United States Patent

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[54] **ELECTROSTATIC MAGNETIC DEVELOPER UNIT GATING APPARATUS**
8 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **118/637**
[51] **Int. Cl.** **B05b 5/00**
[50] **Field of Search** ..... 118/637; 117/17.5; 346/74 (ES), 74 (MP); 355/(Inquired); 101/(Inquired)

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ABSTRACT: A multiple gating arrangement combined with multiple brush developing unit formed with a magnetic developing blanket for effecting quick production and collapse of magnetic developing bristles for use in an electrostatic reproduction machine.

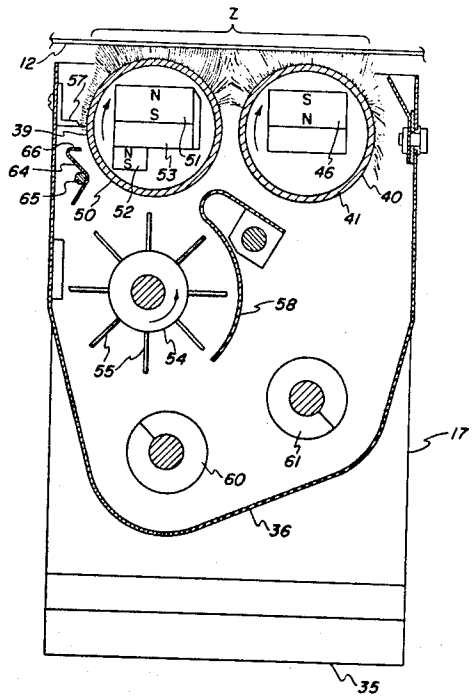
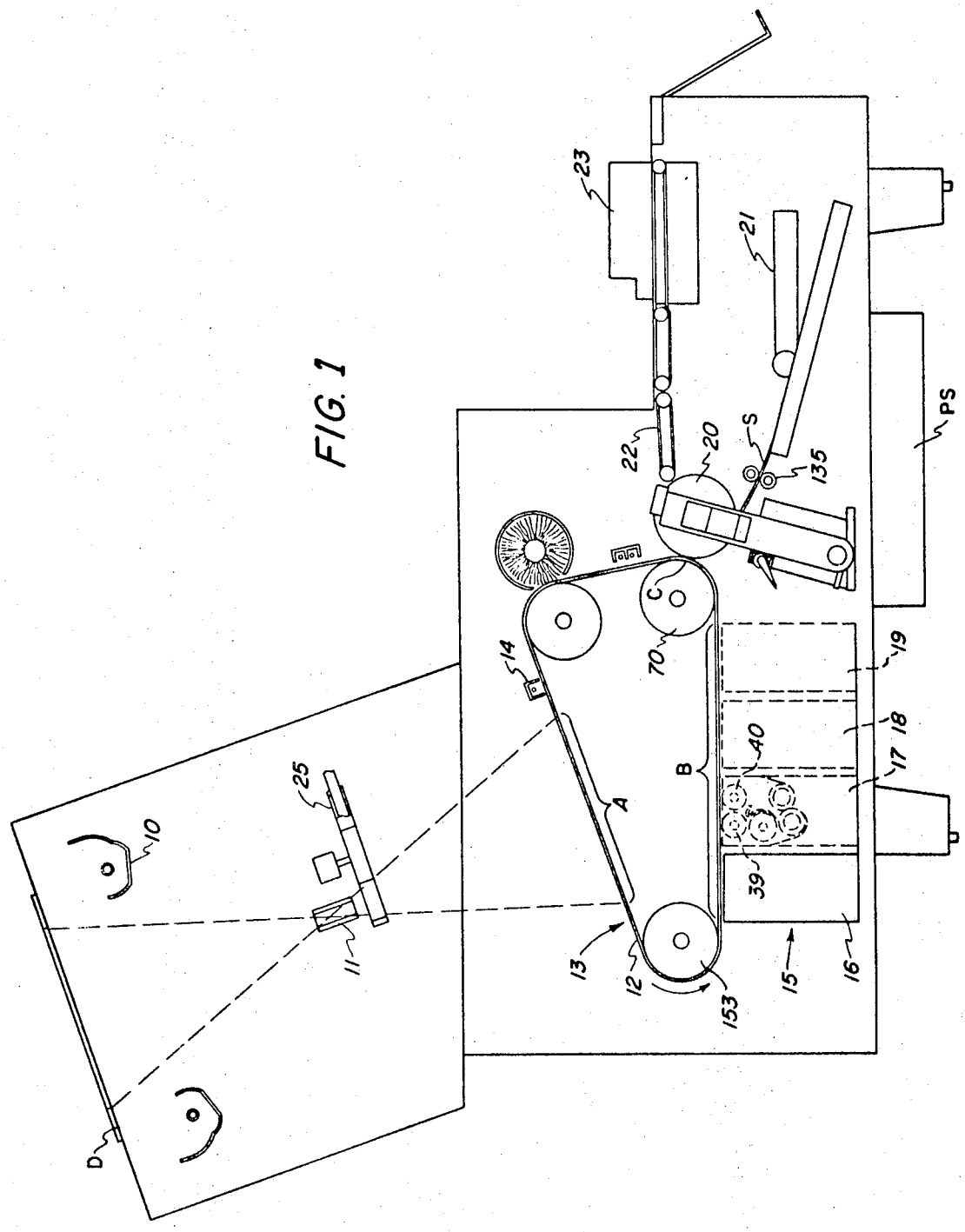


