

[54] **MAGNETIC BRUSH DEVELOPING
APPARATUS**

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[51] Int. Cl.² **G03G 15/08**

[58] Field of Search **118/637; 117/17.5**

[56] **References Cited**

UNITED STATES PATENTS

3,589,895	6/1971	Ville	118/637
3,598,579	8/1971	Robinson	117/17.5

3,599,605	8/1971	Ralston et al.	118/637
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Primary Examiner—Mervin Stein

Assistant Examiner—Douglas Salser

[57] **ABSTRACT**

An electrostatic type copier or reproduction machine having one or more magnetic brush devices for developing the latent electrostatic images formed on the copier photoconductive member, such magnetic brush devices being grounded to permit use of uncoated developer carrier without shorting the magnetic brush or brushes. To suppress image background and enhance image development in the absence of bias on the magnetic brushes, a pre-development corotron is used to place a charge of opposite polarity on the latent electrostatic images to reduce background charge.

5 Claims, 4 Drawing Figures

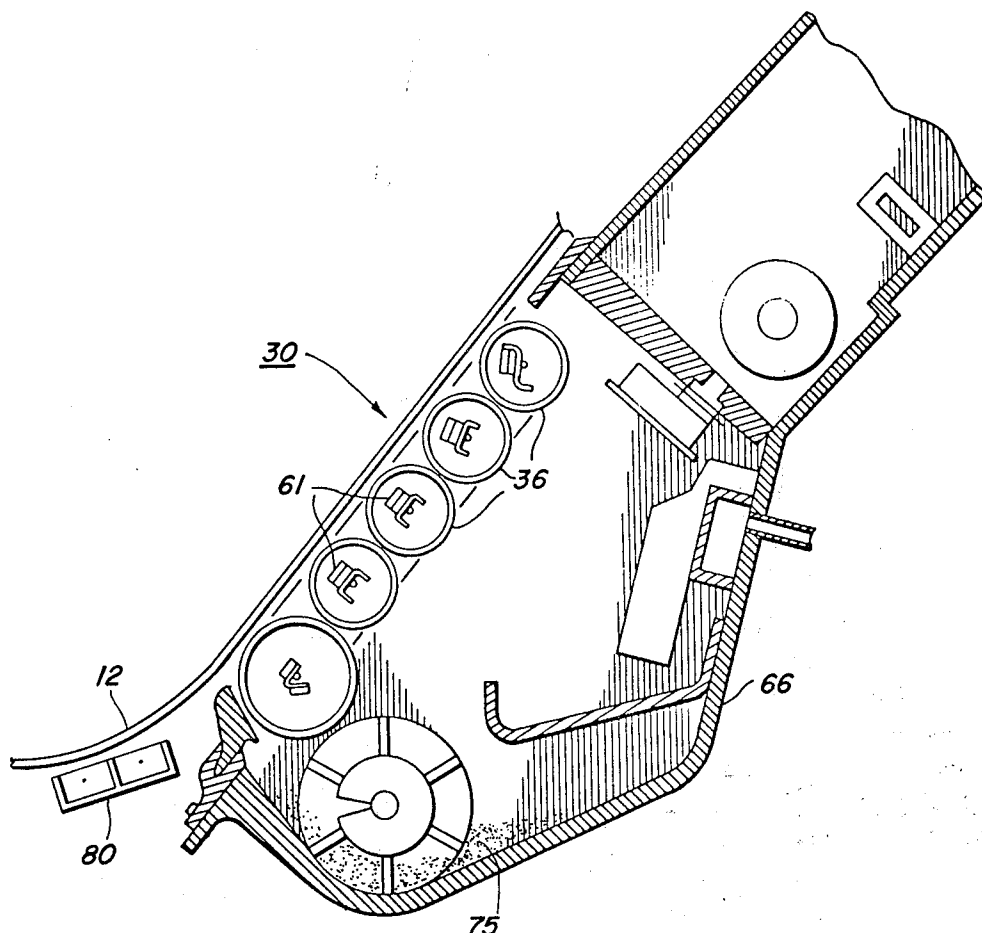


FIG. 3

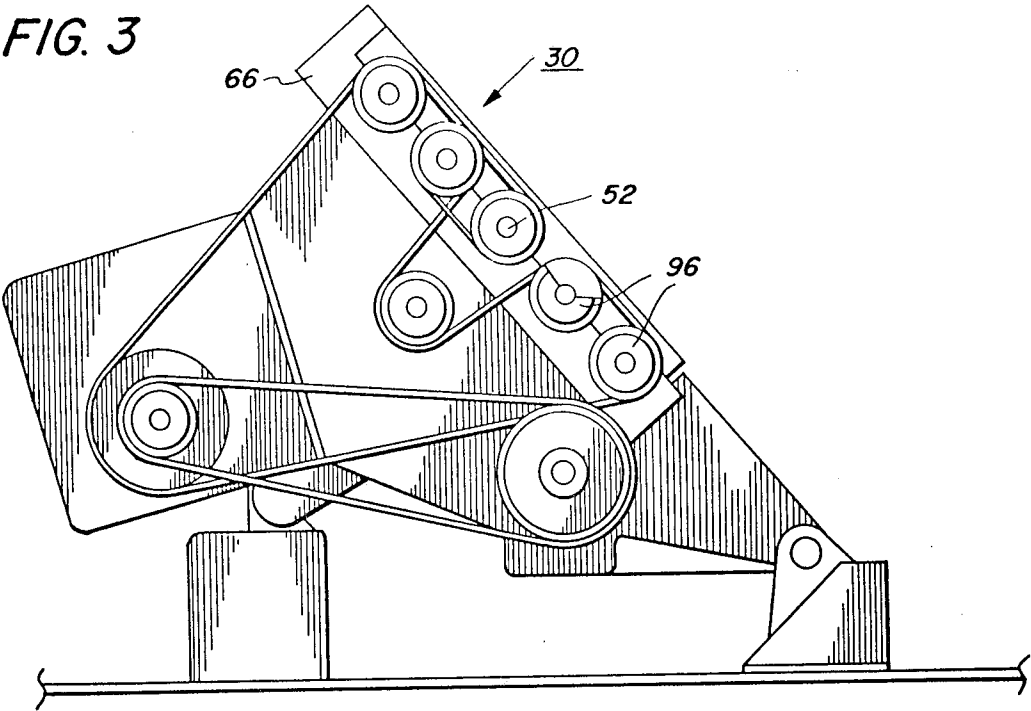


FIG. 2

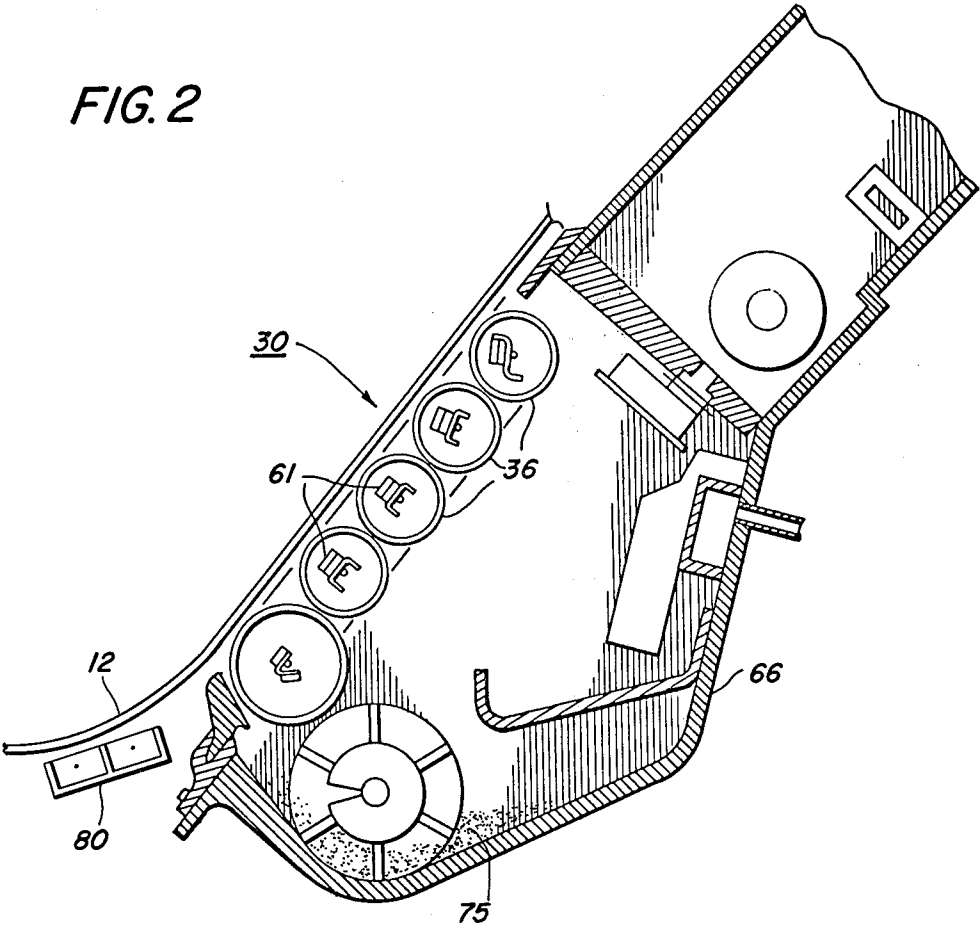
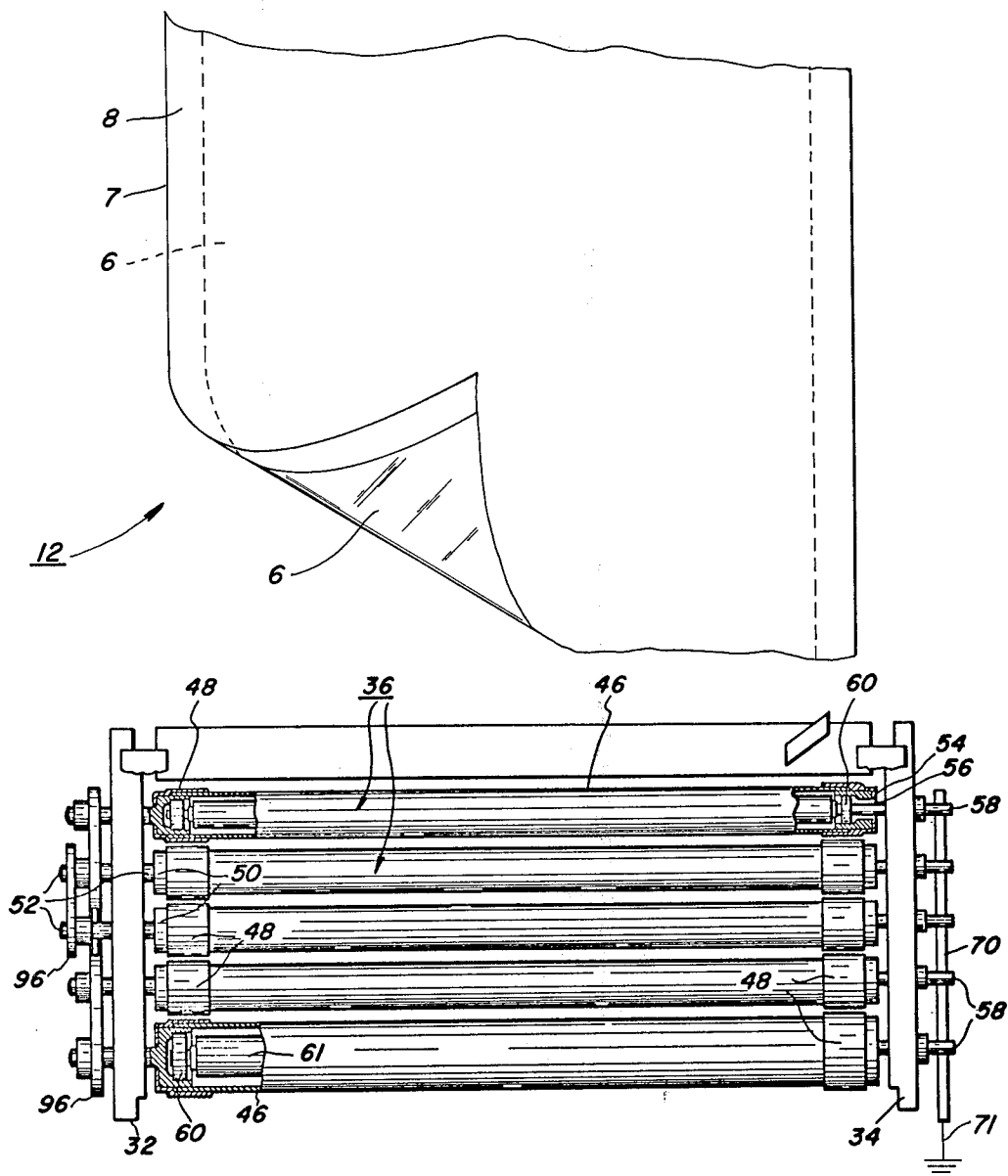


