United States Patent [19]

Hudson

[11] **3,911,864**

[45] **Oct. 14, 1975**

[54] **TONER PRELOADED MAGNETIC BRUSH DEVELOPMENT SYSTEM**

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[73] Assignee: **Xerox Corporation,** Stamford, Conn.

[22] Filed: **Jan. 17, 1973**

[21] Appl. No.: **324,467**

[52] **U.S. Cl.** **118/637;** 117/17.5

[51] **Int. Cl.²** **G03G 15/09**

[58] **Field of Search** ..... 118/636, 637, DIG. 24; 117/17.5

[56] **References Cited**

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3,203,394	8/1965	Hope et al.	118/637
3,443,517	5/1969	Gundlach	117/17.5
3,572,289	3/1971	Maksymiak	118/637
3,641,980	2/1972	Bickmore	118/637
3,662,711	5/1972	Hudson	118/637
3,724,422	4/1973	Latone et al.	118/637
3,754,526	8/1973	Caudill	118/637

Primary Examiner—Mervin Stein

[57] **ABSTRACT**

This invention concerns magnetic brush development. A biased electrode is spaced from a magnetic roller at a location just prior to the roller entering a source of developer (containing toner particles on magnetic carriers). Developer is supplied between the magnetic roller and electrode whereby toner from the developer is attracted to the magnetic roller. As the roller rotates to the developer source developer is attracted to the magnetic roller and then is presented to a latent image on a photosensitive surface. Because the magnetic roller has been preloaded with toner prior to attracting developer from the developer source, this magnetic brush development system results in enhanced as well as quick development.

11 Claims, 3 Drawing Figures

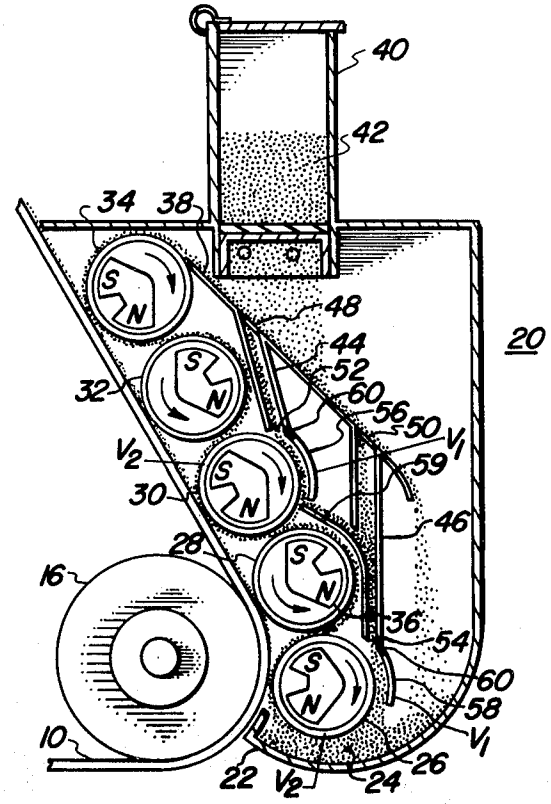
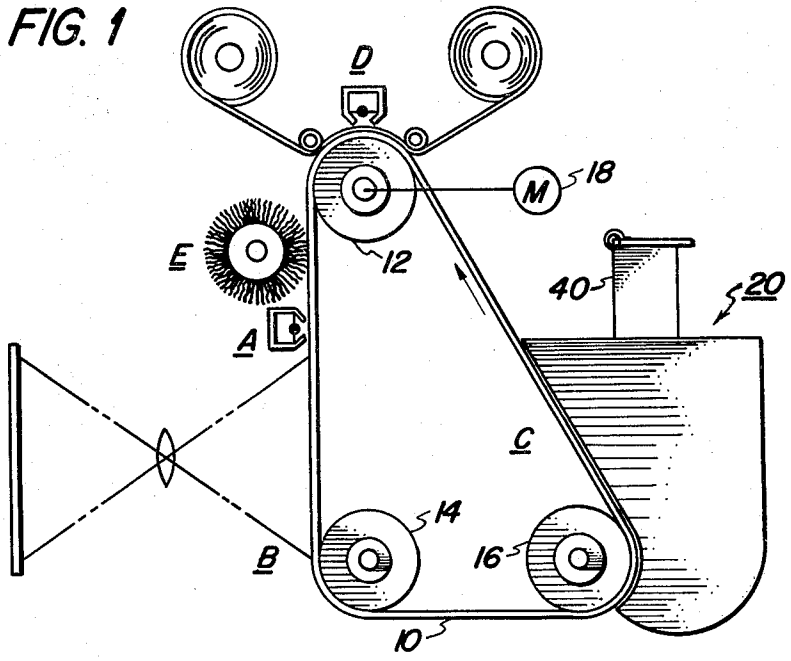


