

[54] **CLEANING DEVICE IN AN
ELECTROPHOTOGRAPHIC COPYING
APPARATUS**

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[58] Field of Search **355/15, 3; 118/637,
118/203, 104, 70; 96/1.4; 15/97-100, 228,
208; 134/6; 117/112**

[56] **References Cited**

UNITED STATES PATENTS

3,099,856	8/1963	Eichorn et al.	355/15 X
2,690,582	10/1954	Sundell	15/228

2,834,695	5/1958	Scalf	134/6
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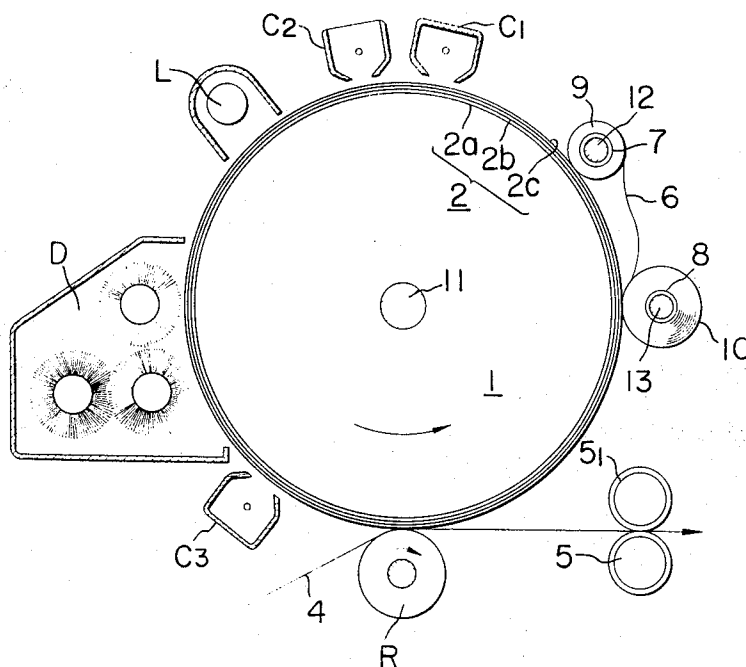
Primary Examiner—Robert P. Greiner

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[57] **ABSTRACT**

An improved cleaning device for use with an electro-photographic copying apparatus especially of the image transfer type. The cleaning device provides a cleaning web turned into S-shaped rolls and movable into contact with and away from a photosensitive medium, whereby any residual toner present on the surface of the photosensitive member can be readily removed by both sides of the cleaning web to completely prevent the formation of ghost images during the repeated use of the photosensitive medium for the image reproduction. The cleaning web can be moved from one of the rolls to the other to remove used portions of the web from the cleaning position and supply fresh portions of the web in place thereof.

