United States Patent

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[54] BRUSH CLEANING DEVICE FOR ELECTROSTATIC MACHINES

1 Claim, 4 Drawing Figs.

[52] **U.S. Cl.** **15/1.5,** 118/637, 355/15
[51] **Int. Cl.** **A47l 13/40**
[50] **Field of Search** ..... 15/1.5, 308, 38, 104 E, 41, 48; 355/15

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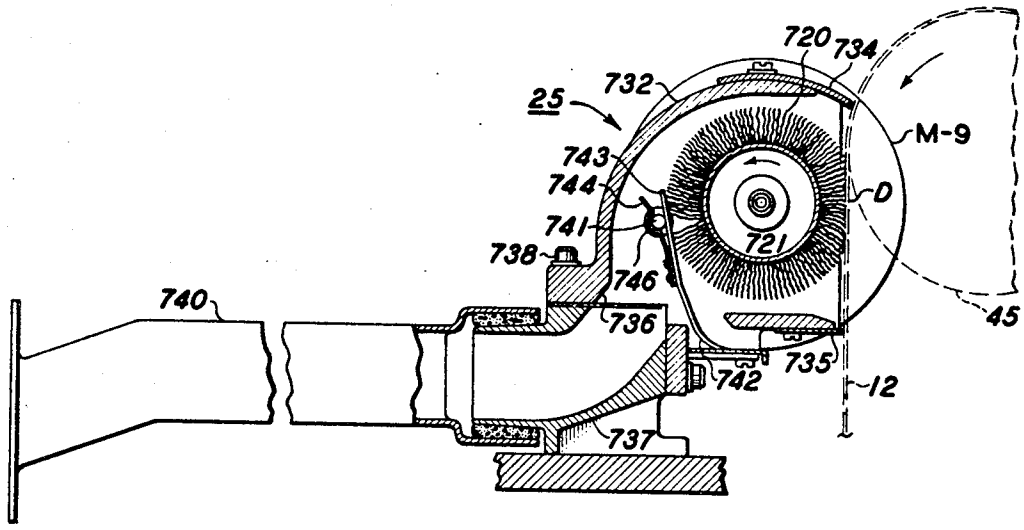
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ABSTRACT: A brush cleaning device for use with the developing system of an electrostatic reproduction machine includes a rotating flicker bar in the path of movement of the tips of the bristles of a cleaning brush. As the bristle tips engage and slide over the bar, toner particles on the bristle tips are flicked-off and are extracted from the vicinity of the brush by a vacuum system.



