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"TONER CARTRIDGE"

The present invention relates to a toner cartridge for use in an image forming apparatus of the type having a developing unit for developing a latent image electrostatically formed on a photoconductive element or similar image carrier by using a developer, or toner, and using a toner cartridge which is filled with a toner and loaded in the developing unit.

In an image forming apparatus of the type described which may, for example, be an electrophotographic copier, printer or facsimile machine, a toner stored in a developing unit is consumed every time an image is formed and, in due course, the supply becomes depleted. A toner cartridge filled with a toner has customarily been loaded in the developing unit in order to supply the toner as needed. To promote accurate manipulations for such toner supply, the image forming apparatus is usually constructed to sense the short supply of toner in the developing unit and display the shortage on a display, thereby urging one to supply toner. Specifically, one is urged to remove the used toner cartridge and then load a fresh toner cartridge in the developing unit.

The prior art apparatus, however, provides no visible instructions as to what the operator is expected to execute after dismounting the used toner cartridge or after mounting a fresh toner cartridge. This often

perplexes the operator concerning the kind of work which should be done after the removal or insertion of a toner cartridge. Moreover, it may occur that after mounting a fresh toner cartridge by a troublesome manipulation one forgets an expected manipulation for feeding the toner to the developing unit, i.e., the image forming operation continues without the toner being supplied at all.

Summary of the Invention

It is therefore an object of the present invention to provide a toner cartridge for use with an image forming apparatus such that anyone can execute a toner supplying sequence without fail.

In accordance with the present invention, we provide a toner cartridge to be removably mounted on an image forming apparatus to supply toner to the apparatus to develop a latent image electrostatically formed on an image carrier, the cartridge comprising:

a body for accommodating the toner;

a shutter mounted on an opening which is formed through said body for movement to cover and to uncover said opening; and

an actuator provided on said shutter for actuating a shutter sensor which is mounted on said image forming apparatus for sensing opening of said shutter.

Brief Description of the Drawings

The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description, taken with the accompanying drawings, in which:-

Figure 1 is a sectional side elevation schematically showing an image forming apparatus (a copier) with which the toner cartridge of the present invention is to be used;

Figure 2 is a perspective view of the copier shown in Figure 1;

Figure 3 is a perspective view of a lid which is mounted on a door cover of the copier and an internal arrangement of a toner cartridge inlet portion which is uncovered by the lid;

Figure 4 is a sectional side elevation of a developing unit installed in the copier;

Figure 5 is a perspective view of a toner cartridge of the illustrative embodiment;

Figure 6 is a sectional side elevation of an arrangement around the toner cartridge inlet portion, in which a microswitch constituting a shutter sensor and its associated construction are omitted; and

Figure 7 is a sectional side elevation showing an arrangement provided in the innermost part of the copier with respect to an intended direction of cartridge insertion.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Fig. 1 of the drawings, an image forming apparatus ~~embodying the present invention~~ is shown which is implemented as an electrophotographic copier by way of example. As shown, the copier has a copier body 100 and an ADF (Automatic Document Feeder) 1 which is mounted on the top of the copier body 100. The ADF 1 feeds sheet documents, print-out paper for computer use or similar documents toward a glass platen 2 one by one. Each document reaching the glass platen 2 is driven thereoutof to be returned to the ADF 1 or to be discharged onto either one of trays 3 and 4. On reaching the glass platen 2, the document is instantly illuminated by a light source 5 over its entire surface through a mirror 6. A reflection from the document is steered by a mirror 7, a lens 8 and a mirror 9 to be focused onto a photoconductive element 11. The photoconductive element in the form of a belt 11 is driven in a direction indicated by an arrow in the figure. The belt 11 is uniformly charged by a main charger 12 before the above-mentioned exposure to the reflection from the document, so that an electrostatic latent image is formed on the belt 11 by the imagewise exposure. A developing unit 13 develops the latent image on the belt 11 by a toner. A transfer charger 10 transfers by corona discharge the resulting toner image from the belt 11 to a paper sheet which is fed from a sheet feed section 14 via a register roller pair 15. The paper sheet having undergone the

image transfer is transported through a fixing unit 16 to a tray 17 provided on the top of the copier body 100. After the image transfer, the surface of the belt 11 is cleaned by a cleaning unit 20 to remove remaining toner particles and impurities.

A toner density sensor 119 is disposed on the toner transport path for sensing the density of the toner being used to develop a latent image. As the development cycle is repeated, the toner stored in the developer container 18 is sequentially consumed resulting in the toner concentration of the developer being lowered little by little. The decrease in toner density would lower the quality of toner images. In the light of this, the developing unit 13 has a toner hopper 36 which defines a toner supply chamber 21. When the toner density sensor 119 detects a decrease in the toner concentration of the developer, its output causes a toner supply roller 32a to rotate so as to feed the toner from the toner supply chamber 21 into the developer container 18. This maintains the toner concentration of the developer in the container 18 in a predetermined range.