10 Claims, 5 Drawing Figures



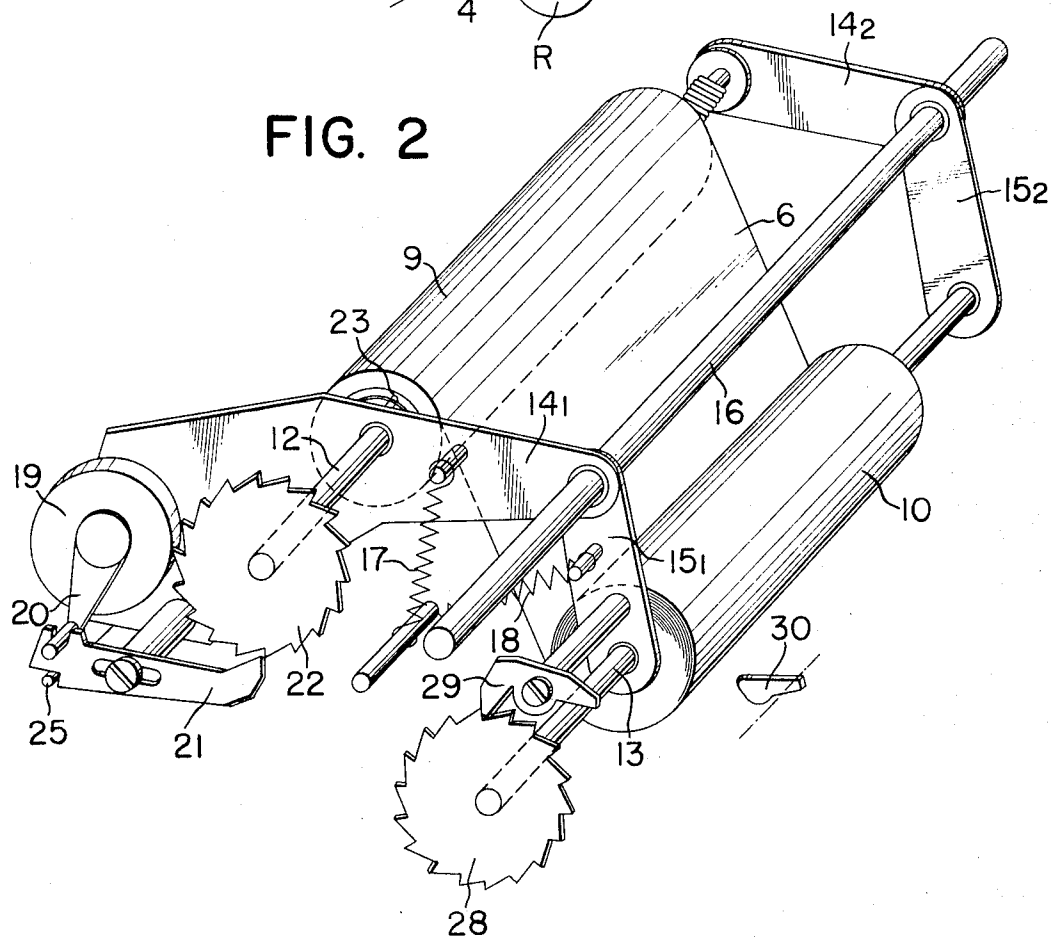
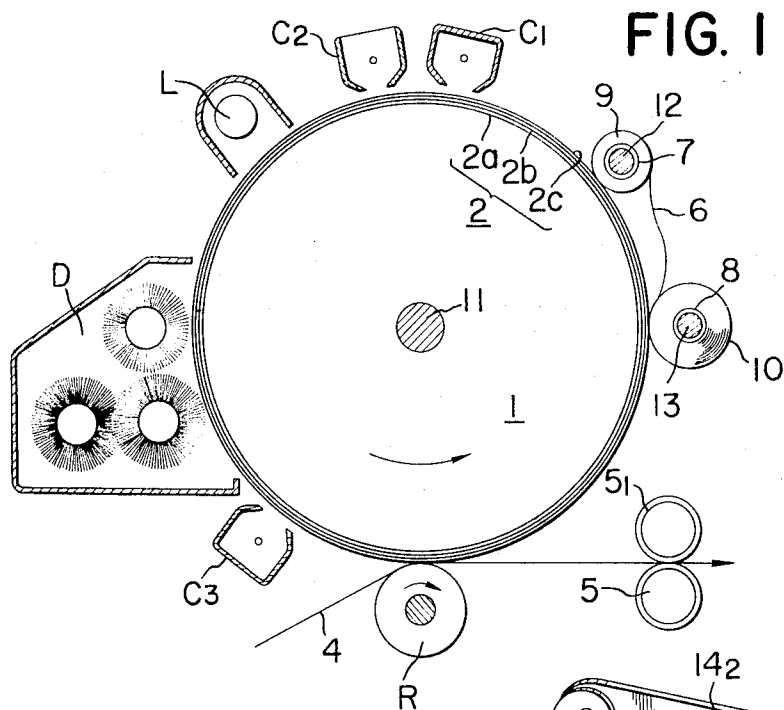


