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(54) Cleaner blades.

(57) A cleaning blade structure (70) for removing residual toner particles from a flexible photoreceptor (10) supported for movement in an endless path. An elastomeric blade member (72) is rigidly supported by a support (74) such that there is no extension of the blade beyond the end of the support. Rigid support of the blade in this manner allows tip loads to be varied independently without varying the tip angle. This allows combinations of tip angles and blade loading which are not possible with conventional cleaner blade devices without changing blade free length and/or thickness.

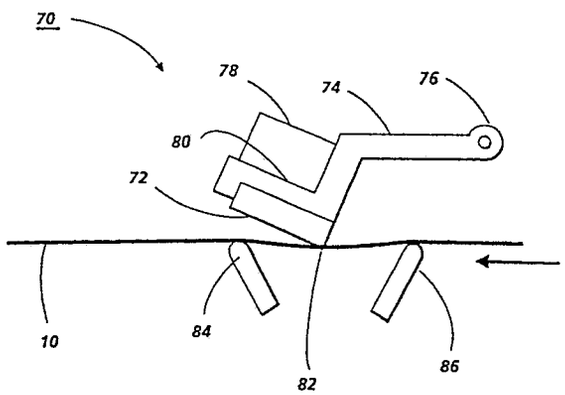

FIG. 2

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Description

This invention relates to an electrophotographic printing machine, and more particularly to a cleaning blade system for use therein.

In electrophotographic printing, a charge-retentive surface, such as a photoconductive member, is charged of a uniform potential. The uniformly-charged photoconductive member is exposed to a light image of an original document being reproduced. Exposure of the sensitized photoconductive surface discharges the charge selectively. This records an electrostatic latent image on the photoconductive surface corresponding to the informational areas contained within the original document being reproduced.

For the purposes of the present invention, which relates to the removal of residual toner particles from a charge-retentive surface subsequent to image transfer, the latent electrostatic image may be formed by means other than by the exposure of an electrostatically-charged photosensitive member to a light image of an original document. For example, the latent electrostatic image may be generated from information electronically stored or generated in digital form which may afterwards be converted to alphanumeric images by image generation electronics and optics. For example, the latent image can be formed electronically by using a modulated laser used in connection with a suitable scanning device. However, such electronic and optical image generation devices form no part of the present invention.

Development of the electrostatic latent image recorded on the photoconductive surface is achieved by presenting developer material to the latent image. Typical developer materials comprise a heat-settable plastics powder, known in the art as toner. The toner particles are selected to have the appropriate charge relative to the electrostatic latent image recorded on the photoconductive surface so that they are electrostatically attracted to the latent image.

After such development of the latent image, to render it visible, the powder images are transferred to a copy substrate such as plain paper.

Frequently, residual toner particles remain adhering to the photoconductive surface after transfer from the photoconductive surface to the substrate material. Heretofore, cleaning devices such as webs, brushes or foam rollers, have not been entirely satisfactory in removing residual toner particles from the photoconductive surface.

One of the more attractive methods for removing residual toner particles from the photoconductive surface has been to use a rotating magnet enclosed in a stationary non-magnetic shell or, alternatively, to utilize stationary magnets enclosed within a rotating, non-magnetic shell. This system attracts carrier granules which, in turn, attract the residual toner particles from the photoconductive surface thereto. However, cleaning systems of this type are presently rather costly and complex in order to achieve the desired cleaning efficiency.

Another of the more attractive methods of removing residual toner particles from a charge-retentive surface is to use a blade to either wipe and/or chisel the residual toner from the surface.

Cleaning blade structures are commercially used for removing residual toner from drum-type photoreceptors used in machines that have a relatively slow (i.e., a small number of copies produced in a given time period) process speed. However, their use in the higher speed machines and in conjunction with belt-type photoreceptors has not met with total acceptance.

Conventional cleaner blade devices are constructed such that there is a free extension of the blade beyond the end of the blade holder. The flexing of the extension of such a blade results in considerable variation in tip angle. The change in blade tip angle can be a factor in tuck failures, planing failure and in the creation of 'comets'. Variations in tip angle may also contribute to a reduction in blade life because of wearing of the tip to a larger, ineffective, radius. In known blade structures of this type, the tip angle varies significantly with change in blade loading. This is because the unconstrained extension of the blade flexes with increased loading thereby increasing the tip angle (i.e. the angle between the charge-retentive surface and the blade).

