shutter lock **130** as toner cartridge **100** moves in direction of insertion A towards its final position in image forming device **20**. In the embodiment illustrated, engagement surface **95** forms part of a basket or tray that holds developer unit **200** in image forming device **20**. In other embodiments, any internal feature or datum in image forming

device **20** may contact extension **180** of cartridge shutter **150** to hold cartridge shutter **150** in place while toner cartridge **100** moves toward its final installed position in image forming device **20**. In other embodiments, developer shutter **250** contacts a stop upon reaching the open position of developer shutter **250** and contact between front face **175** of projection **174** of cartridge shutter **150** and actuation tab **270** of developer shutter **250** holds cartridge shutter **150** in place while toner cartridge **100** moves toward its final installed position in image forming device **20**.

(49) In the example embodiment illustrated, when toner cartridge **100** is fully inserted into image forming device **20**, in its final installed position in image forming device **20**, contact between engagement arm **137** of shutter lock **130** and cam rib **280** of developer unit **200** holds locking arm **139** of shutter lock **130** in the unlocked position with locking arm **139** spaced above rear end **153** of cartridge shutter **150**. In addition, contact between engagement surface **95** in image forming device **20** and extension **180** of cartridge shutter **150** of toner cartridge **100** holds cartridge shutter **150** in the open position which, in turn, holds developer shutter **250** in the open position as a result of contact between front face **175** of projection **174** of cartridge shutter **150** and actuation tab **270** of developer shutter **250**. In this embodiment, when toner cartridge **100** is in its final installed position in image forming device **20**, a latch in image forming device **20** restrains toner cartridge **100** in a direction from front end **107** of body **104** toward rear end **108** of body **104** along longitudinal dimension **114**, overcoming the spring force from springs **176**, **177** on toner cartridge **100** and the reaction force applied to projection **174** of cartridge shutter **150** by actuation tab **270** of developer shutter **250** and preventing these forces from pushing toner cartridge **100** out of image forming device **20**. When cartridge shutter **150** and developer shutter **250** are in their respective open positions, outlet port **122** and window **159** of cartridge shutter **150** of toner cartridge **100** are aligned with inlet port **222** and window **259** of developer shutter **250** of developer unit **200**.

(50) When toner cartridge **100** is removed from image forming device **20**, the above sequence is reversed. The biasing force applied by springs **176**, **177** returns cartridge shutter **150** of toner cartridge **100** to the closed position as toner cartridge **100** moves from the position shown in FIG. **5**E to the position shown in FIG. **5**D, and the biasing force applied by springs **263**, **264** returns developer shutter **250** to the closed position as toner cartridge **100** moves from the position shown in FIG. **5**D to the position shown in FIG. **5**C. Locking arm **139** remains in the unlocked position until guide post **164** moves up raised section **92** of guide rail **90** lifting front end **107** of toner cartridge **100** and allowing the biasing force applied by spring **147** to move shutter lock **130** toward the lowered position and locking arm **139** toward the locked position thereby returning blocking surface **140** to the sliding path of cartridge shutter **150** as shown in FIG. **5**B. When engagement arm **137** of shutter lock **130** disengages from cam rib **280** of developer unit **200** as toner cartridge **100** is further removed from image forming device **20**, spring **147** fully returns shutter lock **130** to the lowered position and locking arm **139** to the locked position as shown in FIG. **5**A.

(51) The above example embodiments show cam rib **280** of developer unit **200** contacting engagement arm **137** of lock body **135** near the bottom end of camming surface **138**. In other embodiments, cam rib **280** may contact any portion of camming surface **138** of engagement arm **138** as engagement arm **137** initially contacts cam rib **280** during insertion of toner cartridge **100** into image forming device **20**. Engagement arm **137** may then slide upward as camming surface **138** slides along cam rib **280** as toner cartridge **100** is further inserted into image forming device **20** until contact between camming surface **138** of engagement arm **137** and cam rib **280** reaches the bottom end of camming surface **138**, after which camming surface **138** may then slide along cam surface **285** of cam rib **280**.