FIG. 3

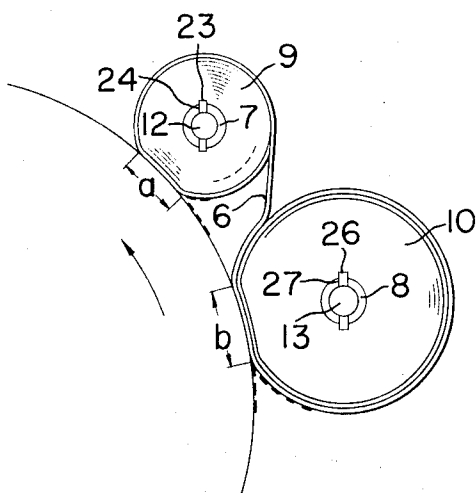


FIG. 5

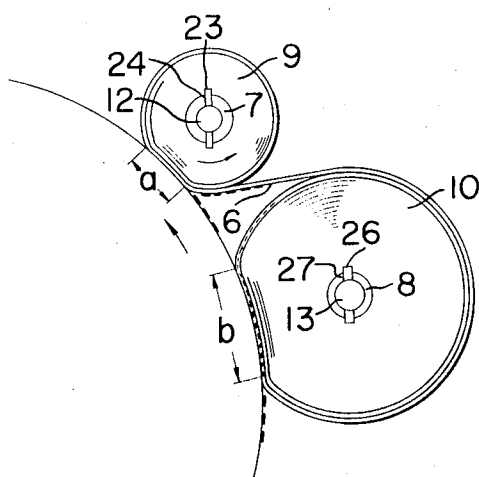
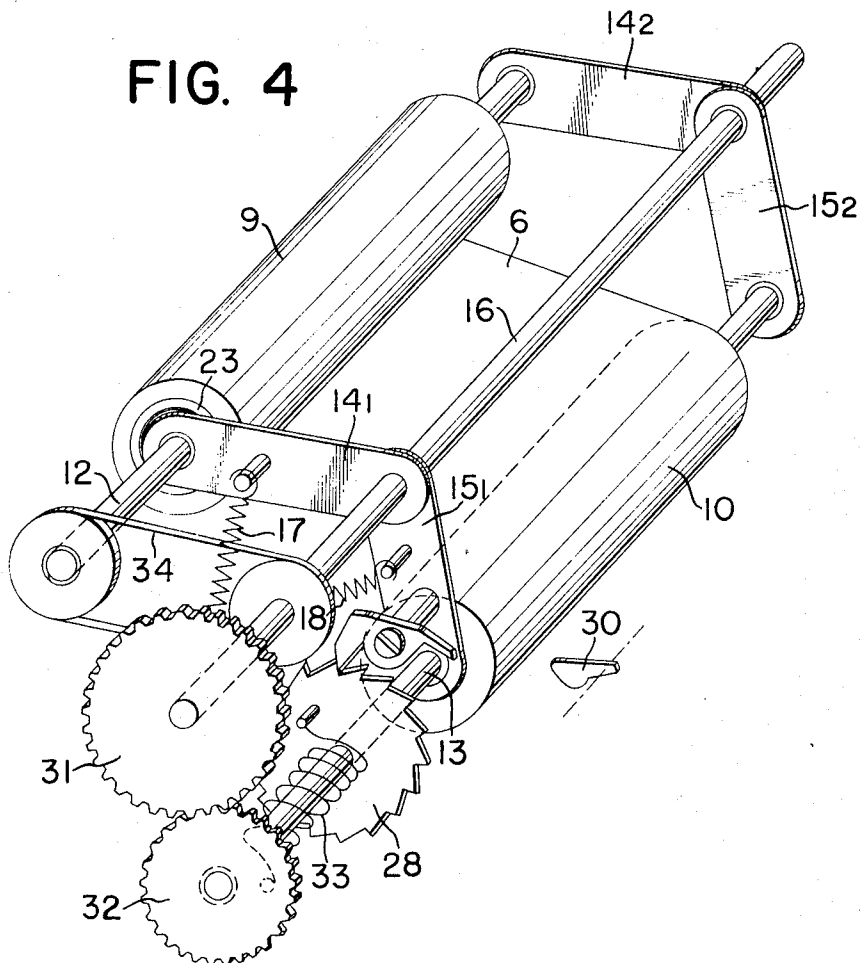


FIG. 4



CLEANING DEVICE IN AN ELECTROPHOTOGRAPHIC COPYING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a cleaning device in an electrophotographic copying apparatus, and more particularly to a cleaning device for use with an electrophotographic copying apparatus of the type in which an image formed on a photosensitive medium for electrophotography is developed and thereafter transferred onto an image transfer medium, and for removing any residual developer present on the photosensitive medium after the image transfer to thereby prevent any ghost image from being formed on that photosensitive medium when it is used for a second image reproduction.