FIG. 1



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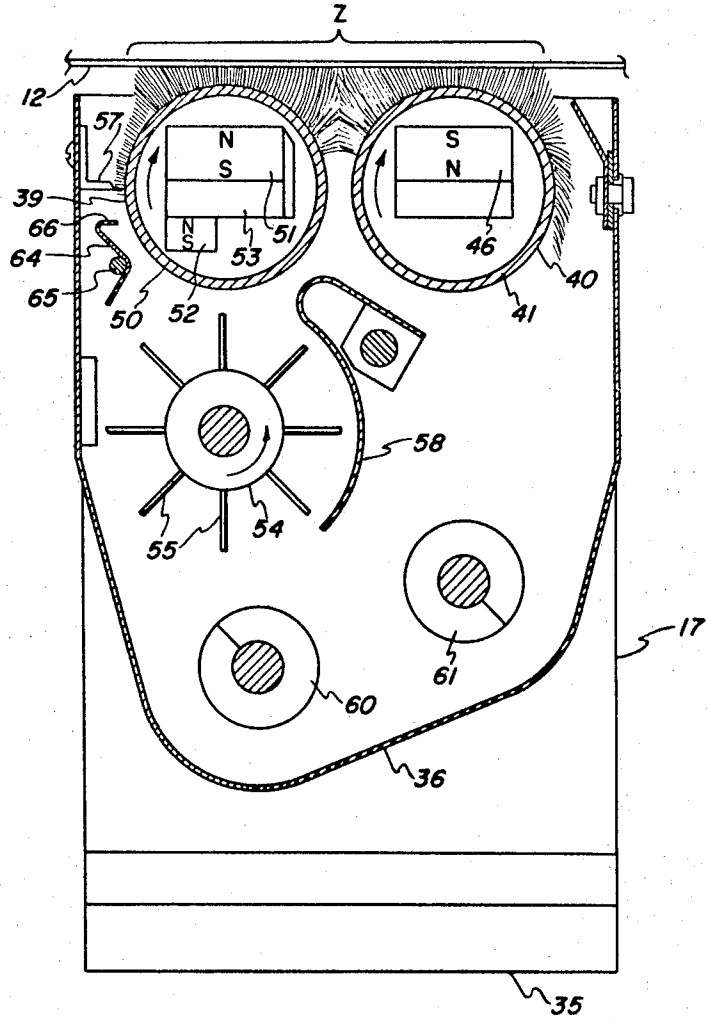


