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[54] CLEANING METHOD AND APPARATUS FOR ELECTROSTATIC COPYING MACHINES 7 Claims, 6 Drawing Figs.

- 15/1.5 [56] References Cited

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[11] 3,572,923

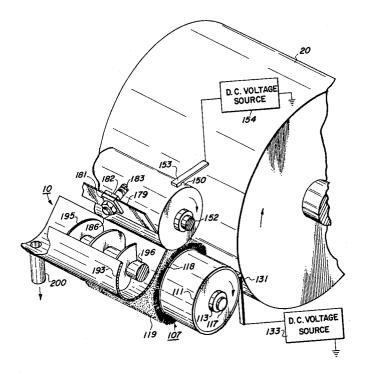
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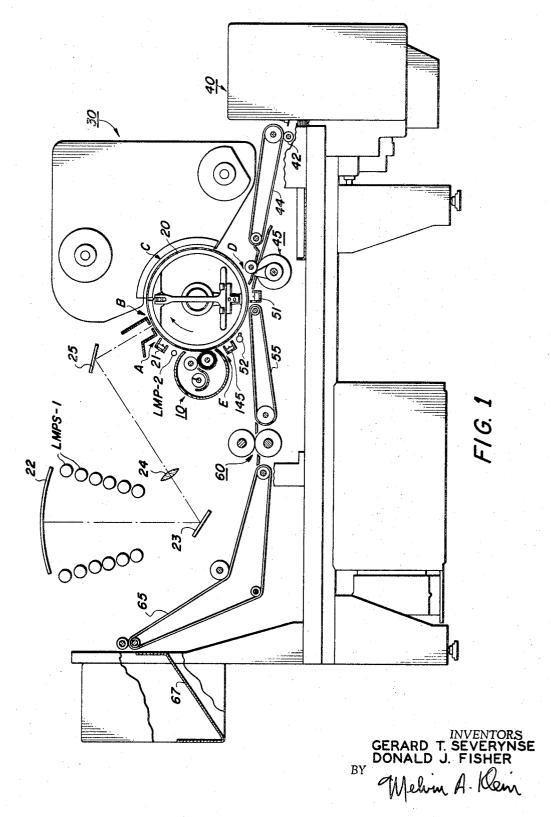
ABSTRACT: Method and apparatus for removing residual images from a recording surface for reuse in a copying system. This is effected by wiping the electrostatic recording surface with an electrically nonconductive element to mechanically remove the toner particles from the surface. At the same time, an electrical bias of a polarity opposite that of the toner particles of sufficient magnitude is applied to the element so as to pull toner from the surface onto the element thereby removing substantially all of the toner from the surface. The element is advanced past an electrically biased means to remove the toner from the element thereby freeing it of the residual toner so that continuous cleaning action is obtained. After this, the toner is removed from the electrically biased means and collected for reuse in the system.



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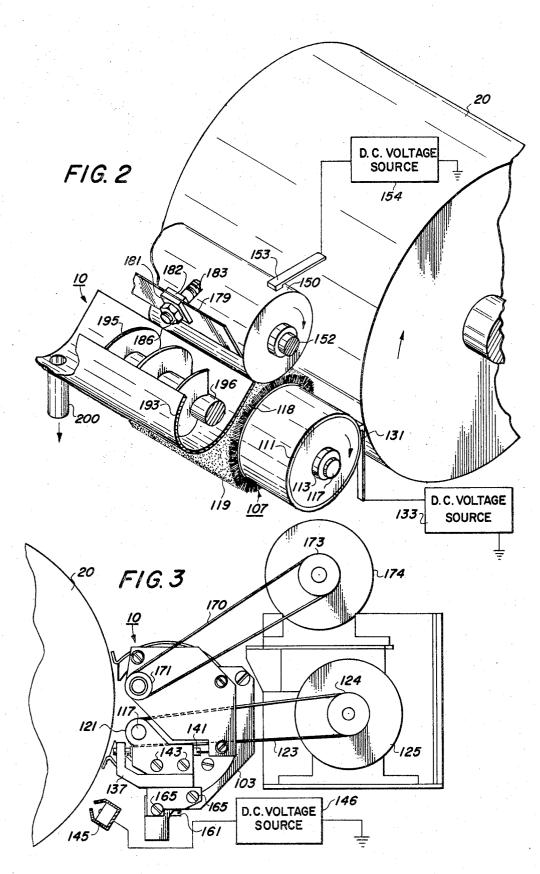