2. Description of the Prior Art

Electrophotography is a widely known technique and a typical example of it is the electrophotographic process invented by Carlson and disclosed in U.S. Pat. No. 2,221,776. The Carlson electrophotographic process comprises the steps of uniformly charging a photosensitive medium formed of a photoconductive layer superposed on an electrically conductive support member, exposing the electrically charged surface of the photosensitive medium to light carrying an original image to thereby form an electrostatic latent image on the photosensitive medium, thereafter developing the latent image by toner in powder form, and fixing the developed image with the aid of heat or solvent or transferring the formed image onto paper or other medium and subsequently fixing the transferred image. Another typical example of the electrophotographic process is disclosed in U.S. Pat. No. 3,438,706, which uses a photosensitive medium formed of an electrically chargeable insulating layer and a photoconductive layer disposed thereon and which comprises the steps of uniformly charging the insulating layer of the photosensitive medium, illuminating an object to be copied and contemporaneously therewith applying electric charges of the opposite polarity or AC corona discharge to the photosensitive medium to thereby form an electrostatic latent image in accordance with the contrast pattern of the original image, and if required, exposing the entire surface of the photosensitive medium to light so as to improve the contrast of the electrostatic latent image, and further passing the photosensitive medium through the steps of developing, image-transferring and fixing to provide a complete copy. In addition to these, there are various other types of electrophotographic processes put into practice or proposed in the art.

According to any of the described electrophotographic processes, the image formed on the photosensitive medium tends to remain thereon even after the image transferring step, and in order to enable such photosensitive medium to be repeatedly used, it has been necessary to provide a cleaning device for removing the residual developer from the photosensitive medium.

According to the prior art, such a cleaning device used with the electrophotographic copying apparatus has employed a plurality of cleaning brushes, such as fur brushes, magnetic brushes or the like, to mechanically or electrically remove the residual developer present on the photosensitive medium. The residual devel-

oper thus removed from the photosensitive medium has been sucked by a stream of air through a filter and discharged out of the copying apparatus. For this purpose, vacuum means has been required and this has necessarily led to a large size and complicated construction of the entire apparatus, and accordingly to a high manufacturing cost thereof. The known cleaning device of the described type has proved considerably effective when it is used with the conventional electrophotographic processes known as Xerox, Electrofax and PIP systems. However, in the electrophotographic process of the type shown in the aforesaid U.S. Pat. No. 3,438,706, the residual developer remaining on the photosensitive medium after the image transfer cannot completely be removed by the known cleaning device because the electrostatic latent image formed on the photosensitive medium has a much higher surface potential than that formed by the other known electrophotographic processes. Such incomplete removal of the residual developer has resulted in the formation of undesirable ghost images on the photosensitive medium when it is repeatedly used for the image reproduction.

SUMMARY OF THE INVENTION

It is a primary object of the present invention to provide an improved cleaning device for use with an electrophotographic copying apparatus of the image transfer type and for completely removing any residual developer on the surface of a photosensitive medium after an image formed thereon has been transferred and thereby making the photosensitive medium ready for repeated use.

It is a further object of the present invention to provide an improved cleaning device for use with an electrophotographic copying apparatus of the image transfer type and employing a web in the form of rolls which is brought into contact with the surface of a photosensitive medium to remove any residual developer thereon after an image formed thereon has been transferred to an image transfer medium.

It is a still further object of the present invention to provide an improved cleaning device for use with an electrophotographic copying apparatus of the image transfer type and in which a portion of the web is used to clean the surface of the photosensitive medium after the image transfer has been effected, whereafter that portion of the web is taken up so that a subsequent cleaning action may be effected by a fresh portion of the web.

It is yet a further object of the present invention to provide an improved cleaning device for use with an electrophotographic copying apparatus of the image transfer type and in which both sides of the web are used to remove any residual developer present on the surface of a photosensitive medium after the image transfer has been effected.

It is a further object of the present invention to provide an improved cleaning device for use with an electrophotographic apparatus of the type for forming an electrostatic latent image of a high potential and in which any residual developer present on a developed image can be completely removed.