FIG. 2

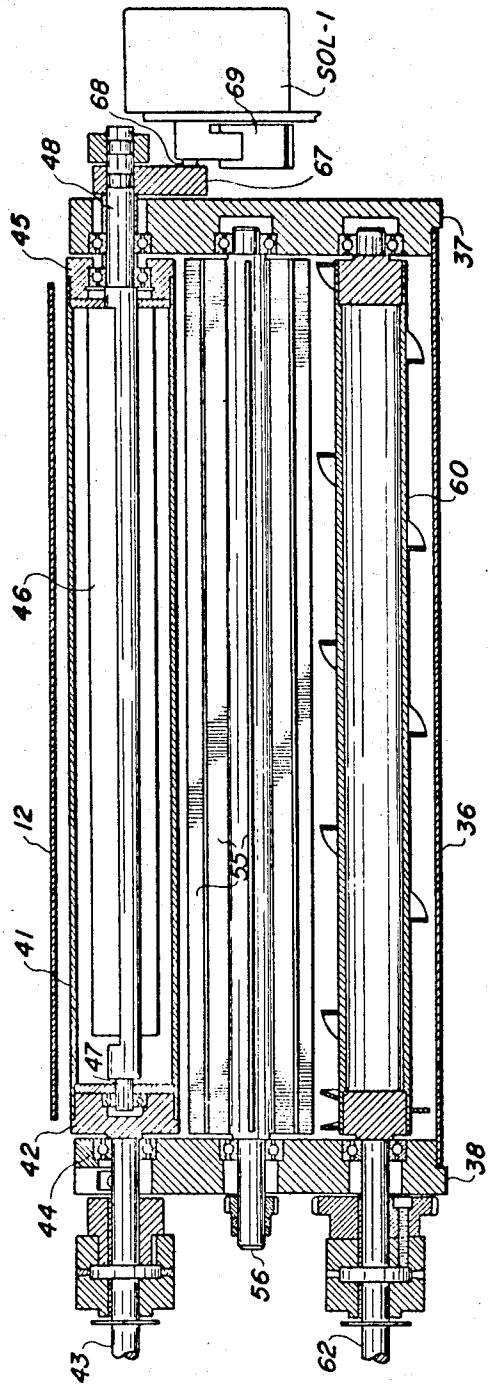


FIG. 3

ELECTROSTATIC MAGNETIC DEVELOPER UNIT GATING APPARATUS

This invention relates to a developing apparatus of the type employing magnetic fields for forming brush bristles that are carried into contact with a latent electrostatic image to be developed.

Generally, for magnetic brush development, there is employed a single magnetic brush arranged in close-spaced relationship relative to a surface carrying a latent electrostatic image. Since the speed of development, especially for solid area images is quite limited with the use of a single brush, there have been attempts to utilize the two magnetic brushes, each having a mechanism for introducing developing material individually. For still higher speeds, and better solid area coverage, the use of two brushes are not adequate. Utilizing more than two brushes while being effective for high-speed developing, involves the need for relatively large developing spaces and complex toner-dispensing equipment.

Therefore, it is a principal object of the present invention to gate individually each magnetic brush of a multiple magnetic brush developing unit of the type having a magnetic developing blanket extending fully between the brushes in contact with a latent image to be developed.

Another object of the invention is to minimize the time required to inactivate and activate the developing condition of a multiple magnetic brush developing unit.

The foregoing objects are acquired by the utilization of a gate upon the lead magnetic brush of a multiple magnetic brush developing unit in order to control the formation or deformation of magnetic bristles in the multiple brush unit. The present invention also includes gating action for the other brush or brushes in the unit by the use of devices to effect the rotation of the magnets in these other brushes in order to control the direction of the magnetic lines of flux for these units. By actuating all of the gating actions, each brush may be inactivated or activated in unison, thereby effectively terminating the developing action of the multiple brush unit in approximately the time that it takes to inactivate or activate one unit.

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:

FIGS. **1** is a schematic view of a reproduction machine showing various electrostatic processing components;

FIG. **2** is an enlarged cross-sectional view of one of the developing units taken along a line parallel to the path of movement of a photoconductor element; and

FIG. **3** is a cross-sectional view of the developing unit taken along a line normal to the path of movement of the photoconductor.

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 components for the machine are schematically illustrated. As in all electrostatic systems as well 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 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 D to be copied is placed upon a transparent support platen fixedly arranged relative to an illumination lamp assembly **10** positioned at the upper end of the machine as viewed in FIG. **1**. While upon the platen, a programming system for the machine introduces a lamp control circuit to cause successive energization of the lamps in the lamp assembly **10** for impinging light rays upon the original thereby producing image rays which when acted upon by separation filters correspond to the color informational areas on the original. The image rays are projected by means of an optical lens system **11** for exposing the photosensitive surface of a xerographic plate at the exposure station A, the plate being in the form of a flexible photoconductive belt **12** arranged on a belt assembly generally indicated by the reference numeral **13**.

The photoconductive belt assembly **13** may be mounted upon the frame of the machine and is adapted to drive the selenium belt **12** at a constant rate in the direction of the arrow as shown in FIG. **1**. During this movement of the belt, the light-imaging rays of an original are successively flashed full frame upon the surface of the belt. The belt structure utilized comprises a layer of photoconductive insulating material such as selenium on a conductive backing that is sensitized prior to exposure by means of a suitable charging corona generator device **14**.