FIG. 4



MAGNETIC BRUSH DEVELOPING APPARATUS

This invention relates to a developing system for reproduction machines, and more particularly, to an improved developing system designed for use with uncoated developer carrier.

As will be understood by those familiar with electrostatic type reproduction and copier machines, the efficacy of such copiers depends in large measure upon the proper relative charge, i.e., the electrostatic development field, being maintained between the copier photoconductive member and the image developing material. For, as appreciated, this electrostatic development field is relied upon to attract the ink portion of the developing material, commonly called toner, to the photoconductive member in conformance with both the outline and density of the electrostatic latent image on the photoconductive member. It will be understood that the electrostatic image was previously formed through exposure of the charged photoconductive member to a light image of the original being copied.

Many copier machines employ one or more magnetic brushes to bring the developing material, which is normally comprised of carrier and toner, into operative relationship with the photoconductive member. In magnetic brush development, the magnetic field generated by the brush or brushes serves initially to attract the developing material to the brush periphery. Thereafter, as the developing material is brought into proximity with the photoconductive member by the moving brush due to the charge relationships between brush, developing material and photoconductive member, toner brush, developing material and photoconductive member, toner is attracted from the brush to the photoconductive member in conformance with the latent electrostatic image thereon. To enhance magnetic brush development and suppress development of unwanted non-image areas, the magnetic brush or brushes are normally biased to a predetermined potential.

As noted, the developing material is composed of carrier particles or beads and toner, the toner particles, due to the triboelectric relationship between the carrier and toner materials, being normally attracted to the carrier. It is this carrier bearing toner that is brought by the developing mechanism, i.e., the aforesaid magnetic brushes, into juxtaposition with the photoconductive member to allow the electrostatic charges on the photoconductive member to draw the toner from the carrier beads and onto the photoconductive member in conformance with the latent electrostatic image thereon.

While the aforesaid carrier may comprise various materials and material compositions, in the case of magnetic developing systems, the carrier material must have magnetic properties in order for the magnetic brush or brushes to operate. However, this may give rise to a shorting problem particularly where uncoated or bare carrier beads are employed in conjunction with biased magnetic brushes since the carrier beads may jam or conglomerate between a magnetic brush and the developing material housing or the photoconductor itself and thus provide a short circuit path to the brush. This condition, which alters the operating bias on the magnetic brush or brushes affected, impairs or destroys developing efficacy, and for that reason may inhibit use of uncoated carrier in magnetic brush developing systems,

or for that matter, in other development systems utilizing biased developing components.

It is therefore a principle object of the present invention to provide a new and improved developing system for electrostatic type reproduction machines which permits use of either coated or uncoated developer carrier.

It is an object of the present invention to provide an electrostatic copier with magnetic brush type developer usable with bare conductive carrier in the developer mix.

It is a further object of the present invention to provide a magnetic brush type developing apparatus for reproduction machines incorporating means to reduce image background charge before development.

It is an object of the present invention to provide an improved electrostatic copier with a pre-development corotron to reduce latent electrostatic image charges thereby avoiding the need to place a bias on the copier developing mechanism.

It is an object of the present invention to provide an improved magnetic brush developing arrangement which obviates the need to utilize insulated operating components.