According to the present invention, the cleaning device for use with an electrophotographic copying apparatus employs means for removing the residual toner which can also serve as means for sucking and dis-

charging the removed toner particles and thereby eliminates the need to additionally provide any separate means for removing the residual toner from the surface of a photosensitive medium, filter, vacuum device and like means for discharging the removed toner there-through. More specifically, the cleaning device of the present invention employs a web-like member which can remove any residual toner from the surface of a photosensitive medium due to the friction with that surface. The removed toner particles are caused to physically enter into the interstices of the fiber forming the web and are held therebetween, whereby such toner particles may be readily removed. The web has coarse and flexible sides having a sufficiently great coefficient of friction relative to the surface of the photosensitive medium to remove any residual toner, and the web is also of such characteristics that the interstices therein can suck and hold the removed toner particles therebetween. Thus, the web of the present invention used for removing the residual toner particles, is adapted not only to remove but also hold such residual toner particles, and this eliminates the necessity of employing any vacuum device which has been required to suck the toner particles according to the prior art.

For the better understanding of these and other objects and features, the present invention will be described in greater detail with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an end view schematically showing the arrangement of various parts in an example of the electrophotographic copying apparatus incorporating the cleaning device of the present invention.

FIG. 2 is a perspective view showing a form of the cleaning device according to the present invention.

FIG. 3 is an enlarged fragmentary view for illustrating the operation of the cleaning device shown in FIG. 2.

FIG. 4 is a perspective view showing another form of the cleaning device according to the present invention which is applicable to the electrophotographic copying apparatus.

FIG. 5 is an enlarged fragmentary view for illustrating the operation of the cleaning device shown in FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, there is shown an electrophotographic copying apparatus of the drum type disclosed in the aforesaid U.S. Pat. No. 3,438,706 to which the present invention is applicable. It includes a rotary drum 1 which has the side wall thereof covered with a photosensitive medium 2 comprising a lamination of an electrically conductive substrate 2a, a photoconductive layer 2b and a transparent insulating layer 2c. Circumferentially of the rotary drum 1, there are sequentially disposed primary charging means C1, secondary charging means opposite in polarity to the primary charging means or AC corona charging means C2 provided with unshown exposure means for exposing the photosensitive medium to light carrying an original image contemporaneously with the secondary charging, an illuminator lamp L for illuminating the entire surface of the photosensitive medium 2, developing means D of either the dry type or the wet type (shown as fur brush system), charging means C3 for facilitating the transfer of an visualized powder image, an image transfer roller R

for urging an image transfer medium 4 into contact with the photosensitive medium 2, and fixing means 5 and 5', for fixing the powder image transferred onto the image transfer medium 4. A full rotation of the drum 1 provides one cycle of copying operation, and such cycle may be repeated to produce copies continuously.

The cleaning device of the present invention may be applied to the above-described copying apparatus of the drum type. Such cleaning device may comprise a web 6 of fibrous material having coarse surfaces and flexibility like tissue paper or toilet paper but having a greater strength than such paper. The web 6 is turned on spools 7 and 8 so as to provide two rolls 9 and 10 forming an arrangement similar to S-shape. These two rolls 9 and 10 are adapted to be urged into contact with the photosensitive medium 2 on the drum 1, whereby both sides of the web 6 act to clean the photosensitive medium 2. In other words, the web 6 twice cleans the photosensitive medium 2 because the S-shaped arrangement of the web 6 on the two rolls 9 and 10 enables the different surfaces of the web to contact the photosensitive medium 2 at the same time.

The material forming the web 6 should preferably be of the following characteristics. For example, if the residual toner on the surface of the photosensitive medium 2 is the result of the dry type development, the material of the web 6 should be paper, ordinary fibrous fabric, fabric with set-up hairs, paper containing synthetic fibers or like material which has such a coefficient of friction that will provide a sufficient frictional force relative to the surface of the photosensitive medium to remove the residual toner therefrom, or alternatively the web 6 should be formed of a material having such flexibility and coarseness as to allow toner particles to enter into the interstices on the surface of the web and be held between such interstices. If the residual toner present on the photosensitive medium has resulted from the wet type development, the web 6 should preferably be formed of a material which presents not only all the described characteristics but also a great capacity of impregnation for the carrier liquid and a great tensile strength sufficient to resist the destruction arising from the impregnation. For instance, fabric, paper containing synthetic fibers or like material may be used in the latter case with satisfactory results.