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 an electrostatic latent image for each exposure, each being in image configuration corresponding to the light image projected from the original D on the supporting platen through the corresponding separation filter. As the belt surface continues its movement, the latent electrostatic images pass through a developing station B at which there is positioned a developer assembly generally indicated by the reference numeral **15** and where the belt is maintained in a flat condition. The developer assembly **15** comprises a plurality of developing devices **16**, **17**, **18** and **19** each of which contains a different color-developing material to provide individual development of the electrostatic images.

The successively developed electrostatic images are 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 images. There is provided at this station a sheet transport mechanism in the form of a transfer drum **20** adapted to support a sheet of paper and to carry the same into image transfer relationship with the belt **12** once for each image transfer operation. A sheet of paper S from a paper-handling mechanism, generally indicated by the reference numeral **21**, is transported into position upon the drum **20** where it is supported during the image transfer function. The transfer of the developed image from the selenium belt surface to sheet material is effected by means of an electrical bias of the opposite polarity as the triboelectric charge on the developing particles utilized in image development being applied to the transfer drum **20** at the point of contact between the sheet and selenium belt as the sheet passes the transfer station C.

After the sheet is stripped from the transfer drum **20**, it is conveyed by conveyor **22** into a fuser assembly generally indicated by the reference numeral **23** wherein the developed and transferred 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.

It is believed that the foregoing description is sufficient for the purposes of this application to show the general operation of an electrostatic copier constructed in accordance with the present invention.

As shown in FIGS. **2** and **3**, the unit **17** comprises a boxlike structure **35** having a rectangular cross section and a length extending beyond the width of the belt **12**. Within the boxlike structure **35**, there is suitably mounted a developer container formed with a thin-walled developer housing **36** closed at its ends, end walls **37** and **38**. The housing **36** contains developing material comprising carrier beads made from magnetizable material and color toner particles which adhere electrostatically in great numbers to the carrier beads. Mounted for rotation within the developer housing **36** are two magnetic brushes **39** and **40** positioned with their axes in parallel and below the selenium belt **12**.

The magnetic brush 40, comprising outer cylinder 41 made of magnetizable material and extending almost the length of the housing 36, is mounted for rotation within the structure 35. One end of the cylinder 41 is closed by a cap 42 which supports a drive shaft 43 in axial alignment with the cylinder and is mounted in bearings 44 on the end plate wall 38. The other end of the cylinder is provided with a cap 45 having a central opening therein. Within the cylinder 41 there is positioned an elongated magnet bar 46 extending nearly the full length of the cylinder and being mounted therein by means of a stub shaft 47 rotatably supported in the end cap 42 and a drive shaft 48 extending through and rotatably mounted in bearings held within the central opening formed in the cap 45. The shaft 48 extends through and is suitably journaled in the end wall 37 so as to be rotated by an external control device as will be described hereinafter. In operation during a development cycle, the brush cylinder 41 is rotated by way of the drive shaft 43 and the magnet 46 remains stationary.

The second magnetic brush 39 comprises a cylinder 50 having a length and diameter equal to the cylinder 41. Within the brush cylinder 50 there is mounted a main magnet bar 51 which is supported in fixed position relative to its enclosing rotatable cylinder. This is accomplished by the use of shafts (not shown) mounted at both ends of the magnet bar 51 and projecting through openings in end caps (not shown) that are used to close and support the ends of the cylinder 50. Such caps and shafts are similar to the cap 42 and the shaft 47 at one end and the cap 45 and shaft 48 at the other end. One of the shafts would be fixed in order to maintain the magnet bar 51 in a fixed position during rotation of the cylinder 50. A second elongated magnet bar 52 is mounted within the cylinder 50 and is attached to a spacer bar 53 secured to the lower surface of the magnet bar 51. The polar orientation of the magnets 46 and 51 are indicated in FIG. 2 and are arranged so that magnetic lines of flux project through the walls of the respective cylinders 41, 50 across the surface of the belt 12 as it moves adjacent the brushes 39, 40.