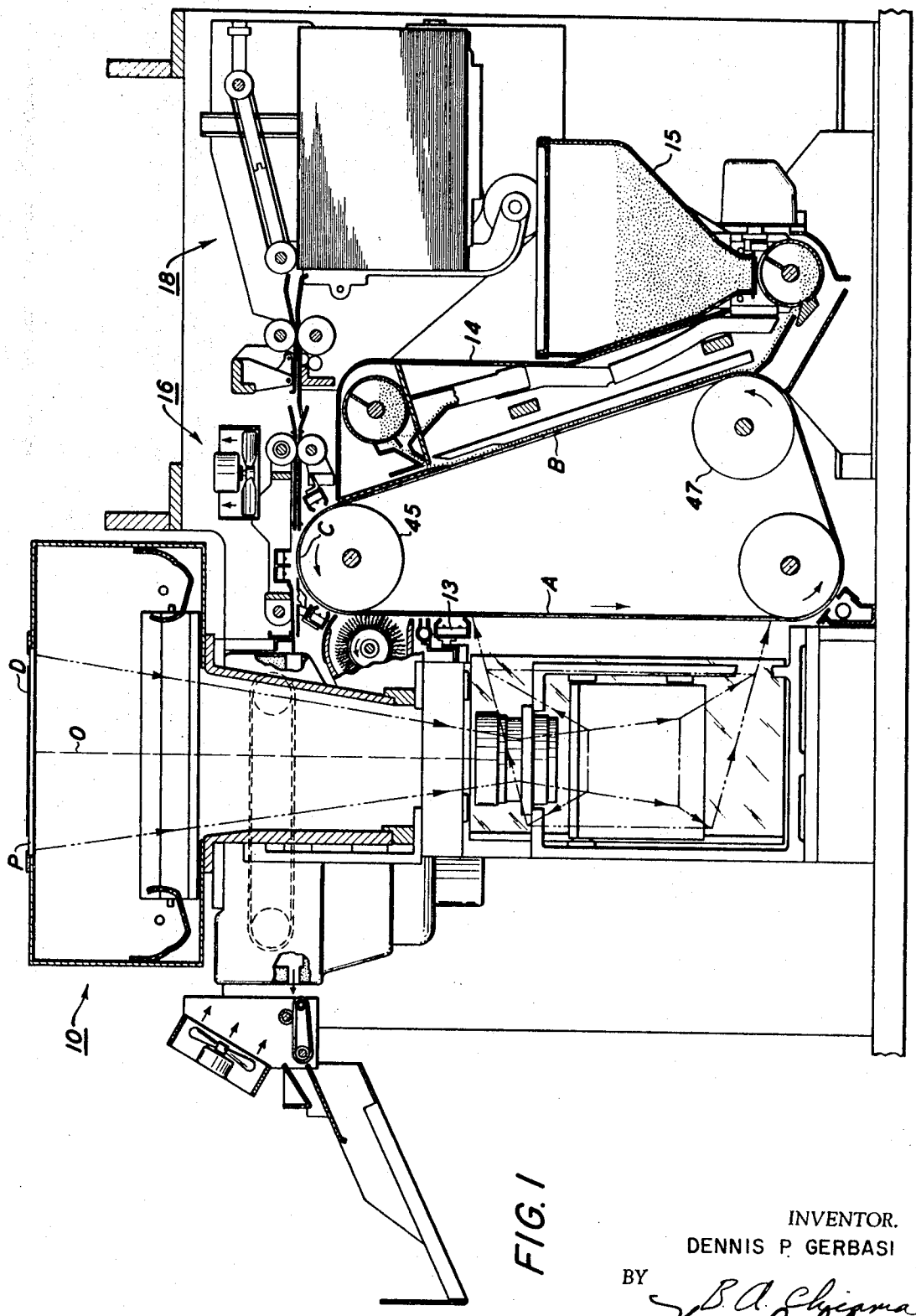


FIG. 1

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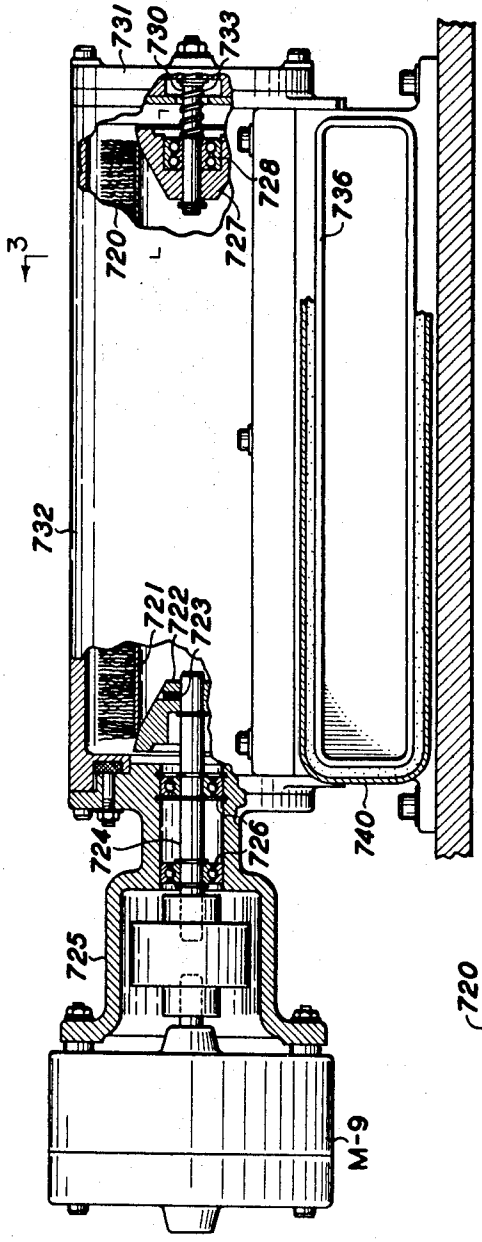