The toner is comprised of toner particles with or without an adjuvant being added thereto.

A display 102, Figure 2, is mounted on the top front portion of the copier body 100. In response to a toner near-end signal from a near-end sensor 22, the display 102 provides a message such as "SUPPLY TONER"

thereon. This display is effected by the co-operation of the toner near-end sensor 22 and a cartridge sensor which will be described.

When a predetermined number of more copies (e.g. 3,000 more copies) are produced without any supplying of toner after the appearance of the above message on the display 102, a toner end signal will be produced to disable the entire apparatus while showing a particular message on the display 102. In the

illustrative embodiment, therefore, even if one does not supply the toner at the instant when the near-end message appears, a predetermined number of more copies can be produced by the remaining toner. If desired, an arrangement may be so made as to output the toner end signal when the toner density remains lowered throughout such an extra number of copying operations and does not increase. In any case, the copier is operable without the supply of toner after the message for urging one to supply toner has appeared.

Referring to Fig. 2, the copier body 100 has a door cover 23 at the front end thereof which is openable about hinges 24. A lid 25 is openably mounted on the door cover 23 to facilitate the removal of a jamming sheet and other manipulations. A projection, not shown, extends from the inner wall of the door cover 23, while an interlock switch, not shown, is affixed to the copier body 100. When the door cover 23 is opened, the projection will actuate the interlock switch into an OFF state to interrupt the image forming operation, i. e., the copying operation of the copier. This is successful in insuring safety operations while the door cover 23 is open. Conversely, when the door cover 23 is closed, the projection will turn the interlock switch to an ON state to resume the copying operation. As shown in Fig. 6, the lid 25 is rotatably connected to the door cover 23 by a shaft 26.

Referring to Fig. 5, a toner cartridge 27 is shown as comprising a body 127 and a shutter 27A which openably closes an opening 27b, Figs. 4 and 6, that is formed through the bottom of the body 127. The toner cartridge 27 is filled with a toner to be supplied. In the illustrative embodiment, the shutter 27A is implemented as a lid which is supported by the body 127 in such a manner as to slide in a direction indicated by an arrow A in Fig. 5. When the slidable shutter 27A is pulled out in the direction A, it uncovers the opening 27b of the body 127. Labeled 27D in Fig. 4 is a seal member affixed to the body 127 for providing seal between the body 127 and the shutter 27A. In Figs. 4 and 6, the toner cartridge 27 is shown in an operative position.

When the toner near-end sensor 22, Fig. 4, detects a toner near-end state, the display 102 shows "SUPPLY TONER" or similar message thereon as previously stated and as will be described in detail later. Urged by the message on the display 102, the operator or the serviceman pulls down the lid 25 to the horizontal position as mentioned in order to replace the toner cartridge. Then, the operator or the serviceman pulls out the empty toner cartridge 27 out of the bore 28, i. e. to the left as indicated by an arrow A in Fig. 6. It is noteworthy that the illustrative embodiment allows the image forming operation, e. g., the copying operation to be continued without interruption even during the replacement of the toner cartridge 27. Specifically, while the door cover 23 is provided with an interlocking device, the lid 25 is not and, hence, does not disturb the image forming operation under way even when it is opened.

A cartridge cover 36A is formed integrally with the toner hopper and has the bore or cartridge mounting and dismounting path 28 thereinside. After the empty toner cartridge 27 has been removed through the opening 23a, a fresh toner cartridge 27 is inserted into the bore 28 through the opening 23a in the

opposite direction to the direction A while being guided by the horizontal lid 25 and an inner cover 34 which is affixed to the toner hopper 36. The toner cartridge 27 is then positioned above the toner hopper 36. As shown in Fig. 4, the new toner cartridge 27 is also guided by guides 36B and 36C which form a part of either one of the cartridge cover 36A and toner hopper 36. In Fig. 4, labeled 36D is a seal member associated with the guide 36B for providing seal between the guide member 36B and the shutter 27A. Two ridges 25b, Fig. 3, are provided on the inner surface of the lid 25 to further facilitate the movement of the toner cartridge 27 into and out of the bore 28, i.e., the lid 25 plays the role of a guide in addition to its original role. For this purpose, the lid 25 is hinged at its lower end. Of course, one may open the door cover 23 and then mount or dismount the toner cartridge 27 by using the inner cover 34 as a guide.