As shown in FIG. 2, the peripheral walls of the brush cylinders 41 and 50 are relatively close to each other. During a development cycle when both cylinders are rotating in unison and with the magnets 46 and 51 held stationary, the brush bristles produced by the use of magnetizable carrier beads in the developing material used in the unit 17 will form on the upper region of the cylinder 50 between this region and the undersurface of the selenium belt 12. These bristles remain formed during the developing cycle, being produced by the magnetic field of the magnet 51 beginning slightly before reaching the closest distance between the cylinder 50 and the belt 12. When the bristles are moved out of the influence of this magnet beyond the closest distance between the belt and the cylinder, they are picked up by the magnetic field of the magnet 46 which is stronger at this point than the diminished strength of the magnetic field attributed to the magnet 51, and carried therealong during rotation of the cylinder 41 until they reach a point beyond the development zone Z when the carrier beads and toner particles drop off the cylinder and back into the housing 36.

During movement of the carrier beads and toner through the development zone Z, the magnetic bristles and, therefore, the development material, is in the form of a "magnetic blanket" the entire width of the zone Z wherein the material is disposed or available for developing purposes. It will be apparent that the width of the development zone Z is larger than the sum of the individual development zones for each of the magnetic brushes 39, 40. One or two additional brushes may be added in the same arrangement in order to extend the dimensions of the "magnetic blanket" and therefore the development zone which will always be larger when so combined than the sum of the development zones for the brushes.

Also mounted within the development housing 36 and below the magnetic brush 39 is an impeller 54 having a plurality of blades 55 radially extending therefrom and having one end rotatable mounted in the end wall 37 and its other end terminating in a drive shaft 56 which in turn is rotatably mounted on and extends through the end wall 38. During a development cycle the impeller 54 is rotated in the direction shown by the arrow in FIG. 2 and serves to carry and throw development material toward the lower surface of the magnetic brush 39. The development material so thrown is picked up by the pickup magnet 52 which commences the formation of bristles on the cylinder 50. As this cylinder rotates, the newly formed bristles come under the influence of the main magnet 51.

A clipping blade 57 is secured to the upper wall of the housing 36 and extends radially toward the cylinder 41 being spaced from the periphery thereof a short distance equal to the length of the bristles to be formed on this magnetic brush. Upon rotation of the cylinder 50 for carrying the magnetic bristles toward the development zone Z, the blade 57 clips the tops of the magnetic bristles for presenting optimum lengths of the bristles to the belt 12. A curved baffle plate 58 is secured interiorly of the housing 36 and extends along for a length equal to the length of the impeller 54 with the center of curvature coincident with that of the impeller. The baffle assists the paddle blades of the impeller in forming large increments of developing material to be removed from the lower region of the housing 36 to the vicinity of the pickup magnet 52 whereat some of the material is formed into magnetic brush bristles.

A pair of augers 60, 61 are mounted in the lower region of the housing 36 for ensuring continual mixing of the particles that comprise the developed material and for ensuring proper quantities at all times. Each of the augers is suitably mounted at one end on the wall 37 while the other ends terminate in a drive shaft 62 which extends through and supported on the end wall 38. A suitable drive mechanism (not shown) may be connected to the shaft 62 and be activated when the machine is in its operative condition.

The magnetic developer unit 17 is also provided with devices which will control the developing action of the unit, and in such a way that the action may be switched on and off as rapidly as possible. Since the development zone Z is relatively wide and more than one magnetic brush is being controlled, the time period in which it takes the "magnetic blanket" over both brushes to become inoperative is shortened by having both brushes controlled separately. To this end, the first of the magnetic brushes; namely, the brush 39 is provided with a gate element 64 fixed to a shaft 65 for rotation therewith.

The gate 64 is formed with an edge 66 extending radially relative to the cylinder 50, and upon the rotation of the shaft 65, is adapted to engage the adjacent periphery of this cylinder. This action serves to scrape off instantly any magnetic bristles on the cylinder 50 thereby preventing the transport of development material beyond the edge 66 and consequently terminating the development action by the magnetic brush 39 except for the developing material still on the brush the instant before gating. This control action of the shaft 65 is made effective by the overall machine-programming system.