(52) The above example embodiments show locking arm **139** spaced above rear end **153** of cartridge shutter **150** when toner cartridge **100** is in its final installed position in image forming device **20**. In other embodiments, locking arm **139** may be configured to move towards cartridge shutter **150** as cartridge shutter **150** approaches the open position. For example, in the embodiment illustrated in FIG. **6**, cam surface **285** of cam rib **280** of developer unit **200** may include an angled

ramp **287** such that engagement arm **137** of shutter lock **130** may slide down angled ramp **287** as engagement arm **137** remains in contact with cam surface **285** of cam rib **280** as result of the biasing force of spring **147** when toner cartridge **100** moves toward its final installed position in image forming device **20** with cartridge shutter **150** moving towards the open position. In this manner, any residual reaction force that may act to push toner cartridge **100** upward or developer unit **200** downward due to contact between toner cartridge **100** and developer unit **200** via shutter lock **130** may be reduced or eliminated. In one example embodiment, ramp **287** may be shaped to taper downward such that locking arm **139** rests on top of cartridge shutter **150** when cartridge shutter **150** is in the open position and toner cartridge **100** is in its final installed position. This eliminates any continual reaction force or other extraneous forces on toner cartridge **100** and developer unit **200** from the biasing force of spring **147** allowing toner cartridge **100** and developer unit **200** to be kept more accurately located against their corresponding positional datums in image forming device **20**.

(53) In the embodiment illustrated in FIG. **6**, ramp **287** of cam rib **280** allows locking arm **139** of shutter lock **130** to move towards cartridge shutter **150** when cartridge shutter moves towards the open position as toner cartridge **100** moves toward its final installed position. In other alternative embodiments, features that allow locking arm **139** to move downward towards cartridge shutter **150** as toner cartridge **100** approaches its final installed position and to move upward away from cartridge shutter **150** when toner cartridge **100** is removed may be provided on engagement arm **137** of shutter lock **130**. For example, in the embodiment illustrated in FIG. **7**, the profile of engagement arm **137** may have a tapered lead-in surface **238** opposite camming surface **138** that contacts cam rib **280** to facilitate upward movement of engagement arm **137** and, consequently, upward movement of locking arm **139** as cartridge shutter **150** moves from the open position to the closed position as toner cartridge **100** is removed from image forming device **20**.

(54) In the above example embodiments, shutter lock **130** operates independently in a way which does not interfere with the opening and closing operation of cartridge shutter **150**. In other alternative example embodiments, shutter lock **130** may be used to control timing and sequencing of the opening and/or closing operation of cartridge shutter **150** as desired. For example, a spring force may be applied to cartridge shutter **150** such that cartridge shutter **150** is held against blocking surface **140** of locking arm **139** before engagement arm **137** of shutter lock **130** contacts cam rib **280** of developer unit **200** during insertion of toner cartridge **100** into image forming device. When engagement arm **137** of shutter lock **130** contacts cam rib **280** and moves toward the raised position as engagement arm **137** slides along cam surface **285**, locking arm **139** is released from contact with cartridge shutter **150** thereby permitting cartridge shutter **150** to move from the closed position to the open position.

(55) Further, although the example image forming device **20** discussed above includes four toner cartridges **100** and corresponding developer units **200** and PC units **300**, more or fewer replaceable units may be used depending on the color options needed. For example, in one embodiment, the image forming device includes a single toner cartridge and corresponding developer unit and PC unit in order to permit monochrome printing.

(56) The foregoing description illustrates various aspects of the present disclosure. It is not intended to be exhaustive. Rather, it is chosen to illustrate the principles of the present disclosure and its practical application to enable one of ordinary skill in the art to utilize the present disclosure, including its various modifications that naturally follow. All modifications and variations are contemplated within the scope of the present disclosure as determined by the appended claims. Relatively apparent modifications include combining one or more features of various embodiments with features of other embodiments.

