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R. A. DREXLER
SINGLE MAGNETIC BRUSH APPARATUS FOR DEVELOPMENT OF
ELECTROSTATIC IMAGES
Filed Feb. 29, 1968

3,457,900

FIG. 1

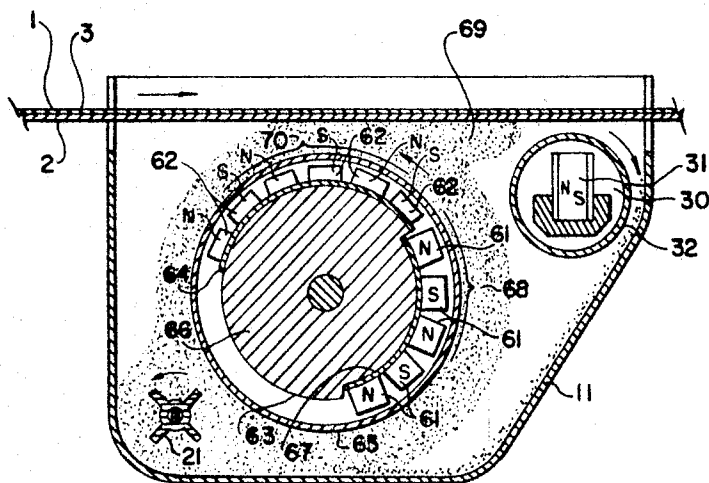
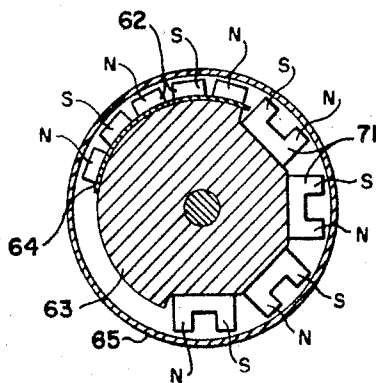


FIG. 2



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ATTORNEYS

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SINGLE MAGNETIC BRUSH APPARATUS FOR DEVELOPMENT OF ELECTROSTATIC IMAGES**Roger A. Drexler, Rochester, N.Y., assignor to Eastman Kodak Company, Rochester, N.Y., a corporation of New Jersey**

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3 Claims

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ABSTRACT OF THE DISCLOSURE

Using a single magnetic brush, developer is fed into a cavity formed by the brush and an electrostatic image-bearing surface faster than it is discharged, creating a roll-back of developer which is effective in toning an image. The magnetic brush is adapted to feed faster than it discharges by placement of strong magnets in a feed portion of the brush and weak magnets in a discharge portion of the brush.

CROSS-REFERENCES TO RELATED APPLICATIONS

Reference is made to commonly assigned cofiled U.S. patent application Ser. No. 709,281, entitled "Method and Apparatus for Development of Electrostatic Images," in the names of Roger A. Drexler and Conrad Altmann.

BACKGROUND OF THE INVENTION

This invention relates to electrostatic images (which term is meant to include all electrostatic charge patterns, regardless of method of formation) and, more specifically, to apparatus for developing electrostatic images carried on an insulating surface.

In electrography, it is common to form an electrostatic image on an insulating surface and to develop that image by applying toner particles thereto. The resulting toner image is then utilized. In the most common commercial applications, the toner is either transferred in image configuration to another surface and then fixed or is fixed to the insulating surface itself. In processes in which the toner is transferred from the insulating surface prior to fixing, the insulating surface generally is reused.

Triboelectric developing systems have been adapted to the general development of electrostatic images. In such systems, finely divided toner particles are held to the surface of much larger carrier particles by electrostatic charges created by triboelectrification, forming a mixture (herein called developer). When the developer is brought into contact with an electrostatic image, the attraction of the image for the triboelectrically charged toner overcomes the attraction of the carrier for the toner and the image is developed.

Among triboelectric developing systems, the most commonly used are cascade systems and magnetic brush systems. In cascade systems, gravity is used to roll developer across the image. Because cascade systems use gravity as their primary moving force, they are necessarily speed limited. In automatic machines, a cascade recirculation system generally requires substantial machine space.