Various techniques have heretofore been employed to clean photoconductive surfaces, as illustrated by the following disclosures which may be relevant to certain features of the present invention:

US-A-3,640,617 discloses a photoconductive sheet having a latent image thereon which is passed through a receptacle containing liquid developer. Excess liquid toner is removed from the sheet by a doctor blade.

US-A-3 706 108 discloses a rotary cleaning brush used to sweep or knock loose the toner particles from a photoconductive surface of a belt. In the specification the fibers of the brush are referred to as blades. The brush is electrically biased so that the blades electrostatically attract toner particles from the belt surface.

US-A-3 989 005 discloses an oil metering device comprising a blade supported in cantilever fashion in a substantially U-shaped channel of a blade holder.

US-A-3 848 993 discloses a cleaning system having a main blade portion which is cantilever mounted generally parallel to, and in the direction of movement of, a photoreceptor surface.

US-A-4 428 665 is directed to a process and an improved apparatus for simultaneously removing and transporting undesirable residual insulating toner particles from a flexible imaging member comprising, in operative relationship, a cleaning roll containing on its surface insulating carrier particles, the cleaning roll being charged to a predetermined potential, a deflected flexible imaging member containing residual insulating toner particles thereon, a cleaning zone encompassed by, and

situated between, the cleaning roll and the deflected flexible imaging member, a magnet contained in the cleaning roll, and magnetic strips contained in the outer periphery of the cleaning roll. In operation the flexible imaging member is deflected into an arc, causing the formation of a cleaning zone encompassed by the cleaning roll and the flexible member.

US-A-4 501 486 is directed to a blade for cleaning toner from a liquid developed imaging surface. The blade comprises a body of high conductivity material formed of rubber impregnated with carbon particles, and a tip contacting the imaging surface formed of an inherently-conductive rubber of lesser conductivity. The liquid developer affects the conductivity of the body but not that of the tip, and the tip is replaceably inserted in a cooperating reëntrant cavity of large surface area formed in the body to provide a low contact resistant therebetween. The blade is electrically biased to improve its attraction of the developer.

US-A-4 527 887 discloses a blade cleaner for removing residual toner from a charge-retentive belt, and a deflected belt in connection with a cleaning device. As viewed in FIG. 2, a shield 82 exerts a force on the belt to cause the aftermentioned deflection.

US-A-4 630 920 discloses a highly-efficient, long-life cleaning blade apparatus for removing residual toner particles from a flexible photoreceptor supported for movement in an endless path. The cleaning blade is supported for pressure engagement with a flexible belt such that the belt is deflected. A backing member is supported in contact with the reverse side of the belt for controlling the degree of belt deflection and thereby the force required by the blade for efficient cleaning to a minimum and effect substantially uniform contact between the blade and the charge-retentive member. The support is positioned downstream of the blade a predetermined distance which minimizes the required cleaning force and also allows the belt to twist, thereby to conform with the blade edge, resulting in substantially-uniform contact between the blade and the belt.

In accordance with the present invention, there is provided a cleaner blade as claimed in the appended claims.

Another advantage of rigidly supporting the blade in the manner described is that it prevents blade set to take place. When the blade set occurs, the tip angle changes, thereby causing the problems previously mentioned. Another advantage of the rigidly-supported blade is that it is relatively insensitive to misalignment. It has been observed that acceptable cleaning is still obtained with the cleaning blade structure notwithstanding a misalignment of 2mm between the charge-retentive surface and the blade. By minimizing the foregoing problems with conventional blade cleaners, a more-reliable cleaner blade has been provided. Accordingly, the cleaner blade structure is suitable for use in relatively high speed machines.

The cleaning blade structure is used in connection with flexible charge-retentive surfaces of the type employed in electrostatic imaging. The blade tip contacts the imaging side of the charge-retentive surface intermediate a pair of supports which contact the back of the charge-retentive surface.

The supports serve to limit the deflection of the belt and provide for a more uniform force along the edge of the cleaning blade and the flexible belt. Correct spacing of the supports precludes adverse vibration problems caused by the blade moving across the seam in the flexible charge-retentive surface. The deflection of the belt, limited by the support members, allows it to conform to the cleaning blade edge, thereby effecting substantiall-uniform contact between the blade edge and the belt.