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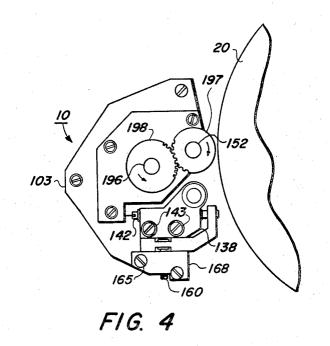




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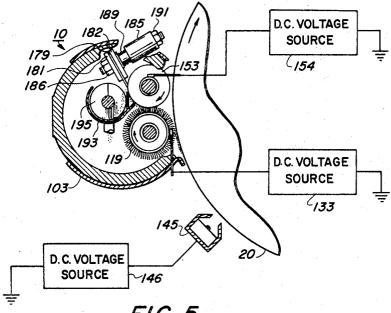
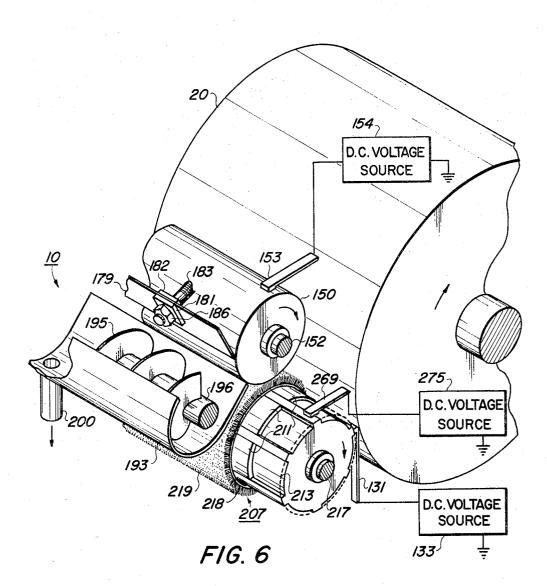


FIG. 5

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CLEANING METHOD AND APPARATUS FOR **ELECTROSTATIC COPYING MACHINES**

This invention relates to electrostatic imaging systems and more particularly, to an improved apparatus for cleaning electrostatic recording surfaces.

The formation and development of images on the surface of recording materials by electrostatic means is well known. One basic process, as taught in U.S. Pat. No. 2,297,691, by C. F. Carlson involved placing a uniform electrostatic charge on a 10 photoconductive insulating layer, exposing the layer to a lightand-shadow image to dissipate the charge on the areas of the layer exposed to the light and developing the resulting latent electrostatic image by depositing on the image a finely-divided electroscopic material referred to in the art as "toner." The 15 toner is normally attracted to those areas of the layer which retain a charge, thereby forming a toner image corresponding to the latent electrostatic image. This image may then be transferred to a support surface such as paper. The transferred image may subsequently be permanently affixed to a support 20surface. After cleaning, the layer is ready for another imaging cvcle.

As is well known in recent years, the steadily increasing size of various industries has required an enormous increase in the 25 amount of paper work that must be accomplished, maintained, and made available for wide interplant circulation. In the present day commercial automatic copiers/reproduction machines, the electrostatic recording surface is in the form of a drum or belt which moves at high rates in timed unison rela-30 tive to a plurality of processing stations. This rapid movement of the electrostatic recording surface has required vast amounts of toner particles to be used during development.

Associated with the increased amounts of toner is the difficulty in removing the residual toner image remaining on the recording surface after transfer. In the reproduction process of Carlson as described above, the residual image is tightly retained on the photoconductive surface by a phenomenon that is not fully understood but believed to be caused by an electrical charge that prevents complete transfer of the toner 40 to the support surface, particularly in the image area. The residual toner image is normally removed by cleaning devices such as a "brush" type cleaning apparatus or "web" type cleaning apparatus. A typical brush cleaning apparatus is disclosed in U.S. Pat. No. 2,832,977 to L. E. Walkup et al. and in 45 U.S. Pat. No. 2,911,330 to H. E. Clark. The brush-type cleaning means usually comprises one or more rotating brushes which brush toner from the photoconductive surface into a stream of air which is exhausted through a filtering system. A typical web cleaning device which retains toner is disclosed in 50 U.S. Pat. No. 3,186,838 to W. P. Graff, Jr. et al.