Referring now to FIGS. 2 and 3 which show the details of the cleaning device according to an embodiment of the present invention, the web 6 has substantially the same width as the photosensitive medium 2, and the opposite ends of the web are secured to spools 7 and 8 (FIG. 3) and the intermediate portion of the web is turned on these spools to form the rolls 9 and 10 connected together in the reversed S-shape. The spools 7 and 8 are mounted on shafts 12 and 13, respectively, which are parallel to a shaft 11 (FIG. 1) having the rotary drum 1 mounted thereon. The side walls of the respective rolls 9 and 10 or the opposite sides of the web 6 are brought into contact with the surface of the photosensitive medium 2 on the drum 1. The shafts 12 and 13 are supported by sets of pivot arms 14₁, 14₂ and 15₁, 15₂ which are all pivotally mounted on a common shaft 16. Springs 17 and 18 are connected to the pivot arms 14₁ and 15₁, respectively, so as to urge the rolls 9 and 10 into contact with the surface of the photosensitive medium 2. The area of contact of the rolls 9 and 10 with the photosensitive medium 2 is made as great as

possible by the elasticity of the rolls, as indicated at *a* and *b* in FIG. 3 or 5.

After a powder image formed on the photosensitive medium 2 has been transferred onto the image transfer medium 4 with the aid of the image transfer roller R in the known manner (FIG. 1), the photosensitive medium 2 is first cleaned by one side of the web 6 forming the roll 10, and then by the other side of the web 6 forming the roll 9. Thus, the photosensitive medium 2 is cleaned twice by the web 6. In addition to this, the wide surface contact between the web 6 and the photosensitive medium 2 as shown by *a* and *b* in FIG. 3 or 5 serves to enhance the cleaning effect and at the same time the toner particles residual on the photosensitive medium 2 are all absorbed into the coarse interstices of the fiber forming the web 6, whereby the photosensitive medium 2 can be perfectly cleaned.

The portions of the web 6 on the rolls 9 and 10 which have thus cleaned the photosensitive medium 2 must be replaced by fresh web portions. Two examples of means for accomplishing this are shown in FIGS. 2-3 and FIGS. 4-5.

In the arrangement of FIGS. 2-3, the rolls 9 and 10 are disengaged from the surface of the photosensitive medium 2 after each cycle of the copying process, that is, every time the drum 1 has made one full rotation to complete one cleaning step, and thereafter a suitable length of the web 6 is taken up by the roll 9. This is achieved by a cam (not shown) which is operable in synchronism with the rotation of the drum 1 so as to force the shafts 12 and 13 and accordingly the rolls 9 and 10 thereon to move away from the photosensitive medium 2 against the springs 17 and 18 upon completion of the cleaning step. When both rolls 9 and 10 are thus disengaged from the photosensitive medium 2, the roll 9 is rotated in the direction to take up the web 6. Means for driving the roll 9 for such rotation may be a motor or a feed mechanism associated with the rotation of the drum 1, but in the shown example use is made of a rotary solenoid 19 which, when electrically energized, rotates a lever 20, which in turn moves a feed pawl 21 to thereby rotate a ratchet wheel 22 mounted on the shaft 12. The rotational movement of the ratchet wheel 22 is transmitted to the spool 7 via pin and clutch 23 and 24 mounted between the shaft 12 and the spool 7, whereby the spool 7 is rotated to take up the web 6 in the direction shown by the arrow in FIG. 3.

When in contact with the photosensitive medium 2, the rolls 9 and 10 tend to rotate with the drum 1. To prevent this, check pin 25 is provided in the feed pawl 21 so that the ratchet assembly 21-22 may serve as means for preventing the reverse rotation of the roll 9. As for the roll 10, a pin and clutch assembly 26-27 connects the shaft 13 to the spool 8, and on the shaft 13 there is mounted a check ratchet wheel 28 which cooperates with a check pawl 29 secured to the pivot arm 15. Thus, when the shaft 13 is forced to move by the unshown cam as described previously, the check pawl 29 is allowed to escape from the ratchet wheel 28 with the aid of a cam 30, thereby liberating the roll 10.

In this way, the photosensitive medium 2 on the drum 1 can be contacted and completely cleaned by fresh sides of the web 6 during every cleaning step.