Other aspects of the present invention will become apparent as the following description proceeds with reference to the drawings, in which:

FIG. 1 is a schematic elevational view depicting an electrophotographic printing machine incorporating the features of the present invention therein, and

FIG. 2 is a schematic elevational view illustrating the cleaning system utilized in the printing machine of Figure 1.

For a general understanding of the illustrative electrophotographic printing machine incorporating the features of the present invention, reference is made to the drawings. In the drawings, like reference numbers have been used throughout to designate identical elements.

Inasmuch as the art of electrophotographic printing is well known, the various processing stations employed in the printing machine illustrated in FIG. 1 will be described only briefly.

As shown in Figure 1, a printing machine comprising the invention may utilize a charge-retentive member in the form of a photoconductive belt 10 consisting of a photoconductive surface and an electrically conductive substrate and mounted for movement past a charging station A, an exposure station B, developer station C, transfer station D, and cleaning station E. Belt 10 moves in the direction of arrow 16 to advance successive portions thereof sequentially through the various processing stations disposed about the path of movement thereof. Belt 10 is entrained about a plurality of rollers 18, 20 and 22, the former of which can be used as a drive roller and the latter of which can be used to provide suitable tensioning of the photoreceptor belt 10. Motor 23 rotates roller 18 to advance belt 10 in the direction of arrow 16. Roller 18 is coupled to motor 23 by suitable means such as a belt drive.

As can be seen by further reference to Figure 1, initially successive portions of belt 10 pass through charging station A. At charging station A, a corona discharge device, such as a scorotron, corotron or dicorotron 24, charges the belt 10 to a selectively high uniform positive or negative potential. Preferably charging is negative. Any suitable control, well known in the art, may be employed for controlling the corona discharge device 24.

Next, the charged portions of the photoreceptor surface are advanced through exposure station B. At exposure station B, The uniformly charged photoreceptor or charge-retentive surface 10 is exposed to a laser based output scanning device 25

which causes the charge-retentive surface to be discharged in accordance with the output from the scanning device. Alternatively, the ROS could be replaced by a conventional xerographic exposure device.

At a development station C, a magnetic brush development system 30 advances developer materials into contact with the electrostatic latent image. The development system 30 comprises a developer housing 32 including a pair of magnetic brush developer rollers 35 and 36. Appropriate developer biasing is accomplished via a bias power supply 41 electrically connected to developer housing 32.

The magnetic brush rolls 35 and 36 may comprise any conventional structure that provides a magnetic field that forms the developer material in the housing 32 into a brush-like configuration in the development zone between the rolls and the charge-retentive surface. This arrangement effects development of the ROS or optically-formed image contained on the charge-retentive surface in a well known manner.

The housing 32 contains developer with black toner 40 having triboelectric properties such that the toner is driven to the areas of the latent image by the electrostatic field (development field) beween the photoreceptor and the electrically biased development rolls.

A sheet of support material 58 is moved into contact with the toner image at transfer station D. The sheet of support material is advanced to transfer station D by conventional sheet-feeding apparatus, not shown. Preferably, the sheet-feeding apparatus includes a feed roll contacting the uppermost sheet of a stack copy sheets. Feed rolls rotate so as to advance the uppermost sheet from stack into a chute which directs the advancing sheet of support material into contact with photoconductive surface of belt 10 in a timed sequence so that the toner powder image developed thereon contacts the advancing sheet of support material at transfer station D.

Transfer station D includes a corona-generating device 60 which sprays ions of a suitable polarity onto the back of sheet 58. This attracts the charged toner powder images from the belt 10 to sheet 58.

At the cleaning station E, residual toner and contaminants or debris such as paper fibers and kaolin are removed from the photoreceptor surface by means of a blade structure 70 (see Figure 2). Structure 70 comprises a blade 72 and blade holder or support 74.

The blade holder is adapted to be pivotally mounted adjacent an end 76 thereof such that the blade structure is disposed above the belt 10 and free to pivot into engagement therewith. A weight 78 secured to a surface 80 of the blade holder 74 serves to bias an edge 82 of the blade 72 into pressure engagement with the belt 10. The blade edge 82 which is delineated by complementary sides of blade 72 contacts the belt such that it forms an acute angle with the belt. The relative movement between the blade and the flexible charge-retentive surface is such that the blade edge chisels the residual toner therefrom. The belt conforms to the edge 82 of the blade, thereby rendering the cleaning system relatively insensitive to blade/belt misalignment.