FIG. 1


D
M
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E
12
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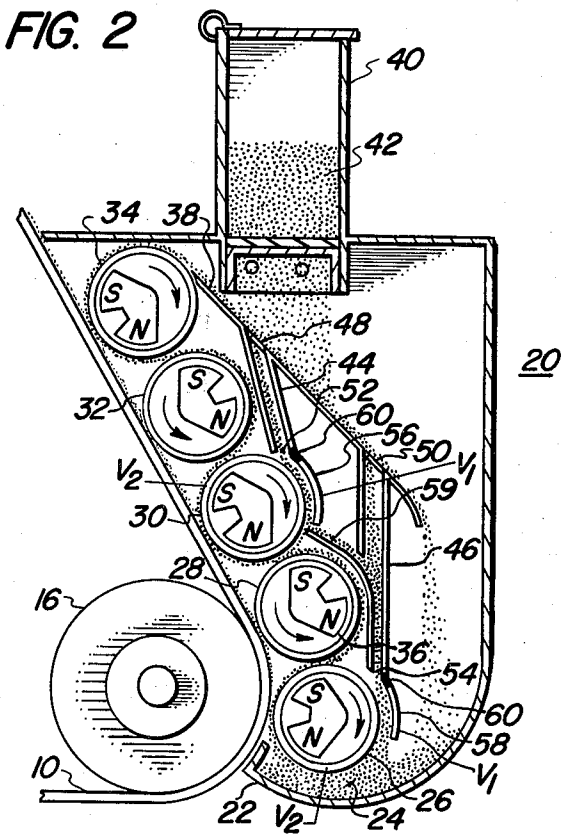
FIG. 2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V1
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V2
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58
V1
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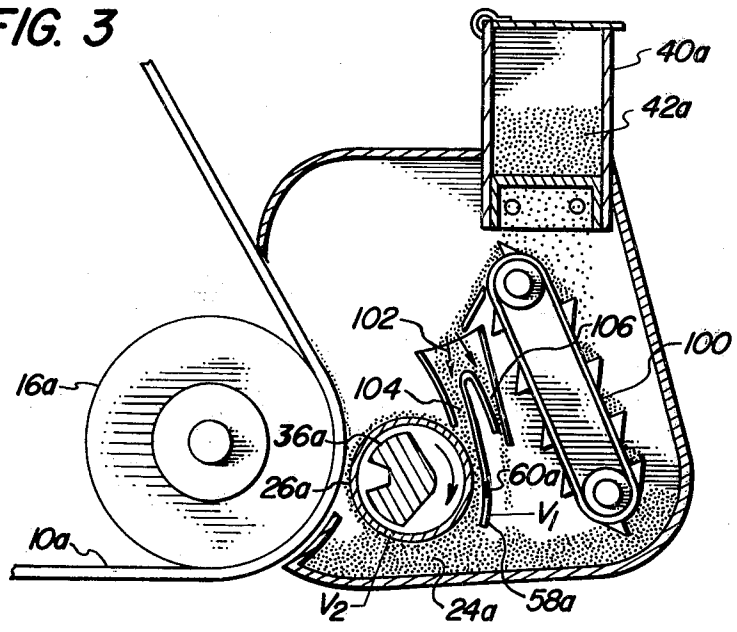
22
V2
24
26

FIG. 3



TONER PRELOADED MAGNETIC BRUSH DEVELOPMENT SYSTEM

DESCRIPTION

This invention relates to enhancing development of an electrostatic latent image and increasing development speed when utilizing a magnetic brush develop- system.

It is an object of the invention to achieve the above by supplying toner particles to a magnetic roller just prior to the roller attracting developer thereto for presenting to a latent image.

The details of the invention can be understood from the following description with reference to the drawing wherein:

FIG. **1** is a view of a general xerographic copying system;

FIG. **2** is a detailed view of one embodiment of the invention; and

FIG. **3** is a view of another embodiment of the invention;

Shown in FIG. **1** is a xerographic machine employing the magnetic brush development apparatus of the instant invention. The elements of this machine, which are constructed for continuous and automatic operation, are all conventional in the xerographic art except for the novel development apparatus, which forms the basis of the instant application. For the purpose of the present disclosure, the several xerographic processing stations in the path of movement of the xerographic surface may be briefly described as follows:

A charging station A, at which a uniform electrostatic charge is deposited on the photoconductive layer of the xerographic surface;