While ordinarily capable of cleaning electrostatic recording surfaces, conventional cleaning devices have not been entirely satisfactory. Most of the known cleaning devices usually become less efficient as they become contaminated with toner 55 which cannot be removed necessitating frequent replacement of the cleaning device. As a result, valuable time is lost during "down time" while a change is being made. A further problem is that cleaning devices employed in current commercial copier/duplicator machines permanently remove residual toner 60 particles from the system. Since toner is an expensive consumable, permanent removal of the residual toner particles from the system during cleaning is undesirable because it adds to the cost of machine operation. Both the web-type and brush cleaning units normally do not return residual toner particles 65 to the reusable developer mass after the cleaning operation due to the collection of lint from the web or brush. Furthermore, the brush is normally rotated at rates which cause heat to be generated resulting in physical and chemical changes in the toner. In addition, an elaborate and noisy vacuum and filtering system is necessary to collect the residual toner particles removed by the brush. Moreover, large amounts of toner particles thrown into the air by the rapidly rotating brush cleaner often drift from the brush cleaning housing and form unwanted deposits on critical machine parts.

While the web type cleaner has some advantages it is difficult to align with the surface of the electrostatic recording surface and uneven contact between the web and the surface as well as uneven takeup of the web on a takeup roll is often encountered even with complex alignment apparatus. Another problem with the web type cleaner is that pressure contact between cleaning webs and some imaging surfaces must be kept to a minimum to prevent destruction of the imaging surface. Thus, there is a continuing need for a better system for cleaning electrostatic recording surfaces.

It is, therefore, an object of this invention to provide method and apparatus for cleaning electrostatic imaging surfaces which overcome the above-noted deficiencies.

It is another object of this invention to improve the quality of prints produced by electrostatic reproduction machines.

It is a further object of this invention to reduce toner consumption in automatic electrostatic imaging machines.

It is also an object of this invention to utilize cleaning apparatus in reproduction equipment which does not require extensive alignment or adjustment.

It is still another object of this invention to remove residual toner which is immediately reusable in an electrostatic imaging system.

It is a further object of this invention to provide simple, inexpensive and reusable apparatus for cleaning electrostatic recording surfaces.

It is a still further object of this invention to provide cleaning apparatus for an electrostatic imaging system which is more efficient than existing cleaning devices.

It is still a further object of this invention to prevent powder cloud formation at the cleaning station of a copier/duplicator machine

It is still a further object of this invention to reduce the noise 35 level of copier/duplicator machines.

These and other objects of the invention are attained generally speaking by wiping the electrostatic recording surface with an electrically nonconductive element to mechanically remove the toner particles from the surface. At the same time, an electrical bias of a polarity opposite that of the toner particles of sufficient magnitude is applied to the element substrate so as to pull toner from the surface onto the element thereby removing substantially all of the toner from the surface. The element is advanced past an electrically biased means to remove the toner from the element thereby freeing it of the residual toner so that continuous cleaning action is obtained. After this the toner is removed from the electrically biased means and collected for reuse in the system.

For a better understanding of the invention as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in conjunction with the accompanying drawings wherein:

FIG. 1 is a schematic sectional view of a reproduction machine incorporating cleaning apparatus according to the present invention with the processing components in section to better illustrate the environment for the present invention;

FIG. 2 is an isometric view partly broken away to better illustrate details of the cleaning apparatus;

FIGS. 3 and 4 are end views of the cleaning apparatus;

FIG. 5 is a sectional view illustrating further details of the cleaning apparatus; and

FIG. 6 is an isometric view of a second embodiment of the cleaning apparatus.

In FIG. 1, there is shown schematically a high speed automatic electrostatic or xerographic reproduction machine incorporating cleaning apparatus generally designated 10 according to the present invention.