This invention relates to a xerographic development apparatus adapted to permit the use of uncoated conductive carrier in the developer mix used to develop the latent electrostatic images formed on a uniformly charged photoconductive member, the combination comprising, means to bring the developer mix including carrier into operative development relationship with the latent electrostatic image on the photoconductive member including at least one magnetic developing brush, and means to suppress image background to avoid developing image background areas, the image suppressing means comprising a charge producing device adapted to expose the photoconductive member to a charge opposite in polarity to the charge on the photoconductive member whereby to reduce image background charge levels.

Other objects and advantages of the present invention will be apparent from the ensuing description and drawings in which:

FIG. 1 is a schematic sectional view of an exemplary electrostatic type reproduction machine incorporating the image background suppressing means of the present invention;

FIG. 2 is an enlarged side view of the magnetic brush developing apparatus of the machine shown in FIG. 1 together with the image suppressing means of the present invention;

FIG. 3 is an elevational view of the opposite side of the magnetic brush developing apparatus shown in FIG. 2 illustrating the brush drives; and

FIG. 4 is a top plan view of the magnetic brush developing apparatus showing details of the brush biasing means.

For purposes of explanation, the invention is incorporated into an exemplary copier/reproduction machine designated generally by the numeral 5 and schematically illustrated in FIG. 1 of the drawings.

A document 11 to be copied is placed upon a transparent support platen 16 fixedly arranged in an illumination assembly, generally indicated by the reference numeral 10, positioned at the left end of the machine. Light rays from an illumination system are flashed upon the document to produce image rays corresponding to

the informational areas. The image rays are projected by means of an optical system onto the photosensitive surface of a xerographic plate in the form of a flexible photoconductive belt 12 arranged on a belt assembly, generally indicated by the reference numeral 14.

As seen best in FIG. 4, the belt 12 comprises a photoconductive layer or surface 6 normally selenium, which is the light receiving surface and imaging medium for the apparatus, on a conductive backing or substrate 7. Normally, photoconductive surface 6 is somewhat less in dimension than that of substrate 7 leaving uncoated side edge portions 8. The photoconductive surface 6 of the belt 12 is made photosensitive by a previous step of uniformly charging the same by means of a corona generating device or corotron 13. Power for corotron 13 is provided by a suitable power source.

The belt is journaled for continuous movement upon three rollers 20, 21 and 22 positioned with their axes in parallel. The photoconductive belt assembly 14 is slidably mounted upon two support shafts 23 and 24, with the roller 22 rotatably supported on the shaft 23 which is secured to the frame of the apparatus and is rotatably driven by a suitable motor and drive assembly (not shown) in the direction of the arrow at a constant rate. During exposure of the belt 12, the reflected light image of such original document positioned on the platen is flashed on the surface of the belt to produce an electrostatic latent image thereon at exposure station 27.

As the belt surface continues its movement, the electrostatic image passes through a developing station 28 in which there is positioned a magnetic brush developing apparatus, generally indicated by the reference numeral 30, and which provides development of the electrostatic image by means of multiple brushes as the same moves through the development zone, as more fully hereinafter described.

The developed electrostatic image is transported by the belt to a transfer station 29 whereat a sheet of copy paper or transfer member is moved between a transfer roller and the belt at a speed in synchronism with the moving belt in order to accomplish transfer of the developed image solely by an electrical bias on the transfer roll. There is provided at this station a sheet transport mechanism, generally indicated at 17, 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 29.

After the sheet is stripped from belt 12, it is conveyed into a fuser assembly, generally indicated by the reference numeral 19, 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 toner particles remaining as residue on the developed images, background particles and those particles otherwise not transferred are carried by the belt 12 to a cleaning apparatus 26 positioned on the rim of the belt between rollers 20 and 22 adjacent a pre-clean corona generator 25. Further details regarding the structure of the belt assembly 14 and its relationship with the machine and support therefor may be found in U.S. Pat. No. 3,730,623, issued May 1, 1973, to W. E. Jordan, and assigned to the same assignee.