Claims

1. A toner container for use in an image forming device, comprising: a body having a reservoir for holding toner; a toner port on the body in fluid communication with the reservoir; a shutter translatable along a first dimension between a closed position blocking the toner port and an open position unblocking the toner port; and a lock translatable along a second dimension orthogonal to the first dimension between a locked position blocking the shutter from moving from the closed position to the open position and an unlocked position unblocking the shutter permitting the shutter to move from the closed position to the open position.
2. The toner container of claim 1, wherein the first dimension is a horizontal dimension, and the second dimension is a vertical dimension.
3. The toner container of claim 2, wherein the lock moves upward when the lock moves from the locked position to the unlocked position, and the lock moves downward when the lock moves from the unlocked position to the locked position.
4. The toner container of claim 1, wherein the lock includes a locking arm having a blocking surface, the locking arm is movable between the locked position where the blocking surface is positioned in a path of the shutter blocking the shutter from moving from the closed position to the open position and the unlocked position where the blocking surface is positioned clear from the path of the shutter permitting the shutter to move from the closed position to the open position.
5. The toner container of claim 4, wherein the locking arm is spaced from the shutter when the lock is in the unlocked position and the shutter is in the open position.
6. The toner container of claim 4, wherein the locking arm contacts the shutter when the lock is in the unlocked position and the shutter is in the open position.
7. The toner container of claim 4, wherein the lock includes a camming surface positioned to receive a force from a corresponding surface in the image forming device that causes the lock to move from the locked position to the unlocked position during installation of the toner container into the image forming device.
8. A toner container for use in an image forming device, comprising: a body having a reservoir for holding toner; a toner port on the body in fluid communication with the reservoir; a shutter translatable along a horizontal dimension between a closed position blocking the toner port and an open position unblocking the toner port; and a lock movable upward and downward between a locked position blocking the shutter from moving from the closed position to the open position and an unlocked position permitting the shutter to move from the closed position to the open position.
9. The toner container of claim 8, wherein the lock is translatable upward and downward between the locked position and the unlocked position.
10. The toner container of claim 9, wherein the lock moves upward when the lock moves from the locked position to the unlocked position, and the lock moves downward when the lock moves from the unlocked position to the locked position.
11. The toner container of claim 9, wherein the lock is translatable along a vertical dimension orthogonal to the horizontal dimension.
12. The toner container of claim 8, wherein the lock includes a locking arm having a blocking surface, the locking arm is movable between the locked position where the blocking surface is positioned in a path of the shutter blocking the shutter from moving from the closed position to the open position and the unlocked position where the blocking surface is positioned clear from the path of the shutter permitting the shutter to move from the closed position to the open position.
13. The toner container of claim 12, wherein the locking arm is spaced from the shutter when the lock is in the unlocked position and the shutter is in the open position.
14. The toner container of claim 12, wherein the locking arm contacts the shutter when the lock is in the unlocked position and the shutter is in the open position.
15. The toner container of claim 12, wherein the lock includes a camming surface for contacting a corresponding surface in the image forming device during insertion of the toner container into the

image forming device and receiving an actuation force from the corresponding surface in the image forming device to move the lock from the locked position to the unlocked position.

16. A toner container for use in an image forming device, comprising: a body having a top, a bottom, a first side and a second side positioned between a first longitudinal end and a second longitudinal end of the body, a longitudinal dimension of the toner container that is orthogonal to a vertical dimension of the toner container extends between the first longitudinal end of the body and the second longitudinal end of the body, the first longitudinal end of the body leads during insertion of the toner container into the image forming device and the second longitudinal end of the body trails during insertion of the toner container into the image forming device, the body has a reservoir for holding toner; an outlet port on the bottom of the body for exiting toner from the reservoir; a shutter movable along the longitudinal dimension of the body between a closed position blocking the outlet port and an open position unblocking the outlet port, the shutter moves in a direction away from the first longitudinal end of the body and toward the second longitudinal end of the body when the shutter moves from the closed position to the open position and the shutter moves in a direction away from the second longitudinal end of the body and toward the first longitudinal end of the body when the shutter moves from the open position to the closed position; and a lock positioned on the first side of the body and movable along the vertical dimension of the body between a locked position blocking the shutter from moving from the closed position to the open position and an unlocked position permitting the shutter to move from the closed position to the open position.

17. The toner container of claim 16, wherein the lock is translatable along the vertical dimension of the body between the locked position and the unlocked position.

18. The toner container of claim 17, wherein the shutter is translatable along the longitudinal dimension of the body between the closed position and the open position.

19. The toner container of claim 16, wherein the lock moves upward when the lock moves from the locked position to the unlocked position, and the lock moves downward when the lock moves from the unlocked position to the locked position.

20. The toner container of claim 16, wherein the lock includes a locking arm having a blocking surface, the locking arm is movable between the locked position where the blocking surface is positioned in a path of the shutter blocking the shutter from moving from the closed position to the open position and the unlocked position where the blocking surface is positioned clear from the path of the shutter permitting the shutter to move from the closed position to the open position.

21. The toner container of claim 20, wherein the locking arm is spaced from the shutter when the lock is in the unlocked position and the shutter is in the open position.

22. The toner container of claim 20, wherein the locking arm contacts the shutter when the lock is in the unlocked position and the shutter is in the open position.

23. The toner container of claim 20, wherein the lock includes a camming surface for contacting a corresponding surface in the image forming device during insertion of the toner container into the image forming device and receiving an actuation force from the corresponding surface in the image forming device to move the lock from the locked position to the unlocked position.

24. The toner container of claim 23, wherein the camming surface is positioned on an engagement arm of the lock spaced apart from the locking arm.

25. The toner container of claim 24, wherein the engagement arm and the locking arm extend downward from the lock.