Gating action of the other magnetic brush 40 is provided by the quick rotation of the magnet 46 for approximately 90° from its illustrated position. As previously stated, the magnet 46 is provided with a shaft 48 that extends externally of the developer housing 36. As shown in FIG. 2, the shaft 48 is rotatably connected to a rocker arm 67 which has a pin 68 extending therefrom at one end to be engaged by a rocker arm 69 arranged to be swung in either direction upon activation of a rotary solenoid SOL-1. This solenoid is suitably mounted on the end wall 37 and connected electrically to the programming system for the machine. Upon energization of the solenoid SOL-1 when it is desired to inactivate the unit 17, the rocker arm 69 is rocked in one direction for producing rocking of the rocker arm 67 with corresponding rotation of the shaft 47. This complete action involves only a very small

increment of time. Rotation of the magnet **46** will remove its magnetic influence upon the magnetic carrier beads attempting to bridge across the gap between the magnetic brushes **39, 40** A suitable machine-programming system may be arranged to effect simultaneously activity of the shaft **65** and the shaft **48** for causing near simultaneous gating of the two magnetic brushes. In this event, only that developing material which forms on the brush **39** beyond the edge **66** will be involved in further development before most of the material falls through the space between the cylinders **41, 50** and, for the brush **40**, that development material which was conveyed from the magnetic brush **39** just prior to a gating requirement will be involved in further development. In this manner, the length of time needed to remove all residual developing material from the "magnetic blanket" on and between the brushes **39** and **40** when gating is programmed is effectively that time needed to remove the material from just one of the brushes. As opposed to the use of a magnetic conveyor belt between two rollers, an arrangement which cannot be effectively gated to on-off conditions in acceptable short periods of time, the present "magnetic blanket" concept, especially with the employment of many individual magnetic brushes, has the advantage that the gating periods for the entire coverage of the blanket is effectively the same for only one of the brushes utilized.

While the invention has been described with reference to the structure disclosed herein, it is 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.

I claim:

1. An apparatus for developing a movable surface bearing a latent electrostatic charge image including:

a plurality of cylindrical members mounted in spaced relation with an open space therebetween, said members having their axes generally in parallel and being arranged in spaced tangential relationship to the surface;

each of said members having associated therewith means for producing a magnetic field across a portion of the periphery thereof and across said surface as the same moves, said last-named means being arranged to produce bristles of magnetizable particles on each of the members during rotation thereof;

at least one of said members being positioned to receive a supply of developing material having magnetizable particles and developing powder electrostatically carried by the particles thereby initiating the formation of bristles thereon;

said one of said members having a gating element associated therewith which when activated extends toward said one member to prevent the effective formation of bristles thereon;

another of said members having means associated with the magnetic field producing means therefor for preventing the field from producing bristles on said other member.

2. The apparatus of claim **1** wherein said gating element and said means associated with the magnetic field producing means for said other member being arranged to be activated in unison.

3. The apparatus of claim **1** wherein said magnetic field producing means for said other member comprises a magnet mounted within said other member and said means associated with said magnetic field producing means includes means for orienting said magnet whereby it is ineffective in producing a magnetic field across said portion of the periphery thereof.

4. The apparatus of claim **1** wherein said other member receives a supply of developing material from said one member.

5. An apparatus for developing a latent electrostatic image on a moving photoconductive insulating surface including;

a housing for containing a supply of developing material comprising magnetizable carrier particles and electrostatically adhering developing particles;

a plurality of cylindrical members mounted in spaced relation in the housing with open space therebetween and arranged adjacent to and in spaced tangential relationship with said photoconductive insulating surface with their longitudinal axes generally normal to the path of movement of said surface;

means for rotating said members;

means supported within the cylindrical members for producing a magnetic field across at least a portion of the periphery of each of the members, and upon rotation thereof causing the formation of bristles of developing material upon said portion of each member arranged to contact said surface during movement thereof;

said means for producing a magnetic field being cooperable with said rotating cylinders for producing movement of bristles along a portion of one of the cylinders, across said open space between the same and an adjacent cylinder, and along a portion of the adjacent cylinder with the developing material remaining in contact with said surface thereby presenting a partially unsupported magnetic developing belt during development of the latent electrostatic image;

said one of said members having a gating element associated therewith which when activated extends toward said one member to prevent the effective formation of bristles thereon;

another of said members having means associated with the magnetic field producing means therefor for preventing the field from producing bristles on said other member.

6. The apparatus of claim **5** wherein said gating element and said means associated with the magnetic field producing means for said other member being arranged to be activated in unison.

7. The apparatus of claim **5** wherein said magnetic field producing means for said other member comprises a magnet mounted within said other member and said means associated with said magnetic field producing means includes means for orienting said magnet whereby it is ineffective in producing a magnetic field across said portion of the periphery thereof.

8. The apparatus of claim **5** wherein said other member receives a supply of developing material from said one member.