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(71) Applicant: **XEROX CORPORATION**
Xerox Square - 020
Rochester New York 14644(US)

(72) Inventor: **Seanor, Donald A.**
264 Garnsey Road
Pittsford New York 14534(US)

(72) Inventor: **Garsin, Paul A.**
135 London Road
Webster New York 14580(US)

(74) Representative: **Prior, Nicholas J. European Patent Attorney et al,**
Rank Xerox Limited Patent Department 338 Euston Road
London NW1 3BH(GB)

(54) **Apparatus for cleaning particles from a surface.**

(57) An apparatus (50) for cleaning particles from a surface, which includes a magnetic transport (52, 54) for moving a cleaning material into contact with the surface. The magnetic transport (52,54) is electrically biased to a polarity and magnitude sufficient to attract the particles from the surface to the cleaning material. An electrically non-conductive member (62), positioned closely adjacent to the magnetic transport (52, 54), is electrically biased to the same polarity as the magnetic transport (52,54) with the magnitude thereof being greater than the magnitude of the electrical bias applied to the magnetic transport (52,54). In this way, particles adhering to the cleaning material are attracted therefrom to the member (62).

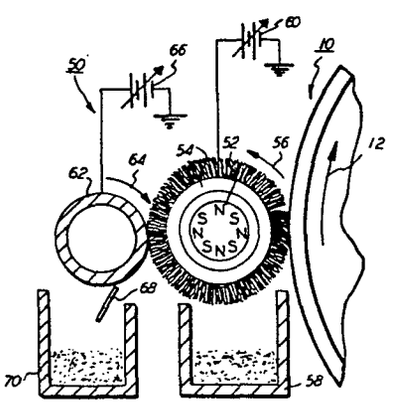

FIG. 2

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APPARATUS FOR CLEANING PARTICLES FROM A SURFACE

This invention relates to apparatus for cleaning particles from a surface, particularly in an electrophotographic reproduction machine.

In such a machine, residual toner particles frequently remain adhering to the photoconductive surface after the transfer thereof to the sheet of support material. Hereinbefore, ordinary cleaning devices such as brushes or foam rollers, have not been entirely satisfactory in cleaning residual particles from the photoconductive surface. One of the more attractive methods for cleaning particles from the photoconductive surface has been to use a rotating magnet enclosed in a stationary, non-magnetic shell. This system attracts carrier granules which, in turn, attract triboelectrically the residual toner particles from the photoconductive surface. One of the problems assiciated with a cleaning system of this type is that the residual toner particles remain adhering to the carrier granules. Thus, these residual toner particles must be removed from the carrier granules in order to successfully perform the cleaning operation over long periods of time. Various types of cleaning systems using these techniques have hereinbefore been utilized.

U.S. Patent No. 3,580,673 discloses an apparatus for cleaning toner particles from a recording surface. The apparatus includes a rotatably mounted non-magnetic cylindrical member housing a permanent bar magnet. The cylindrical member moves magnetic beads into contact with the recording surface. An electrical bias opposite in polarity to the polarity of the toner particles is applied thereto. The electrical bias is sufficient to attract the toner particles to the cleaning beads. A conductive roll is positioned in contact with the magnetic beads. The roll is electrically biased to the same polarity as the cylindrical member with their magnitude being sufficiently

high to attract the toner particles from the cleaning beads thereto.

U.S. Patent No. 3,920,329 describes a background removal apparatus including a magnetic brush for removing background toner from a photoreceptor. The magnetic brush has a rotatably mounted, non-magnetic cylinder with two permanent bar magnets being positioned interiorly thereof. As the cylinder rotates, it advances magnetic carrier beads into contact with the photoreceptor to triboelectrically attract the background toner thereto. The magnetic brush is electrically biased to a positive polarity. A re-claim roller is positioned closely adjacent to the magnetic brush and also biased to a positive polarity of a greater magnitude to attract the particles from the carrier granules thereto. The re-claim roller is made from a non-magnetic material e.g. non-magnetic stainless steel.