The automatic reproducing machine comprises an electro-70 static recording element or xerographic plate 20 including a photoconductive layer or light-receiving surface on a conductive backing and formed in the shape of a drum, which is mounted on a shaft journaled in a frame to rotate in the direction indicated by the arrow to cause the drum surface 75 sequentially to pass a plurality of processing stations.

For the purpose of the present disclosure, the several xerographic processing stations in the path of movement of the drum surface may be described functionally as follows:

A charging station, at which a uniform electrostatic charge is deposited on the photoconductive layer of the xerographic 5 drum:

An exposure station, at which a light or radiation pattern of copy to be reproduced is projected onto the drum surface to dissipate the drum charge in the exposed areas thereof and thereby form a latent electrostatic image of the copy to be 10 reproduced;

A developing station, at which a xerographic developing material including toner particles having an electrostatic charge opposite to that of the electrostatic latent image are 15 cascaded over the drum surface, whereby the toner particles adhere to the electrostatic latent image to form a xerographic powdered image in the configuration of the copy being reproduced;

electrostatically transferred from the drum surface to a transfer material or a support surface; and

A drum cleaning and discharge station, at which any residual toner particles remaining on the drum surface after image transfer are removed, and at which the drum surface is exposed to a relatively bright light source to effect substantially complete discharge of any residual electrostatic charge remaining thereon.

The charging station located as indicated by reference character A includes a corona charging device 21 which comprises a corona discharge array of one or more corona discharge electrodes that extend transversely across the drum surface. The charging device is energized from a high potential source and is substantially closed within a shielding member.

Next subsequent thereto in the path of motion of the xerographic drum is an exposure station B. An optical scanning or projection system is provided to project a flowing image onto the surface of the photoconductive drum from a stationary original.

The optical scanning or projection assembly comprises a stationary copyboard which consists of a transparent curved platen member 22, such as, for example, a glass plate or the like, positioned on the exterior of the cabinet, which is adapted to support a document to be reproduced, the document being uniformly illuminated and arranged in light projecting relation to the moving light-receiving surface of the xerographic drum. Uniform lighting is provided by banks of lamps LMPS-1 arranged on opposite sides of the copyboard.

Scanning of the document on the stationary copyboard is accomplished by means of a mirror assembly which is oscillated relative to the copyboard in timed relation to the movement of the xerographic drum. The mirror assembly, which includes an object mirror 23, is mounted below the copyholder 55 to reflect an image of the document through a lens 24 onto an image mirror 25, which, in turn, reflects the image onto the xerographic drum through a slot in a fixed light shield 26 positioned adjacent to the xerographic drum surface.

Adjacent to the exposure station is a developing station C in $_{60}$ which there is positioned a developer apparatus 30 including a casing or housing having a lower or sump portion for accumulating developer material. A bucket type conveyor is used to carry the developing material to the upper part of the developer housing where it is cascaded over a hopper chute 65 onto the xerographic drum to effect development. A toner dispenser is used to accurately meter toner to the developing material as toner particles are consumed during the developing operation. Any suitable dispenser may be used as, for example, the dispenser described in U.S. Pat. NO. 3,013,703 to 70 Hunt.

Positioned next and adjacent to the developing station is the image transfer station D which includes a sheet feeding arrangement adapted to feed sheets of support material, such as paper or the like, successively to the xerographic drum in 75 replacement of the cleaning apparatus is not a concern.

coordination with the presentation of the developed image on the drum surface at the transfer station.

The sheet feeding mechanism includes a sheet feed device 40 adapted by means of vacuum feeders to feed the top sheets of a stack of sheets on a tray to rollers 42 cooperating with the belts of paper transport 44 for advancing the sheet sufficiently to be held by paper transport 44 which in turn conveys the sheet to a sheet registration device 45 positioned adjacent the xerographic drum. The sheet registration device arrests and aligns each individual sheet of material and then in timed relation to the movement of the xerographic drum, advances the sheet material into contact with the xerographic drum in registration with a previously formed xerographic powder image on the drum.