The toner cartridge 27 has the shutter 27A at its bottom, as previously stated. After a new toner cartridge 27 has been positioned as shown in Figs. 6 and 7, the shutter 27A is pulled out in the direction A with the cartridge body 127 being left in the bore 28. At the time when the shutter 27A abuts against a stop, not shown, which is provided on the body 127, the opening 27b at the bottom of the body 127 is fully uncovered. If desired, an arrangement may be made such that the shutter 27A being pulled in the direction A removes a seal which is adhered to the bottom of the cartridge 27, thereby automatically

uncovering the opening 27b. When the opening 27b is uncovered, fresh toner is dropped from the toner cartridge 27 into the toner supply chamber 21 through an opening 37 which is formed through the top of the toner hopper 36. The toner supply chamber 21 has an agitating member 32 thereinside. Supplied with the fresh toner, the copier is operable for a long period of time thereafter. The agitating member 32 is driven in a rotary motion by a motor 44, Fig. 7, to agitate the toner in the toner supply chamber 21 while feeding the toner toward a toner supply roller 32. After the supply of toner, the shutter 27A of the toner cartridge 27 is pushed into the copier to the original position, and then the lid 25 is closed.

As stated above, the toner cartridge 27 can be replaced simply by opening the lid 25 which is void of an interlocking device and, therefore, without interrupting the copying operation under way. This further increases the productivity of the copier.

The cleaning device 20 shown in Fig. 1 removes remaining toner particles from the surface of the photoconductive belt 11, as stated earlier. If an arrangement is so made as to collect the removed toner or waste toner in the toner cartridge 27 which has been emptied, the need for an exclusive receptacle will be eliminated. As shown in Fig. 7, in the illustrative embodiment, a toner discharge conduit 51 is configured such that its end enters the toner cartridge 27 when the latter is inserted into the copier.

In this condition, the shutter 27A of the cartridge 27 is pulled out to let a fresh toner to drop and, after the cartridge 27 has been emptied, the shutter 27A is closed again. Then, the cartridge 27 is ready to receive the waste toner from the cleaning device 20 therein. In the event of replacement of the cartridge 27 with a new cartridge, the collected waste toner will be discarded together with the used cartridge 27. Should the waste toner be collected in an exclusive receptacle, an extra and troublesome operation would be needed to replace the receptacle after the replacement of the cartridge 27.

A problem with a prior art electrophotographic copier of the type described is that after the removal of the used toner cartridge 27 or the insertion of a new toner cartridge the copier does not indicate on a display thereof the kind of work which should be done next. In such a situation, one is apt to continue with the copying operation without the supply of toner despite having removed the used toner cartridge or inserted a new toner cartridge, forgetting to pull out the shutter, for example. Especially, when the copier, like the copier shown and described, is so constructed as to continue the copying operation even during the supply of toner in order to reduce the down time as far as possible, one often forgets to pull out the shutter.

The copier shown and described allows the waste toner to be collected in a toner cartridge, as discussed earlier. Such a configuration needs some implementations against the following

occurrences. Specifically, if the copier is continuously operated without a new toner cartridge being loaded after the removal of the used one, the waste toner will be introduced in the toner hopper to smear the background of toner images or to cause scattering of toner particles. When one forgets to pull out the shutter of a new toner cartridge after the insertion of the latter in the copier, the waste toner will be sequentially collected in the new cartridge as the copying operation is continued. Then, the waste toner fills up the cartridge together with the fresh toner and is solidified. Moreover, the waste toner is apt to block toner transport devices intervening between the cleaning unit and the toner cartridge to thereby damage such devices. In the worst case, the waste toner will fill up even the entire cleaning unit to cause solidification and overflow of toner as well as damage to the entire cleaning unit and sometimes to the photocondutive element.

In the light of the above, the copier illustrated herein not only urges one to supply toner to the developing unit 13 but also allows one to execute a sequence of steps for toner supply smoothly. A device is provided for sensing the execution of the individual steps for toner supply, while a display responsive to the outputs of the sensing device notifies the operator of the kind of work which has to be done next.

In the illustrative embodiment, the above-mentioned sensing device comprises the previously stated toner near-end sensor 22,

a cartridge sensor, responsive to the insertion of the toner cartridge 27, and a shutter sensor 61, Figure 9, responsive to opening of the shutter 27A. The toner near-end sensor 22 and cartridge sensor 60 co-operate to determine that the toner supply is needed, causing the display 102 to show a message for alerting one to such a condition.

Assume that the toner near-end sensor 22 produces a toner near-end signal due to the short supply of toner while the copier is operating with the toner cartridge 27 loaded as shown in Figure 7 and, therefore, sensed by the cartridge sensor. Then, the toner near-end signal is fed to a controller together with a cartridge sense signal. In response, the controller 69 causes the display 102 to provide the previously mentioned message "SUPPLY TONER" for urging one to replace the toner cartridge 27 and thereby supply a fresh toner to the developing unit 13.