U.S. Patent No. 4,006,987 discloses an apparatus for cleaning residual toner from an electrostatic recording medium. The cleaning apparatus includes an electrically biased, rotatably mounted cylindrical sleeve. Permanent magnets are mounted fixedly interiorly of the sleeve. As the sleeve rotates, magnetic particles adhering thereto contact the recording medium and triboelectrically attract the residual toner thereto. A roller contacts the magnetic particles to attract the residual toner therefrom. The roller comprises an electrically grounded conductive metal cylinder having an insulating layer coated thereon.

The present invention is characterized by means for transporting a cleaning material into contact with the surface, said transporting means being electrically biased to a polarity and magnitude sufficient to attract the particles from the surface to the cleaning material; and non - electrically conducting means, electrically biased to the same polarity as the transporting means and

to a magnitude greater than the magnitude electrically biasing said transporting means, for attracting the particles from the cleaning material thereto.

One way of carrying out the invention is described in detail below with reference to the accompanying drawings which illustrate only one specific embodiment.

Figure 1 is a schematic elevational view depicting an electrophotographic printing machine incorporating cleaning apparatus according to the present invention therein; and

Figure 2 is a schematic elevational view showing the cleaning apparatus of Figure 1.

As shown in Figure 1, the electrophotographic printing machine employs a drum, indicated generally by the reference numeral 10. Preferably, drum 10 includes a conductive substrate, such as aluminum, having a photoconductive material e.g., a selenium alloy, deposited thereon. Drum 10 rotates in the direction of arrow 12 to pass through the various processing stations disposed thereabout.

Initially, drum 10 moves a portion of the photoconductive surface through charging station A. At charging station A, a corona generating device, indicated generally by the reference numeral 14, charges the photoconductive surface of drum 10 to a relatively high, substantially uniform potential.

Thereafter, the charged portion of the photoconductive surface of drum 10 is advanced through exposure station B. At exposure station B, an original document is placed face-down upon a transparent platen. The exposure system, indicated generally by the reference numeral 16, includes a lamp which moves across the original document illuminating incremental widths thereof. The light rays reflected from the original document are transmitted

through a moving lens system to form incremental width light images. These light images are focused onto the charged portion of the photoconductive surface. In this manner, the charged photoconductive surface of drum 10 is discharged selectively by the light images of the original document. This records an electrostatic latent image on the photoconductive surface which corresponds to the informational areas contained within the original document. It has been found that illuminating the charged portion of the photoconductive surface fails to totally discharge the photoconductive surface. Thus, the photoconductive surface retains background charge areas which are of some residual voltage level. For example, the background areas may have a nominal potential of about 50 volts while the electrostatic latent image or image areas may have a nominal potential of about 350 volts.

Next, drum 10 advances the electrostatic latent image recorded on the photoconductive surface to development station C. At development station C, a magnetic brush development system, indicated generally by the reference numeral 18, transports the developer material into contact with the photoconductive surface of drum 10. The toner particles are attractd from the carrier granules to the electrostatic latent image forming a toner powder image corresponding to the informational areas of the original document.

Continuing now with the various processing stations disposed in the electrophotographic printing machine, after depositing the powder image on the photoconductive surface, drum 10 advances the powder image to transfer station D. At transfer station D, a sheet of support material is positioned in contact with the powder image formed on the photoconductive surface of drum 10. The sheet of support material is advanced to transfer station D by a sheet feeding apparatus, indicated generally by the reference numeral 20. Preferably, sheet

feeding apparatus 20 includes a feed roll 22 contacting the uppermost sheet of the stack 24 of sheets of support material. Feed roll 22 rotates in the direction of arrow 26 so as to advance the uppermost sheet from stack 24. Registration rollers 28, rotating in the direction of arrow 30, align and forward the advancing sheet of support material into chute 32. Chute 32 directs the advancing sheet of support material into contact with the photoconductive surface of drum 10 in a timed sequence. This insures that the powder image contacts the advancing sheet of support material at transfer station D.