In the arrangement of FIGS. 4-5, the roll 9 is associated with a motor or other suitable drive source so that it is rotated always in the opposite direction to the rota-

tion of the photosensitive medium to thereby rewind the web 6 from the roll 9. Thus, the fresh portion of the web 6 rewound from the roll 9 is contacted with the surface of the photosensitive medium 2 during each cleaning step. The velocity of rotation of the roll 9 may preferably be one-tenth of or less than the peripheral speed of the photosensitive medium 2. The rewind rotation of the roll 9 is transmitted to a disc loosely mounted on the shaft 13 of the roll 10, via a suitable transmission mechanism including a belt 34, shaft 16 and gears 31 and 32. Thus, the disc (which is provided by the gear 32 in the illustrated example) is rotated to charge a coil spring 33 wound on the shaft 13 between the gear 32 and the check ratchet wheel 28.

After the cleaning step, when at least the roll 10 is disengaged from the photosensitive surface and the check assembly 28-29 is released, the amount of the web 6 rewound from the roller 9 is taken up on the roller 10 by means of the spring 33.

As has been described above, the cleaning device of the present invention produces no scattered toner particle which has been experienced with the known cleaning devices using fur brushes or magnetic brushes to remove the residual toner from the photosensitive medium, and this means a great advantage from a hygienical point of view. Moreover, the present invention eliminates the need to employ a vacuum pump and filter which have been provided to suck the removed toner according to the prior art. Also, any residual toner present on the photosensitive medium can be positively removed by the web contacting the entire surface area of the photosensitive medium and there is no possibility of a ghost image being produced on the photosensitive medium when repeatedly used for the copying process. Thus the photosensitive medium can always ensure the formation of highly clear images. Furthermore, the web employed with the cleaning device of the present invention has its both sides effective for the cleaning action and this leads to the minimization and economization of the web material.

What is claimed is:

1. A cleaning device for use in an electrophotographic copying apparatus having a photosensitive medium on which an electrophotographic image is formed, comprising a cleaning web, two rolls disposed adjacent said photosensitive medium, said cleaning web being wound in the form of an S-shape between said two rolls, means for supporting said two rolls individually and pivotally whereby said two rolls are moveable to a cleaning position and at least one of said two rolls is also moveable to a non-cleaning position, means for urging said two rolls into contact with the surface of a photosensitive medium when in said cleaning position whereby said cleaning web cleans said photosensitive medium, means for moving at least said one of said two rolls from said cleaning position to said non-cleaning position to permit removal of a used portion of said cleaning web, and means associated with said one of two rolls for advancing said cleaning web to remove a used portion of said cleaning web and supply a fresh portion thereof when at least said one of said two rolls is in said non-cleaning position.

2. A cleaning device according to claim 1, wherein said urging means comprises springs provided to pull said two rolls in a direction toward the surface of said photosensitive medium.

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3. A cleaning device according to claim 1, including means for maintaining said two rolls stationary when in said cleaning position.

4. A cleaning device according to claim 1, wherein said electrophotographic copying apparatus includes means for moving said photosensitive medium relative to said two rolls, wherein said two rolls comprise a web supply roll and a web take-up roll, and further including means for rotating said web supply roll in the same rotational direction as that of said photosensitive medium when said two rolls are in said cleaning position.

5. A cleaning device according to claim 4, wherein the used portion of said cleaning web is taken up when said web take-up roll is in said second non-cleaning position.

6. A cleaning device according to claim 4, wherein said web take-up roll includes means charged with a recovery force when said web supply roll is being rotated and said web take-up roll is in said cleaning position, for rotating said web take-up roll by the use of said recovery force when said web take-up roll is in said non-cleaning position whereby the used portion of said cleaning web is taken up.

7. A cleaning device according to claim 4, wherein

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the speed of movement of said web provided by said web supply roll is at or less than one-tenth of the peripheral speed of said photosensitive medium.

8. A cleaning device according to claim 1, wherein said moving means includes means for moving said two rolls to said non-cleaning position and said advancing means includes means for rotating said two rolls for taking up the used portion of said cleaning web and supplying a fresh portion thereof when said two rolls are in said non-cleaning position.

9. A cleaning device according to claim 1, further comprising means for restraining the rotation of at least one of said two rolls when in said cleaning position and means for releasing said restraining means upon movement of said one of said two rolls to said non-cleaning position.

10. A cleaning device according to claim 1, wherein said two rolls comprise a web supply roll and a web take-up roll and wherein said cleaning web is unwound from the bottom of said web-supply roll adjacent said photosensitive medium to and around the top of said web take-up roll.

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