In magnetic brush systems, the carrier particles are ferromagnetic in nature. These ferromagnetic carrier par-

ticles are held to an applicator surface, for example, a non-magnetic cylinder, in bristle formation by magnetic attraction. With the proper use of applicator, one or more magnets and developer, the bristles can be brushed across a surface carrying an electrostatic image. The electrostatic attraction of the toner for the image overcomes the triboelectrically created attraction between toner and ferromagnetic particles and the image is developed. Areas of the image exerting less attractive force on the toner than is exerted by the carrier are cleaned of toner as they are brushed. This is commonly aided by application of an electrical bias to the carrier through the applicating surface of the brush. Magnetic brushes also have been designed to give either fringe or solid area development by adjusting the conductivity of the carrier. They can also be made to tone areas of less charge and clean areas of greater charge giving what is known in the art as a reverse development.

Commercial applications of magnetic brush development have been quite extensive. However, such applications generally have been concentrated in the area of development of electrostatic images formed on a non-reusable insulating surface, such as zinc oxide coated paper. That is, the toner image is fixed to the insulating surface carrying the electrostatic image rather than being transferred prior to fixing.

In applying magnetic brush development to systems in which the surface to be toned is to be reused after utilization of the toner pattern, certain problems are accentuated. For example, repeated rubbing by the fairly coarse bristles of the magnetic brush has a tendency both to scratch the insulating surface and to create a toner scum on it. These problems are particularly severe when the insulating surface is photoconductive, as in xerography, because of difficulties in proper image formation on a scratched or scummed photoconductive surface.

Additionally, a powder transfer process greatly increases image degradation caused by carrier carryout. More specifically, small carrier particles are commonly picked up by the insulating surface in the toning operation and have the effect at toner transfer of holding a large area of the transfer surface away from the photosensitive surface thereby inhibiting powder transfer. This problem is much reduced if no transfer of toner is included in the process, as is the case when the powder is fixed to the toner surface.

In the co-filed application in the name of Drexler and Altmann, mentioned above, an apparatus for solving these problems is described in which developer is fed into a cavity adjoining the insulating surface at a faster rate than it is discharged therefrom creating a soft, gently tumbling development medium in contact with the insulating surface. Among structures contemplated for producing this soft, gently tumbling development medium, is a two-magnetic brush system in which one magnetic brush, performing the feed function, rotates faster than the other magnetic brush, performing the discharge function.

SUMMARY OF THE INVENTION

According to the invention, the functions of feed and discharge in the apparatus of said Drexler and Altmann application are performed by a single magnetic brush having both a feed portion and a discharge portion.

In a preferred embodiment, the feed portion has associated with it, a series of strong magnets which can aid in feeding a large amount of developer. The discharge portion also has magnets associated with it, but they are weaker than those of the feed portion. The brush is positioned to form a cavity with the insulating surface and, in operation, creates in the cavity an accumulation of developer in the form of a rollback in contact with the insulating surface.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic cross-sectional view of a magnetic brush assembly constructed according to the invention.

FIG. 2 is a schematic cross-sectional view of an alternate arrangement of magnets for the apparatus of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

According to FIG. 1, an electrostatic image carried on an insulating surface 2 of a moving web 1 having a conductive backing 3 is to be developed or toned. The surface 2 is moved past a magnetic brush 63. The magnetic brush 63 can be adapted from a variety of designs known in the prior art. According to FIG. 1, a preferred design for this application includes a stationary core 66 of nonmagnetic material around portions of which are placed two magnetic pole pieces 64 and 67 which may be made of soft steel or other magnetic material. Mounted around the circumference of the pole pieces 64 and 67 are two series 61 and 62 of permanent magnets, for example, rubber bonded barium ferrite magnetic strips or poles. Concentric with the arrangement of these elements and on the outside thereof is a rotatable, preferably outside surface roughened, nonmagnetic roller 65. The brush is mounted in a trough 11 or other reservoir means for holding triboelectric developer. Developer in the trough 11 is agitated by a paddle wheel 21. Toner can be periodically fed into the trough by any suitable toner dispensing mechanism, not shown.