Transfer station D includes a corona generating device 34, which applies a spray of ions to the backside of the sheet. This attracts the powder image from the photoconductive surface of drum 10 to the sheet. After transfer, the sheet continues to move with drum 10. A detack corona generating device (not shown) neutralizes the charge causing the sheet to adhere to the drum. The sheet is then separated from drum 10. Conveyor 36 advances the sheet in the direction of arrow 38, from transfer station D to fusing station E.

Fusing station E, indicated generally by the reference numeral 40, includes a back-up roller 42 and a heated fuser roller 44. A sheet of support material with the powder image thereon passes between back-up roller 42 and fuser roller 44. The powder image contacts fuser roller 44 and the heat and pressure applied thereto permanently affixes it to the sheet of support material. After fusing, forwarding rollers 46 advance the finished copy sheet to catch tray 48. Once a copy sheet is positioned in catch tray 48, it may be readily removed therefrom by the machine operator.

Invariably, after the sheet of support material is separated from the photoconductive surface of drum 10, some residual toner particles remain adherring thereto. These particles are cleaned from the photoconductive

surface of drum 10 at cleaning station F. Preferably, cleaning station F includes a cleaning system 50 which attracts the toner particles from the photoconductive surface of drum 10 thereto. The detailed structure of cleaning system 50 will be described hereinafter with reference to Figure 2.

Figure 2 depicts cleaning apparatus 50 in greater detail. As shown thereat, cleaning apparatus 50 comprises a cylindrical magnet 52 having a plurality of magnetic poles impressed about the circumferential surface thereof. A non-magnetic, conductive, tubular member 54 is interfit over magnet 52. The interior circumferential surface of tube 54 is spaced from the exterior circumferential surface of magnet 52. Tube 54 is mounted rotatably. A constant speed motor rotates tube 54 at a substantially constant angular velocity. Preferably, magnet 52 is made from barium ferrite with tube 54 being made from aluminum. Magnet 52 is mounted fixedly and remains substantially stationary as tube 54 rotates in the direction of arrow 56. As tube 54 rotates in the direction of arrow 56, it passes through housing 58. Housing 58 stores a supply of magnetic granules. These magnetic granules are attracted to tube 54. Voltage source 60 is connected to tube 54 and applies a D.C. electrical field thereto. Preferably, the polarity of this field is opposite to that of the toner particles adhering to the photoconductive surface of drum 10 and of a magnitude sufficient to attract the toner particles from the photoconductive surface to the magnetic particles adhering to tube 54. The magnetic particles are selected so that the toner particles have a triboelectric affinity thereto. Preferably, voltage source 60 electrically biases tubular member 54 to a voltage level ranging from about 300 to about 500 volts.

Roller 62 is positioned closely adjacent to tube 54. As roller 62 rotates in the direction of arrow 64, it attracts the toner particles from the magnetic particles

adhering to tube 54. Voltage source 66 electrically biases roller 62 to the same polarity as voltage source 60 electrically biases tube 54. However, the magnitude of the electrical bias applied by voltage source 66 to roller 62 is greater than the electrical bias applied by voltage source 60 to tube 54. For example, the magnitude of the electrical bias applied to roller 62 may range from about 300 to about 500 volts with the specific magnitude selected being greater than the magnitude of the electrical bias applied to tube 54. Preferably, roller 62 is made from aluminum having a coating of aluminum oxide thereon. Preferably, the layer of aluminum oxide ranges from about 20 microns to about 30 microns thick.

A metering blade 68 is located closely adjacent to roller 62 for removing the toner particles therefrom. Metering blade 68 deflects or shears the toner particles from roller 62 into the chamber of housing 70. Toner particles fall into the chamber of housing 70 under the influence of gravity. These toner particles may be recycled for subsequent re-use in the printing machine development system. By way of example, blade 68 may be made from sheet metal extending across the width of roller 62.