FIG. 2

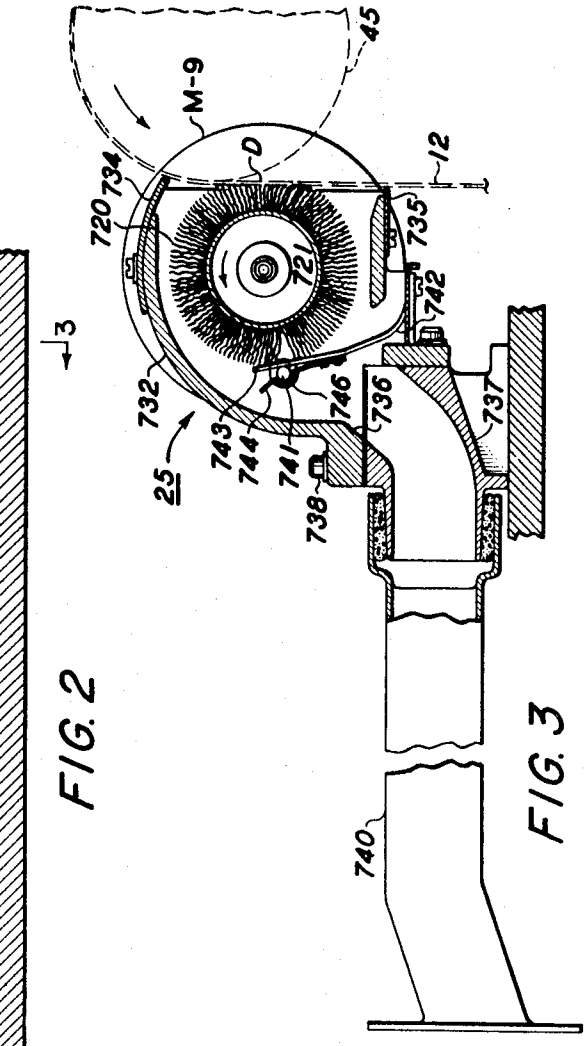


FIG. 3

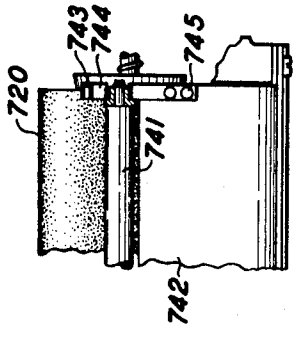


FIG. 4

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BRUSH CLEANING DEVICE FOR ELECTROSTATIC MACHINES

This invention relates to brush cleaning systems, and particularly, to improvements in a brush cleaner for particulate material that is particularly adapted for use with automatic copiers/reproducers capable of high speed operation.

As is well known in recent years, the steadily increasing size of various industries has required an enormous increase in the 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, which are adapted to produce copies of between 5 and 60 8×11 inch sheets of copy per minute, the photoreceptor device is in the form of a drum which rotates in timed unison relative to a plurality of processing stations.

As a solution for overcoming the disadvantages for high-speed copying and to increase the capability for still high reproduction speeds the latest machine concept for copiers utilizes flash exposure of a document and the arrangement of a moving photoconductor material in the form of an endless belt. This rapid movement of a reproduction surface has required vast amounts of toner particles during development processes. There has been no effective way in which to remove residual toner from the belt that will insure the opportunity to recover the toner particles for later use and which would not require periodic cleaning of the cleaning device generally utilized in these electrostatic machines.