Referring to FIGS. 2 through 4, there is illustrated the magnetic brush developing assembly 30 which

comprises a series of rollers 36 rotatably supported in frame end plates 32, 34. The rollers 36 are comprised of a cylindrical sleeve 46 of a roughened surface formed of a nonpermeable material and extending almost the length of the housing of the developing apparatus 30. End sleeves 48 are shrunk fit on each cylindrical sleeve 46 adjacent the ends thereof. One end of the sleeve 46 is closed by a cap 50 which supports a roller drive shaft 52 in coaxial alignment with the sleeve 46. The other end of the sleeve 46 is closed by a cap 54 having an orifice 56 through which extends shaft 58 of the internal bar magnets 61. Suitable bearing means 60 are provided to permit the sleeve 46 to rotate relative to shaft 58.

The roller drive shafts 52 are suitably mounted in bearings in end plate 32 and carry on their projecting ends drive sprockets 96.

Referring specifically to FIGS. 2 and 3, the magnet roller assembly 30 is disposed within a housing, generally indicated as 66, having a generally rectangular cross section and a length extending beyond the width of the photoconductive belt 12. Housing 66 is substantially closed except for an opening opposite photoconductive belt 12 whereat development of the latent image on belt 12 is effected. Housing 66 in effect serves as a container for developing mix or material 75 comprising carrier beads of magnetizable material and colored electrostatic toner particles which adhere thereto.

Magnetic brush rollers 36 are grounded through a wiper 70, wiper 70 being in electrical contact with magnet shafts 58. Wiper 70 extends along and is supported by side plate 34 to form an electrical path from each of the rollers 36 to ground line 71.

During development, the rollers 36 are rotated in unison in the same direction from a suitable drive source via sprockets 96, the internal bar magnets 61 remaining stationary. The brush bristles produced by the influence of the magnetic field emanating from the bar magnets 61 acting upon the magnetizable carrier beads in the developing material will form on the upper region of the sleeve 46 between the rollers 36 and the surface of the selenium belt 12.

This takes the form of a "magnetic blanket" extending continuously over all of the brushes of rollers 36 for the entire width of the development zone 28 wherein the material is disposed or available to some degree for developing purposes. Further details regarding the formation and effect of the "magnetic blanket" are described in U.S. Pat. No. 3,640,248, issued Feb. 8, 1972, to W. B. Nielander, and assigned to the same assignee.

Rollers 36 cooperate with the electrostatic charge on belt 12 to establish an electrostatic development field in the developing area 28. The aforesaid electrostatic development field serves to attract toner particles to photoconductor belt 12 in conformance with the latent electrostatic image on belt 12. As will be understood by those skilled in the art, the aforesaid electrostatic development field is essential if the latent images on belt 12 are to be developed, and must be exactly controlled if optimum development of the latent image on belt 12 is to be attained. Accordingly, any uncontrolled change in the aforesaid electrostatic development field may degrade the image developed to a point where it is less than satisfactory.

The developing material 75 normally comprises a carrier, usually small metal beads, and toner or ink particles. The carrier beads and toner are chosen for their

triboelectric relationship. To enhance the aforescribed electrostatic development prior practice has been to bias the magnetic brush rollers 36 to a certain preset potential level. In that circumstance, the metal carrier beads were normally coated or encased in a suitable insulating release material, which, so long as the coating remained intact and was not worn off, kept the bead insulated. Further, to guard against shorting of the magnetic brush rollers in these biased brush systems, the end of mounting sleeves 48 were normally made from insulating materials to prevent shorting of the brush rollers 36 with the uncoated sides 8 of belt 12. And, in a similar vein, other components such as the drive sprockets 96 were made from insulating material.

However, in some applications, it is desirable to use bare or uncoated metal beads. Should carrier beads of this latter type jam or compress together between a magnetic brush roller 36 and the housing 66 or between a roller 36 and the uncoated portion, such as sides 8, of belt 12, a current or ground path may be formed, shorting out the brush and upsetting the electrostatic development field. In addition, metal contaminants may be present in the developing material and may short out one or more of the biased brush rollers 36.