One removes the used toner cartridge 27 by the previously described procedure as instructed by the message on the display 102. Then, the cartridge sensor indicates that the cartridge 27 has been removed. At this instant, the toner near-end sensor 22 continuously produces the toner near-end signal. The display 102 informs the operator of the next job step, i.e., inserting a new toner cartridge by displaying a message such as "INSERT NEW CARTRIDGE". Watching this message, the

operator inserts a new toner cartridge 27 to the deepest position, as stated earlier. Then, triggered by the cartridge sensor, the display 102 informs the operator of the next job to be done by a message such as "PULL CARTRIDGE SHUTTER".

As the operator pulls the shutter 27A in the direction A as instructed by the message, a shutter sensor senses the opening of the shutter 27A resulting in the message "PULL CARTRIDGE SHUTTER" being turned off. At the same time, in the illustrative embodiment, a message urging the operator to close the shutter 27A again appears on the display.

As shown in Figure 5, a recess 176 is formed in the deepest portion of the side wall 75 of the shutter 27A for receiving a roller 74 of the shutter sensor.

Assume that a new toner cartridge 27 has been loaded in the position shown in Figure 7 and sensed by the cartridge sensor 60, but the shutter 27A has not been pulled out yet. In this condition, the roller 74 is held in contact with the side wall 75 of the shutter 27A. As the operator pulls out the shutter 27A as instructed by the previously mentioned message, the recess 176 of the shutter side wall 75 approaches the roller 74 which is rolling on the side wall 75. As soon as the shutter 27A reaches the outermost or open position, the recess 176 mates with the roller 74 with the result that a shutter open signal is given to show that the shutter 27A has been

pulled out, i.e., it has been opened. In response to this the controller controls the display 102 to turn off the message "PULL CARTRIDGE SHUTTER" and, instead, produces a message such as "PUSH CARTRIDGE SHUTTER" for urging the operator to return the shutter 27A to the original position. Watching this message, the operator will push the shutter 27A to its deepest position.

It will be seen that the recess 176 of the shutter 27A constitutes a specific form of an actuator for actuating the shutter sensor which is responsive to opening of the shutter 27A. Preferably, the recess 176 should be positioned such that it actuates the shutter sensor when the shutter 27A is fully pulled out. In this embodiment, therefore, the recess 176 is located at the innermost position. If desired, the recess 176 may be replaced with a notch or a projection. Such an exclusive actuating portion may even be omitted if an arrangement is made to move the roller 74 and thereby operate the shutter sensor when the side wall 75 of the shutter 27A moves away from the roller 74.

In the embodiment shown and described, it is when the amount of toner remaining in the toner hopper 36 is reduced that

the toner near-end sensor 22 determines that the toner supply is short. Alternatively, a toner shortage sensor one specific form of which is the near-end sensor 22 may be responsive to a condition wherein the amount of toner remaining in the toner hopper 36 is substantially zero.

In the illustrative embodiment, the toner from the toner supply chamber 21 is fed into the developer container 18, and the toner cartridge 27 is loaded in the toner hopper 36 to supply the toner into the chamber 21. The present invention is, of course, applicable to any other type of developing device such as a device wherein a toner cartridge is directly mounted in the developer container 18 to supply a toner into the container 18, or a device operable with a one-component developer which does not contain a carrier.

In summary, the present invention allows one to surely complete a sequence of steps for toner supply, i. e., from the removal of the used toner cartridge to the insertion of a new toner cartridge while watching instructions on a display.

Various modifications will become possible for those skilled in the art after receiving the teachings of the present disclosure without departing from the scope thereof as defined by the following claims.

Various further details of the image-forming apparatus of Figures 1 to 4 are described and claimed in our GB-A-2224458 the disclosure of which is incorporated herein by reference.

C L A I M S

1. A toner cartridge to be removably mounted on an image forming apparatus to supply toner to the apparatus to develop a latent image electrostatically formed on an image carrier, the cartridge comprising:

a body for accommodating the toner;

a shutter mounted on an opening which is formed through said body for movement to cover and to uncover said opening; and

an actuator provided on said shutter for actuating a shutter sensor which is mounted on said image forming apparatus for sensing opening of said shutter.

2. A toner cartridge as claimed in claim 1, wherein said shutter is slidably mounted on said body and uncovers said opening of said body when pulled out.

3. An apparatus as claimed in claim 2, wherein said actuator is positioned relative to said shutter sensor such that said actuator actuates said shutter sensor when said shutter is pulled out to a maximal position.

4. A toner cartridge for an image forming apparatus, the cartridge being constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in Figures 3 to 7 of the accompanying drawings.

~~5. An image forming apparatus fitted with a toner cartridge according to any one of claims 1 to 4.~~