It is therefore the principal object of this invention to improve electrostatic reproduction machines by removing residual developing material from the photoconductor belt with greater efficiency and less down time for the cleaning apparatus.

Another object of this invention is to utilize a flicking device with a rotating cylindrical brush which will not destroy the particles being removed from the surface to which the brush is applied and to eliminate buildup of toner particles on the flicking bar.

These and other objects of this invention are obtained by means of a brush housing for supporting a cylindrical brush for rotation.

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 the present invention therein with the processing components in section to better illustrate the environment for the present invention;

FIG. 2 is an elevational view, partly broken away in section of the brush cleaning assembly used in the xerographic machine;

FIG. 3 is a sectional view of the brush cleaner taken along the line 3–3 in FIG. 2;

FIG. 4 is a fragmentary view of a detail utilized in the brush cleaner.

For a general understanding of the illustrated copier/reproduction machine, in which the invention may be incorporated, reference is had to FIG. 1 in which the various system components for the machine are schematically illustrated. As in all electrostatic systems such as a xerographic machine of the type illustrated, a light image of a document to be reproduced is projected onto the sensitized surface of a xerographic plate to form an electrostatic latent image thereon. Thereafter, the latent image is developed with an oppositely charged developing material to form a xerographic powder image, corresponding to the latent image on the plate surface. The powder image is then electrostatically transferred to a support surface to which it may be fixed by a fusing device whereby the powder image is caused permanently to adhere to the support surface.

In the illustrated machine, an original to be copied is placed upon a transparent support platen P fixedly arranged in an illumination assembly generally indicated by the reference numeral **10**, arranged at the left end of the machine. While upon the platen, an illumination system flashed light rays upon the original thereby producing image rays corresponding to the informational areas on the original. The image rays are projected by means of an optical system for exposing the photosensitive surface of a xerographic plate in the form of a flexible photoconductive belt **12** arranged on a belt assembly slidably mounted upon a support bracket secured to the frame of the machine and which is adapted to drive the belt **12** in the direction of the arrow at a constant rate. During this movement of the belt, the reflected light image of an original on the platen is flashed upon the xerographic surface of the belt. The belt surface that intercepts the light rays comprises a layer of photoconductive material such as selenium on a conductive backing that is sensitized prior to exposure by means of a charging corona generator device indicated at **13**.

The flash exposure of the belt surface to the light image discharges the photoconductive layer in the areas struck by light, whereby there remains on the belt a latent electrostatic image in image configuration corresponding to the light image projected from the original on the supporting platen. AS the belt surface continues its movement, the electrostatic image passes through a developing station B in which there is positioned a developer assembly generally indicated by the reference numeral **14** and where the belt is maintained in a flat condition. The developer assembly **14** comprises horizontally and vertically conveying mechanisms which carry developing material to the upper part of the belt assembly whereat the material is dispensed and directed to cascade down over the upwardly moving inclined selenium belt **12** in order to provide development of the electrostatic image.

As the developing material is cascaded over the xerographic plate, toner particles in the development material are deposited on the belt surface to form powder images. As toner powder images are formed, additional toner particles are supplied to the developing material in proportion to the amount of toner deposited on the belt during xerographic processing. For this purpose, a toner dispenser generally indicated by reference numeral **15** is used to accurately meter toner to the developer material in the developer assembly **14**.

The developed electrostatic image is transported by the belt to a transfer station C whereat a sheet of copy paper is moved at a speed in synchronism with the moving belt in order to accomplish transfer of the developed image. There is provided at this station a sheet transport mechanism generally indicated at **16** adapted to transport sheets of paper from a paper handling mechanism generally indicated by the reference numeral **18** to the developed image on the belt at the station B.

After the sheet is stripped from the belt **12**, it is conveyed into a fuser assembly generally indicated by the reference numeral **21** wherein the developed and transferred xerographic powder image on the sheet material is permanently affixed thereto. After fusing, the finished copy is discharged from the apparatus at a suitable point for collection externally of the apparatus.