In recapitulation, it is clear that the cleaning system of the present invention removes residual toner particles adhering to the photoconductive surface after transfer of the powder image to the sheet of support material. The cleaning apparatus comprises a magnetic transport which advances magnetic particles having a triboelectric affinity into contact with the residual toner particles. The magnetic transport is electrically biased to a suitable polarity and magnitude to attract the toner particles from the photoconductive surface to the magnetic particles adhering thereto. The toner particles, in turn, are removed from the magnetic particles by being attracted to a roller which is electrically biased to the

same polarity as the magnetic transport with the magnitude thereof being greater than the magnitude of the electrical bias applied to the magnetic transport. A metering blade removes the residual toner particles from the roller and deflects them into the chamber of a housing for subsequent reuse in the printing machine.

CLAIMS:

1. An apparatus (50) for cleaning particles from a surface, characterised by,

means (52, 54) for transporting a cleaning material into contact with the surface, said transporting means (52, 54) being electrically biased to a polarity and magnitude sufficient to attract the particles from the surface to the cleaning material; and

non-electrically conducting means (62), electrically biased to the same polarity as said transporting (52, 54) means and to a magnitude greater than the magnitude electrically biasing said transporting means (52, 54), for attracting the particles from the cleaning material thereto.

2. Apparatus (50) according to Claim 1, wherein said attracting means (62) includes a roller (62) positioned closely adjacent to said transporting means (52, 54).

3. Apparatus (50) according to Claim 2, further including a roller voltage source (66) coupled to said roller (62), said roller voltage source (66) electrically biasing said roller (62) to a first polarity and a first magnitude.

4. Apparatus (50) according to Claims 2 or 3, wherein said roller (62) is preferably made from aluminum having a layer of aluminum oxide coated thereon.

5. Apparatus according to claim 1, 2, 3 or 4 wherein said transporting means (52, 54) includes:

a non-magnetic tubular member (54) closely spaced to the surface; and

a magnetic member (52) disposed interiorly of and spaced from the interior peripheral surface of said tubular member (54).

6. Apparatus (50) according to Claim 5, further including a tube voltage source (64) coupled to said tubular member (54), said tube voltage source (66) electrically biasing said tubular member (54) to a second polarity and second magnitude with the second polarity being the same as the first polarity and the second magnitude being less than the first magnitude.

7. Apparatus (50) according to Claim 6, further including:

means (68) for removing the particles from said roller (62); and

means (70) for storing the particles removed from said roller (62).

8. Apparatus (50) according to Claim 7, wherein the cleaning material includes magnetic granules.

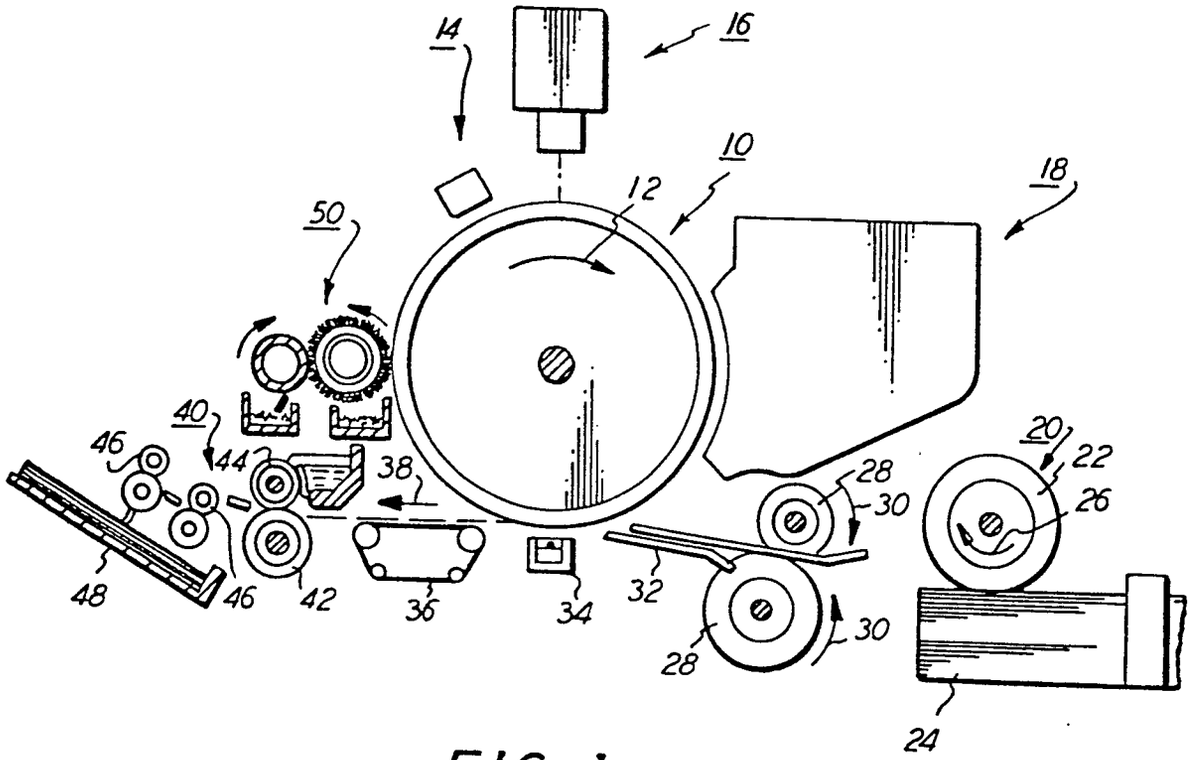
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FIG. 1