To assist in establishing the necessary electrostatic development field without biasing the magnetic brush rollers 36, a second corotron 80 is provided between the exposure and development stations 27, 28, respectively. Corotron 80 is of a polarity opposite that of charging corotron 13, and is preferably of a constant current type. One suitable corotron is disclosed in U.S. Pat. No. 2,868,989, issued Jan. 13, 1959, to A. C. Haacke. Corotron 80 is driven by a suitable operating circuit, such as that shown in aforesaid U.S. Pat. No. 2,868,989, the driving circuit for corotron 80 being designed to provide preferably a corotron current approximately one-fourth that of charge corotron 13.

In a typical reproduction or copying machine such as the machine 5 illustrated, charge corotron 13 may establish a charge of approximately 800 volts positive on the photoconductive belt 12. Following imaging at exposure station 27, the charge defining the latent electrostatic image will vary, with image background areas (the fully exposed portions of the image) being approximately 100 volts positive. Heretofore, in systems where the magnetic brush rollers 36 are themselves biased, a typical bias might be between 160 to 200 volts positive in order to suppress, i.e. inhibit development of, image background areas.

In the present invention wherein the several magnetic brush rollers 36 are not biased but are instead grounded, corotron 80 is set to produce a charge of approximately 200 volts negative. This opposite charge serves to reduce the overall charge of the latent electrostatic image by approximately 200 volts with the result that image background becomes approximately 100 volts negative. This negative background voltage inhibits, i.e. suppresses, the attraction of toner particles thereto to prevent unwanted development of the image background areas.

While a multiple magnetic brush development system has been shown and described, it will be understood that a single magnetic brush may be used. And in cascade development systems employing one or more development electrodes such as shown in U.S. Pat. No.

3,670,700, the development electrodes may be grounded and a pre-development corotron such as corotron 80 used to inhibit development of image background areas while allowing uncoated carrier beads to be used.

While the invention has been described with reference to the structure disclosed, it is not confined to the details set forth, but is intended to cover such modifications or changes as may come within the scope of the following claims.

What is claimed is:

1. In a xerographic development apparatus for developing the latent electrostatic images formed on a uniformly charged photoconductive member, the combination of:

developing means for developing said latent electrostatic images on said photoconductive member, said developing means including a developer mix comprised of uncoated conductive carrier and ink particles, and at least one magnetic developing brush, said brush being free of electrical bias to permit use of said uncoated conductive carrier, and means to suppress image background while avoiding biasing of said magnetic brush, said suppressing means comprising a charge producing device upstream of said magnetic developing brush adapted to expose said photoconductive member to a charge opposite in polarity to the charge on said photoconductive member before development whereby to reduce image background charge levels.

2. The apparatus according to claim 1 including means to ground said magnetic developing brush.

3. The apparatus according to claim 1 in which said charge producing device is adapted to reverse the polarity of the charge of said image background areas.

4. In a xerographic development apparatus adapted to use a developer mix incorporating uncoated conductive carrier particles, the combination of:

at least one developing member;

means to ground said developing member to obviate shorting of said developing member by said conductive carrier, and

means to suppress the background areas of a latent electrostatic image to enhance development thereof by said developing member without placing a bias voltage on said developing member, said background suppressing means comprising a charge producing device upstream of said developing member adapted to reverse the polarity of the charge comprising said image background areas.

5. In an electrostatic reproduction apparatus having a photoconductive member on which latent electrostatic images of the originals being reproduced are made, first charging means for uniformly charging said member in preparation for imaging, means to expose said charged member to a document being copied to form a latent electrostatic image of the document thereon, means to develop the latent image with a developer material consisting of a mixture of bare carrier and toner particles, the developing means including a housing for said mixture and at least one magnetic brush, and transfer means for transferring the image developed on said member to copy substrate material, the combination of:

means connecting said magnetic brush to a ground common to said developer housing whereby a

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bridging circuit established by a conglomeration of
said carrier particles between said brush and said
housing will not change the developing characteris-
tics of said magnetic brush; and
second charging means upstream of said magnetic 5
brush to generate a charge opposite said first

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charging means, said second charging means
charge being adapted to reduce overall latent elec-
trostatic image charge so that the charge compris-
ing image background areas are reversed to sup-
press developing of said image background areas.
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