The next and final station in the device is a belt cleaning station having positioned therein a corona precleaning device **24** similar to a corona charging device to impose an electrostatic charge on the selenium belt and residual powder adherent thereto to aid in effecting the removal of the powder, a belt cleaning assembly **25** including a rotating brush device adapted to remove any powder remaining on the xerographic belt after transfer and a source of light, in the form of lamp LMP-1, whereby the selenium belt **12** is flooded with light to cause dissipation of any residual electrical charge remaining on the xerographic drum.

Suitable drive means may be arranged to drive the selenium belt **12** in conjunction with timed flash exposure of an original to be copied, to effect conveying and cascade of toner material, to separate, and feed sheets of paper and to transport the

same across the transfer station C and to convey the sheet of paper through the fuser assembly in timed sequence to produce copies of the original.

It is believed that the foregoing description is sufficient for the purposes of this application to show the general operation of an electrostatic copier using an illumination system constructed in accordance with the invention. For further details concerning the specific construction of the electrostatic copier, reference is made to copending application Ser. No. 731,934 filed concurrently herewith in the name of Hewes et al.

The belt cleaning assembly **25** shown in FIGS. **2—4** comprises the rotatable brush **720** of such construction as to apply extremely light pressure to the photoconductive surface of the selenium belt **12** and to dislodge any powder particles that may adhere thereto. The brush is preferably formed of synthetic fur secured to a rigid cylinder **721** and is supported at its left end by a truncated cone shaped plug **722** formed with serrations thereon to grip the internal surface of the cylinder for rotation therewith. The plug **722** is fixed by a pin **723** to a shaft **724** of a motor M-9 mounted in a frame **725**, bearings **726** being positioned within the frame and surrounding the shaft **724** for rotatably supporting the shaft. At its opposite end the cylinder **721** is supported by a second truncated cone-shaped plug **727** provided with serrations thereon similar to the plug **722** that is rotatably and movably mounted by a bearing **728** to a stub shaft **730** fastened at a casing cover **731** secured by nuts to a housing **732** which serves to contain the brush **720**. A coil spring **733** encircles the shaft **730** between the internal surface of the cover **731** and the adjacent end of the bearings **728** in order to permit limited axial movement of the plug **727** for permitting easy removal of the brush **720** and maintaining constant pressure on the drive arbor for the brush despite variations in brush length.

For containing toner powder particles removed from the belt **12** by the belt cleaning device, the housing **732** encompasses approximately the entire brush area and as shown in FIG. **3** when applied to the belt **12** the opened end of the housing is nearly rendered closed by the adjacent surface of the belt. In order to insure as close as possible an airtight relationship between the selenium belt **12** and the interior of the brush housing **732** the upper edge portion of the housing is provided with an adjustable seal plate **734** which may be moved circumferentially relative to the housing wall in order to permit close positioning of the leading edge of the seal plate to the selenium belt during movement thereof. Similarly the lower wall section of the housing **732** is provided with an adjustable seal plate **735** which has a leading that may be moved toward and away relative to the belt **12** in order to minimize the spacing therebetween.

At the other end remote from the side thereof which faces the selenium belt, the housing **732** is formed with an exhaust opening **736** in the form of an elongated slot having its axis parallel to the axis of the brush cylinder **721**. An adapted **737** is fastened to the housing **732** by suitable screws **738** and is formed with an opening conforming to the opening **736**. The adapter serves to connect an exhaust duct **740** to the housing. The exhaust duct **740** may be connected to a suitable high volume, low pressure vacuum system in order to continuously exhaust toner particles accumulating within the housing **732** during brush cleaning operation.

In order to aid in the removal of toner particles from the bristles of the brush **720** during rotation thereof, the belt cleaning assembly is provided with a flicker device including a flicker rod or bar **741** mounted between the exhaust slot **736** and the brush and extends throughout the length of the housing **732** parallel to the axis of the cylinder **721**. Actually the flicker device comprises the rod **741** and a flicker plate **742** in the form of a curved sheet metal plate extending the entire length of the housing **732** in the path or in alignment between the axis of the cylinder **721** and the exhaust opening **736**. The flicker bar **741** is spaced slightly from the interior edge of the plate **742** and serves as the leading edge thereof interposed in the path of movement of the bristles for the brush **720** in order to cause flickering thereof.