The transfer of the xerographic powder image from the drum surface to the sheets of support material is effected by means of a corona transfer device 51 that is located at or immediately after the line of contact between the support A transfer station, at which the xerographic powder image is 20 material and the rotating drum. In operation, the electrostatic field created by the corona transfer device is effective to tack the support material electrostatically to the drum surface, whereby the support material moves synchronously with the drum while in contact therewith. Simultaneously with the tacking action, the electrostatic field is effective to attract the toner particles comprising the xerographic powder image from the drum surface and cause them to adhere electrostatically to the surface of the support material.

Immediately subsequent to the image transfer station, there 30 is positioned a stripping apparatus to paper pickoff mechanism 52 for removing the sheets of support material from the drum surface. This device, which is of the type disclosed in U.S. Pat. No. 3,062,536 to Rutkus et al. includes a plurality of small diameter orifices supplied with pressurized 35 aeriform fluid by a suitable pulsator or other device. The pulsator is adapted to force jets of pressurized aeriform fluid through the outlet orifices into contact with the surface of the xerographic drum slightly in advance of the sheet of support material to strip the leading edge of the sheet from the drum 40 surface and to direct it into an endless conveyor 55 whereby

the sheet material is carried to a fixing device 60. At the fixing device, the transferred xerographic powder image on the sheet of support material is permanently fixed or fused thereto as by heat. After fusing, the reproduction is discharged from the apparatus at a suitable point for collection externally of the ap-

paratus by means of the conveyor 65. In the embodiment shown, the reproductions are discharged from conveyor 65 into a receiving tray 67.

The next and final station in the device is a drum cleaning station E, at which cleaning apparatus 10 constructed in accordance with the invention removes substantially all residual toner particles remaining on the xerographic drum surface after transfer for reuse in the system in a manner to be described. A discharge lamp LMP-2 floods the xerographic drum with light to cause dissipation of any residual electrical charge remaining on the xerographic drum subsequent to cleaning

It is believed that the foregoing description is sufficient for the purposes of this application to show the general operation of a copying machine incorporating cleaning apparatus constructed in accordance with the invention. Suitable drive means are provided to drive the drum, rotating mirror and sheet feed mechanism at predetermined speeds relative to each other, and to effect operation of the bucket-type conveyor and toner dispenser mechanism and the other operation mechanisms. For further details concerning the specific construction of a copying machine similar to that shown reference is made to U.S. Pat. No. 3,301,126 issued on Jan. 31, 1967.

Referring now to FIGS. 2-5, there is shown details of the cleaning apparatus 10. The cleaning apparatus of this invention is adapted to remove the residual toner material in such a manner that it can be reused with the developer material and at the same time be effective for continuous cleaning whereby Cleaning apparatus 10 comprises a housing 103 secured to the machine frame which housing partially encloses a fabric cleaner assembly 107. Fabric cleaning assembly 107 includes a conductive cylindrical member 111 which is supported on an insulating member 113 which in turn is secured for movement to a rotatable shaft 117. Cylindrical member 111 is in direct contact with the underside of a layer 118 which serves as a backing layer for nonconductive fabric cleaning fibers 119, it being understood that layer 118 may be made out of either conductive or nonconductive materials for a purpose to be described.

Shaft 117 is journaled for rotation in housing 103 and is driven in a direction indicated by the arrow by a pulley 121 connected at one end thereof which in turn is driven by a tim-15 ing belt 123 encircling pulley 121 and a drive pulley 124 which is mounted for rotation on a drive motor 125. In this manner the fabric cleaner assembly 107 provides good wiping action between the cleaning fibers 119 and the surface of the drum. For very efficient wiping action it is desirable that the 20 fabric cleaner assembly 107 be driven in an opposite direction at the nip to the drum at speeds ranging from about half to about three times the speed of rotation of the drum, and preferably at about 1 to 1.5 times the drum speed. Alternatively, the fabric cleaner assembly can be driven in the same 25 direction at the nip as the drum, it being kept in mind that the assembly must then be driven at a higher speed so that there will be sufficient relative motion to obtain the desired wiping action of the cleaning fibers on the surface of the drum.