According to FIG. 1, as the roller 65 is rotated in counterclockwise direction, developer is magnetically held to its outer surface and is moved by it. The first series 61 of magnets is located in a feed portion 68 of the brush 63. These magnets are strong enough to aid the roller 65 in moving substantial developer to a cavity 69 formed by the roller 65 and the insulating surface 2. The second series 62 is located in a discharge portion 70 of the brush. These magnets are weaker than those in the feed portion 68. There is, thus, a tendency to discharge less developer than is fed into the cavity 69, creating an accumulation of developer in the cavity until it falls off the ends or back through the feed portion into the trough. This accumulation takes the form of a rollback from the contact of the magnetic brush 63 with the insulating surface 2. If the insulating surface is moved in a direction opposite to that of the roller, the rollback gently tumbles giving excellent mixing and, therefore, excellent triboelectric charging of toner. In addition, it gives a soft toning medium less likely to scratch the insulating surface 2 and less likely to create a scum of toner on it than prior devices using the bristle part of a magnetic brush for toning.

Because the rollback of developer is not closely associated with the magnetic fields of the magnetic brush, there is a tendency toward carrier carryout. This tendency can be ignored in many applications, especially those in which the toner image is fixed to the insulating surface 2. However, for other applications, especially those in which the toner is transferred to another surface, it is advantageous to provide a carrier scavenging mechanism 30. This mechanism includes a strong magnet 31 positioned close to the insulating surface and a carrier receiving surface 32. As carrier carried by the insulating surface 2 comes into close proximity with magnet 31,

the magnet attracts such carrier toward surface 32 which is rotating to carry it away, for example, back to the developer trough 11.

FIG. 2 shows a different magnet arrangement associated with the feed portion of the magnetic brush. Instead of magnetic strips, horseshoe magnets 71 are used.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

I claim:

1. In a developing apparatus for use in applying toner to a moving insulating surface carrying an electrostatic image by contacting said surface with a developer comprising toner particles and ferromagnetic carrier particles, said apparatus including:

means defining a cavity adjacent to said insulating surface,

developer feed means for feeding developer into said cavity at a first rate,

developer discharge means for discharging developer from said cavity at a second rate, and

said first and second rates being so chosen to cause a substantial accumulation of developer in said cavity in contact with said insulating surface,

the improvement wherein said developer feed means and said developer discharge means comprises a single magnetic brush having:

a feed portion and a discharge portion, each portion being at least partially adjacent said cavity, and magnetic flux producing means arranged so that the flux produced thereby is stronger in said feed portion than in said discharge portion.

2. In a developing apparatus for use in applying toner to a moving insulating surface carrying an electrostatic image by contacting said surface with a developer comprising toner particles and ferromagnetic carrier particles, said apparatus including:

reservoir means for holding said developer, means defining a cavity adjacent said insulating surface,

developer feed means for feeding developer from said reservoir means into said cavity at a first rate,

developer discharge means for discharging developer from said cavity at a second rate,

said first and second rates being so chosen to cause a substantial accumulation of developer in said cavity in contact with said insulating surface,

the improvement wherein said developer feed means and said developer discharge means comprise a single magnetic brush having:

a nonmagnetic, cylindrical applicator surface forming at least a portion of said cavity defining means, said applicator surface being rotatable through a path having a feed portion extending from said reservoir into said cavity and a discharge portion extending from said feed portion out of said cavity, and

magnetic flux producing means arranged so that the flux produced thereby is stronger in said feed portion than in said discharge portion whereby, in operation, a substantial accumulation of gently tumbling developer is created in said cavity.

3. A developing apparatus for use in applying toner to a moving insulating surface carrying an electrostatic image by contacting said surface with a developer comprising toner particles and ferromagnetic carrier particles, said apparatus including:

reservoir means for holding said developer,

a magnetic brush having:

a nonmagnetic, cylindrical applicator surface rotatable through a path from said reservoir means into close proximity with said insulating surface in a direction opposite to movement of said insulating surface, said

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path including a feed portion extending from said reservoir a portion of the distance to said position of close proximity and a discharge portion extending from said feed portion past said position of close proximity,
a series of permanent magnets located inside said applicator surface and in close proximity to said feed portion and said discharge portion of said path, said magnets in close proximity to said feed portion being substantially stronger than said magnets in close proximity to said discharge portion, whereby, in operation, a substantial accumulation of developer is created in front of said position of close proximity between said insulating surface and said applicator surface.

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PETER FELDMAN, Primary Examiner

U.S. Cl. X.R.

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