The rod **721** is held between a thin ribbon **743** formed from the material of the plate **742** at each end thereof as shown in FIG. **4** and a flat spring element **744** secured by rivets **745** to the ribbon material **743** at each end thereof. The spring **744** is formed with an angled or curved portion **746** spaced from the ribbon **743** and between which the end of the rod **741** may be placed under spring bias provided by the element **744**. The structure **743**, **744** and **746** are provided at each end of the flicker plate **742** in order to releasably hold the flicker rod **741**. These structures also permit rotation of the rod **741** which occurs by the continuous engagement of the moving bristles on the brush **720** during rotation thereof.

During cleaning operation using synthetic fur brushes **720** to clean a photoconductive surface such as a xerographic plate **12**, there has been found severe filming of toner particles of the surface after short use thereof. The cause of this filming has been traced to some degree to the impaction of toner particles onto the brush bristle tips which occurs where the bristles strike the conventional stationary flicker bar. It has been found that the filming occurs since the toner builds up on the fixed flicking bar leading edge where it contacts the bristles and becomes "tarlike" after several cycles with the tarlike toner being transferred to the bristle tips and in turn to the photoconductive surface being cleaned. The rotation of the flicker rod **741** minimizes toner buildup because of the continuously changing surface area exposed to the bristles at any one instant of time and the cooler temperature provided by a moving area such as afforded by a rotating rod.

For optimum cleaning situations, the bar **741** is coated with material selected so that its relative position on the triboelectric series is different than for the material of the brush bristles, so that a voltage is induced on the brush and bar of opposite polarity. The polarity of the charge produced by the corotron **24** is selected so that it also is of opposite polarity to the brush thereby effecting a charge on residual toner particles that is the same as the charge on the flicker bar. Toner particles enter the brush housing and are attracted by the brush bristles, which carries the particles against the bar. Upon striking the bar, the particles are dislodged and, since the charge on the toner and the bar are similar, the particles are repelled from the bar and more easily removed from the housing.

During operation of the belt assembly **25** the rotating bristles of the brush **720** continuously wipe off the residual toner particles resting upon the belt **12** as it moves from the transfer station of the machine to the charging station thereof. The residual toner particles are pulled off the surface of the belt and brought into contact with the flicker rod **741** thereby becoming disengaged from the brush bristles and allowed to be sucked through the exhaust adapter **737** and into the exhaust duct **740**. A filter mechanism may be attached to the remote end of the duct **741** in order to receive the air entrained toner particles for separating the same and permit reclaiming of the toner particles. The vacuum system utilized with the duct **740** produces a flow of air through the brush cleaning housing **732** drawing air through the narrow slits between the seal plates **734** and **735** and the adjacent surface of the belt **12**.

While there is in this application specifically described one form which the invention may assume in practice, it will be understood that this form of the same is shown for purposes of illustration, and that the invention may be modified and embodied in various other forms without departing from the scope of the appended claims.

What I claim is:

1. Apparatus for removing previously charged particles from a surface including

a housing,

a cylindrical brush mounted for rotation in the housing and in sweeping contact with the surface,

means for rotating said brush for producing a continuous sweeping action of the bristles of the brush relative to the surface thereby removing particles therefrom,

an elongated flicking member extending parallel to and along substantially the length of said brush and positioned so as to be inwardly radially relative to the outer tips of the bristles whereby rotation of the brush will produce flicking action for the particles adhering to the bristles,

said flicking member being coated with a material having its

relative position in a triboelectric series different than for the material of the bristles whereby a charge is produced on the bristles tips of opposite polarity to that on the particles for attracting the same from the surface and wherein the charge on the bristles is opposite that of the charge on the flicking member for repelling the particles from the flicking member after a flicking.