In accordance with the invention, as the cleaning fibers 119^{-30} are moved past the drum surface, an external potential of a polarity opposite to that of the toner particles is applied to conductive cylindrical member 111 causing an electrical field or lines of force to emanate radially from the support layer 35 beneath the cleaning fibers to thereby attract the toner particles from the drum surface onto the cleaning fibers. To accomplish this, a DC voltage 133 is applied to conductive cylindrical member 111 by one or more brush members 131 as the fabric cleaning assembly is rotated on a shaft 117. DC voltage 40133 is of an opposite polarity from the toner particles and ranges in magnitude up to several thousand volts to enable attraction of the electroscopic toner particles onto the cleaning fibers 119. It has been found that voltages ranging from about 500 volts to about 2000 volts perform well for this purpose. It 45 should be noted that the DC voltage 133 can be varied and hence this voltage can be selectively changed to obtain an optimum operating condition.

Desirably cleaning fibers 119 are made from any suitable 50 nonconductive material to prevent shorting of the voltage applied from DC voltage 133 and is substantially uneffected by changes in humidity. Typical cleaning fiber materials are acrylic velvets, orlon, polypropylene fabric, nylon, rayon, acetates, mohair, arnel, glass, dynel, dacron, cotton, and other natural and synthetic fibrous or filamentary materials and mixtures thereof. In addition in order to enhance the attraction of the toner particles to the cleaning fibers 119, the fibers may be made out of or coated with a material having a triboelectric attraction for the toner particles. Typical materials having this relationship are described in U.S. Pat. No. 2,618,551 to Walkup, U.S. Pat. No. 2,618,552 to Wise, U.S. Pat. No. 2,638,416 to Walkup and Wise, and U.S. Pat. No. Re 25,136 to Carlson. It should be noted that the feature of the triboelectric attraction to the cleaning fibers normally enables a decrease in the 65voltage being applied.

Cleaning fibers 119 desirably have good mechanical wiping action on the drum surface to thereby loosen the toner particles which are then attracted to them due to the attractive force from the electrical potential being applied. The cleaning 70 fibers extend to any suitable length which may range from about one-sixteenth of an inch to about five-sixteenths of an inch and preferably range from about one-eighth of an inch to about three-sixteenths of an inch for a fiber density ranging from about 10,000 to about 750,000 fibers per square inch. 75

It has been found that for a cleaning fiber length of about three-sixteenths of an inch, very good results are obtained with 1,500 volts applied by DC voltage 133. Desirably the interference between the cleaning fibers and the drum surface range from about one-fourth to half the length of the fibers. In order to adjust the interference between the cleaning fibers and the drum surface, shaft 117 can be moved relative to the machine frame and hence the drum surface by moving support plates 137 and 138 of housing 103 which are movable along 10 adjusting members 141, 142, respectively, by turning the adjusting members whereby the shaft 117 is able to be moved toward and away from the drum surface. Screws 143 received in housing 103 when tightened insure that support plates 137, 138 and hence shaft 117 are held firmly in place during the operating conditions.

To further enhance the electrostatic attraction of the toner particles onto the cleaning fibers 119, a corona generating device 145 is positioned in the path of the drum just prior to the fabric wiper assembly to place a charge on the toner particles of the same polarity as the particles which in this case would be negative. This charge desirably reduces the attraction of the toner particles to the surface of the drum and insures that the toner particles are properly negatively charged so that they will be attracted to the positive potential applied by DC voltage 133. It has been found that a current ranging from about 2 to about 10 microamps for the corona generating device is sufficient for this purpose. Corona generating device 145 is suitably powered as by a variable source of DC voltage 146.

After the toner particles have been removed from the drum surface onto the cleaning fibers 119, the toner particles are then removed from the fibers to ensure that the particles are not redeposited onto the drum surface. To accomplish this, there is an electrically biased roll 150 positioned in the path of the cleaning fibers 119 which is connected to an external potential of a polarity opposite to that of the toner particles and of a sufficient magnitude to attract them from the cleaning fibers onto the surface of the roll. Roll 150 is mounted for rotation on a shaft 152 to move in a direction opposite to that of the fabric wiper assembly at the nip to obtain good relative movement therebetween. It should be understood, of course, that the roll may be rotated in a reverse direction by making appropriate changes in the speed and associated cleaning parts.