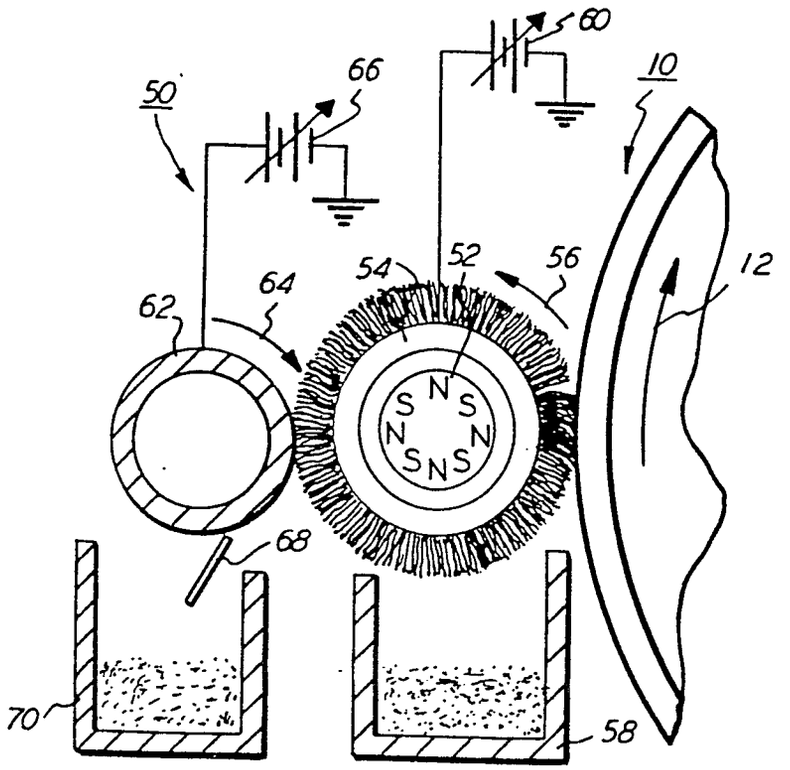
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FIG. 2

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EUROPEAN SEARCH REPORT

0036290
Application number

EP 81301015.4

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	GB - A - 1 259 890 (RANK XEROX) + Figs. 1-6; claims; page 3, lines 98-103 + --	1-8	G 03 G 21/00
X	US - A - 4 095 980 (SATOMI) + Figs.1,2; abstract; claims + ----	1-7	
			TECHNICAL FIELDS SEARCHED (Int. Cl.³) G 03 G 21/00

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
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T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	10-06-1981	KRAL

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