The blade may be fabricated from any suitable elastomeric material. The blade holder comprises a rigid structure to which the blade 72 is attached such that the entire surface of the blade contacting the holder is in intimate contact with the blade holder. In other words, the blade has no free extension beyond the end of the blade holder, as is the case with known blade structures.

A pair of rigid backing or support members 84 and 86 is stationarily supported in contact with the opposite side of the belt from the side contacted by the blade 72. The support members limit the deflection of the belt 10 and thereby control the force created between the blade and the belt. The support members may be in the form of a blade, roller or flat plate. They may be fabricated from metal, plastics or rubber. The support members are positioned so that they contact the back of the flexible charge-retentive surface. They are spaced a distance from each other so as to minimize the blade vibration as the blade passes over a seam of the flexible charge-retentive surface.

As will be appreciated, there has been shown and described a cleaning blade apparatus which allows for load variations without variation in tip angle thereby obviating the problems encountered with the use of known structures because of the change in tip angle. Thus, combinations of tip angles and blade loading which are not possible with conventional cleaner blade devices are possible with this invention, without changing the blade free length and/or thickness.

Claims

1. A cleaner blade structure for removing residual material from a flexible charge-retentive surface, comprising:
a rigid support member (74);
a blade member (72) supported such that an edge (82) formed by contiguous surfaces is biassed towards the path of the charge-retentive surface (10);
the edge and one of the surfaces forming it being adapted to effect a chiseling action on the flexible charge-retentive suface;
the blade member being supported by the rigid support such that its tip angle is insensitive to blade loading.variations.

2. Apparatus according to claim 1, wherein the blade member is supported along its entire extent by the rigid support, whereby the blade member does not extend beyond the end of the rigid support.

3. Apparatus according to claim 1 or 2, in which the support is adapted to be mounted for pivotal movement.

4. Apparatus according to any preceding claim, wherein the support is biassed by means of a weight (78) carried by the support.

5. Apparatus according to any preceding

claim, in which the edge is adapted to intercept the path of the charge-retentive surface intermediate two transversely-extending supports (84, 86) therefor.

6. Apparatus according to claim 5, wherein the spacing between the supports is such as to minimize vibration of the cleaner blade as it contacts a seam in the charge-retentive surface.

7. Reprographic apparatus including means for forming toner images on a flexible charge-retentive surface, and a cleaner blade as claimed in any preceding claim mounted to bear on the flexible surface.