Roll 150 is made from any suitable conductive material and may be in the form of a cylinder or as a solid member. The roll is electrically biased via a brush member 153 connected to a DC voltage 154 which is of the same polarity as DC voltage 133 but is desirably of a higher magnitude whereby as the cleaning fiber tips contact the roll surface the toner particles are attracted to it. DC voltage 154 may range from about 1,000 volts to about 3,000 volts. It has been found that an in-55 terference between the cleaning fibers 119 and the surface of roll 150 ranging from about one-fourth to about half the length of the fibers performs well with DC voltage 133 being at about 1,500 volts and a cleaning fiber length of about threesixteenths of an inch. To vary the interference between the cleaning fibers 119 and the surface of roll 150, adjusting members 160, 161 are provided in housing 103 which when turned enable support plate 137, 138 and hence shaft 117 to be moved toward and away from their roll surface. Screws 165 received in support plates 167, 168 of housing 103 when tightened ensure that shaft 117 is held firmly in place during the operating condition.

The drive for the bias roll 150 ranges from about the same speed as the fabric wiper assembly to more than double the speed of the fabric cleaning assembly as an upper limit. It has 70 been found that where the bias roll is moved opposite in direction to the cleaner fabric assembly at the nip that the same speed produces very good results but that at least twice this speed is necessary where the direction of the bias roll is in the same direction as the fabric wiper assembly at the nip. 75 Driving force is provided in any suitable manner as by a timing

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belt 170 wound around a pulley 171 connected at one end of the bias roll shaft 152 and also wound around a pulley 173 mounted for rotation on drive motor 174.

To present continuous cleaning surfaces and also to recover the toner particles so that they may be returned and reused in the development system of the machine, a scraper assembly 177 is positioned in the path of roll 150. Scraper assembly 177 comprises a blade member 179 which is held firmly in place by blade holder elements 181, 182 by any suitable retaining 10 means such as screws. Blade holder elements 181, 182 are connected to housing 103 by one or more adjustable bolt members 183 each of which is received through an insulating block member 185 secured to the housing as by screws. A nut 136 constrains blade holder elements 181, 182 against a compression spring 189 seated against insulating block member 185. Contact pressure of the blade member 179 with roll 150 is adjustable by turning nut 191 received on bolt member 183.

As the toner particles are removed from the surface of roll 150 by the blade element they are collected in a tray 193 from which they are removed by an auger 195 mounted for rotation on a shaft 196 driven by the roll shaft 152 through gears 197, 198 which are connected to the shaft 152 and shaft 196, respectively. Auger 195 rotates through the toner material collected in the tray in a direction shown by the arrow to move the toner toward one or more conduits 200 from which the toner particles are discharged either by gravity or any suitable means for reuse at the development station.

A second embodiment of the present invention in which the fabric cleaner assembly is in the form of a segmented roll is 30 shown in FIG. 6 where like numerals identify like elements. The segment roll enables different potentials to be applied to obtain greater selectivity and control in the removal of the toner particles from the drum surface for collection and reuse. With this embodiment a fabric cleaner assembly 207 com- 35 prises a plurality of conductive commutator segments 211 which are embedded in a suitable insulating member 213, which, in turn, is secured for movement to a rotatable shaft 217. Commutator segments 211 are in direct contact with the underside of a layer 218 which is the backing layer for non- 40 conducting cleaning fibers 219. Layer 218 may be a continuous piece as shown or instead may be formed as a plurality of separate elements which correspond to each of the conducting segments 211. As in the embodiment of FIGS. 1-5 above, an external potential of a polarity opposite that of the toner parti- 45 cles is applied to the commutator segments 211 causing an electrical field or lines of force to emanate from the support below the cleaning fibers to thereby attract the toner particles from the drum surface onto the fibers. To this end, one or 50 more brush elements 231 are connected to DC voltage 133 to contact each commutator segment as the shaft rotates thereby enabling the toner particles to be attracted to cleaning fibers from the drum surface. As in the other embodiment above, the cleaning fibers 219 are moved past a bias roll 150 connected to a DC voltage 154. At the vicinity of interference intermediate the cleaning fibers 219 and the surface of bias roll 150, commutator segments 211 are contacted by one or more brush elements 269 which are connected to a DC voltage 275. DC voltage 275 is of the same polarity as the toner particles so 60 that the toner particles are thereby repelled in the direction of the bias roll 150. DC voltage 275 may range from ground to about 2,000 volts depending upon the voltage applied by the DC voltage 154, the height of the cleaning fibers and the extent of the interference between the cleaning fibers and the 65 surface of bias roll 150. Generally speaking, the higher the voltage applied to the bias roll surface, the lower the DC voltage 275 is and vice versa. It has been found that the potential difference between the voltage on the bias roll surface and the DC voltage 275 on the commutator segments ranging from 70 about 800 to about 2,700 performs very well.