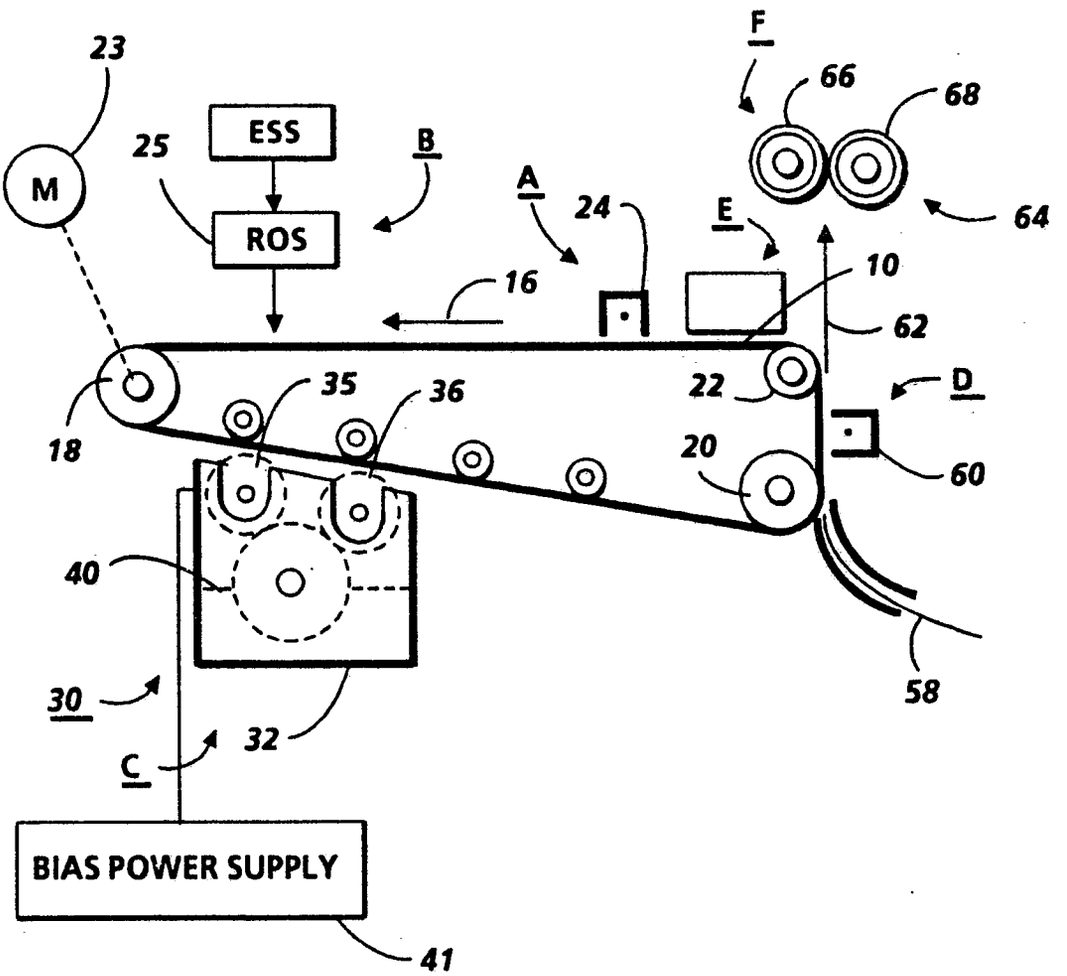
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FIG. 1

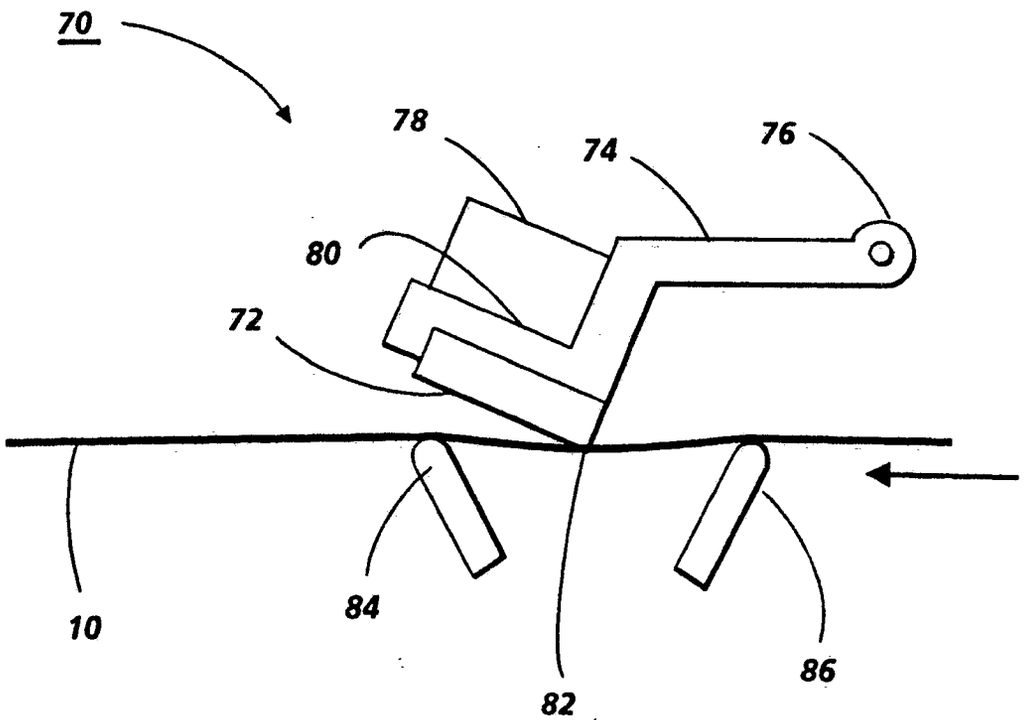

FIG. 2