Above is described a new and novel cleaning apparatus capable of removing substantially all of the residual toner particles on the surface of an electrostatic recording member and for collecting the toner for reuse in the copier/duplicating 75 about 800 volts to about 2,700 volts.

machine. Heretofore, cleaning of the recording surface was accomplished by a rotating brush or web which had to be discarded and replaced after periodic use and which prevented the toner from being reused in the development system again. With the present invention, the toner particles are removed from the recording surface in such a manner that objectionable filming of the toner does not occur and hence the toner is adapted for reuse in the system repeatedly. Furthermore, no powder cloud is formed at the cleaning station which undesirably can cause a malfunction of the machine. Also, the cleaning apparatus of the present invention does not require extensive repair or adjustment as in the case of the prior art cleaning devices. In short, the apparatus of the 15 invention not only provides cleaning greatly efficient but is also inexpensive and reusable while permitting toner collected to be used repeatedly.

While the invention has been described with reference to the structure disclosed herein, it should not be confined to the 20 details set forth since it is apparent that various modifications can be made. Thus a plurality of units can be used instead of one and the cleaning fibers may be in the form of an endless belt with an appropriate biasing potential applied through an electroded substrate opposite the photoconductor drum. Other modifications will occur to those skilled in the art and it is intended to cover such modifications or changes as may come within the purposes and improvements of the scope of the following claims.

We claim:

1. Cleaning apparatus for removing electrostatically adhering toner particles from an electrostatic recording surface for reuse comprising:

- wiper means including a support layer having electrically nonconductive fibers extending therefrom, said wiper means being adapted for movement past an electrostatic recording surface on which electrostatically adhering toner particles are contacted said fibers;
- circuit means coupled to said wiper means including a first voltage of a polarity opposite that of said toner particles and of a magnitude sufficient to attract said toner particles onto said fibers as they pass into contact with said recording surface:
- roll means positioned in the path of said wiper means, said roll means being coupled to a second voltage of the same polarity as said first voltage and sufficiently high to attract said toner particles from said fibers for deposit onto the surface thereof; and
- means positioned in the path of said roll means for removing electrostatically adhering toner particles from the surface of said roll means into a collection source whereby said toner particles continuously removed from said electrostatic recording surface can be reused.

2. Apparatus according to claim 1 including means for applying a charge of the same polarity as said toner particles to said recording surface before said toner particles are contacted by said fibers.

3. Apparatus according to claim 1 wherein said circuit means includes a plurality of uniformly spaced conductive elements secured to and in electrical contact with said support layer, a third voltage of a polarity opposite to that of said first voltage and of a magnitude lower than said first voltage, and distributor means to apply electrical power of different polarities according to said first and third voltages to successive

ones on said elements as each element is advanced to a predetermined position adjacent to said recording surface and said roll means.

4. Apparatus according to claim 2 wherein said first voltage ranges from about 500 volts to about 2,000 volts and said second voltage ranges from about 1,500 volts to about 3,000 volts.

5. Apparatus according to claim 3 wherein the potential difference between said second and third voltages ranges from 6. Apparatus according to claim 1 including means for moving said wiper means toward and away from said recording surface and toward and away from said roll means.

7. Apparatus according to claim 1 wherein the height of said fibers ranges from about one-eighth of an inch to about three-sixteenths of an inch.