An exposure station B, at which the light or radiation pattern of copy to be reproduced is projected onto the xerographic surface to dissipate the charge in the exposed areas thereof to thereby leave a latent electrostatic image of the copy to be reproduced;

A developing station C, at which a xerographic developing material, including toner particles having an electrostatic charge opposite to that of the electrostatic latent image, are moved into contact with the image bearing surface, whereby the toner particles adhere to the electrostatic latent image to form a xerographic powdered image in the configuration of the copy being reproduced;

A transfer station D, at which the xerographic powder image is electrostatically transferred from the xerographic surface to a transfer material or a support surface; and

A cleaning and discharge station E, at which the xerographic surface is brushed to remove residual toner particles remaining thereon after image transfer, and at which the surface is exposed to a relatively bright light source to effect substantially complete discharge of any residual electrostatic charge remaining thereon.

The latent electrostatic images to be developed are formed on a photosensitive surface **10** formed in the shape of an endless belt. The surface **10** could be of any configuration including a disposable photoconductive web or sheets as well as a drum shaped reusable photoconductor. The belt is adapted to be rotated about three supporting rollers **12, 14** and **16,** two of which, **14** and **16** are idler rollers and the third of which, **12,** is a power imparting roller driven by any convenient power source **18.** The movement of the photosensitive surface

permits its surface to be moved past the various xerographic processing stations including the development zone C.

Referring now to FIG. **2,** the xerographic developing apparatus is provided within a developer housing **20** formed of a non-magnetic material. The lower portion of the housing is trough-like in configuration to define a sump **22** to support a quantity of two-component magnetic developer mix **24.** The developer employed includes image developing toner particles and larger carrier granules having magnetic properties. The carrier granules may be metallic or other materials having magnetic properties either uncoated or coated with a carrier coating material so that a triboelectric charge is generated between it and the toner upon mutual interaction. This charge is necessary to effect the xerographic development of the images. Examples of such magnetic developer are described in U.S. Pat. No. 2,874,063 to Greig.

Located within the housing **20** are a plurality of magnetic rollers which comprise non-magnetic rotatable hollow cylinders **26, 28, 30, 32** and **34** arranged to rotate in alternating directions.

Each of these cylinders has an associated gear member (not shown) for imparting the alternating directions thereto. The gears employed for rotating the cylinders are connected to a suitable source of power, not shown, for imparting motion thereto. This mechanism can be the same as shown in FIG. **2** of U.S. Pat. No. 3,572,289 to Maksymiak.

Located within each of the cylinders is a magnet **36,** preferably permanent, with north and south poles extending the length of the magnetic cylinders with their field producing poles facing in the direction over which the developer will be moved. For example, within cylinders **26, 30** and **34,** the poles of the magnets face toward the photoconductor surface to be developed for the presentation of developing material to the image. The field producing magnets of the cylinders **28** and **32,** which function to merely transport the developer, have their field producing poles in a direction away from the photoconductive surface. Thus, when the cylinders are rotated, magnetic developer will be entrained by the magnetic fields emanating through the rotating cylinder **26** to cause developer to move in brushing contact with the photoconductive surface.

Upon reaching the uppermost position of cylinder **26,** the magnetic developer is passed beyond the effect of the magnetic field of cylinder **26** into the effect of the magnetic field emanating from the next adjacent roller **28.** In this manner, the developer may be magnetically attracted and then conveyed between adjacent cylinders from the uppermost position of a lower cylinder to the lowermost position of the next higher sylinder. This procedure continues until the developer contacts the uppermost roller **34** whereafter, continued cylinder rotation will permit the developer to be dropped onto a guide plate **38** inasmuch as it is no longer within the field of influence of any magnetic field producing means. Located above the housing **20** is a well-known toner reservoir or dispenser **40** containing toner particles **42** therein. Toner is dispensed from the housing onto the guide plate **38.** Attached to the guide plate **38** are chutes **44** and **46** having inlet openings **48** and **50,** respectively. The excess developer deposited on the plate **38** by the roll **34** and the toner particles **42** discharged from the dispenser **40** slide down

the guide plate **38** with a portion thereof entering inlet openings **48** and **50** of the chutes **44** and **46** and a portion thereof skipping over the chute openings onto the lower end of the plate **38** and being discharged therefrom directly into the developer sump **22.** The inlet openings **48** and **50** extend the length of the magnetic rollers and are of such a width as to control the amount of developer entering thereinto and passing directly to the developer sump. The chutes **44** and **46** have an outlet opening **52** and **54,** respectively, which extend the entire length of the magnetic lower rollers **30** and **26.** A pair of electrodes **56** and **58** are provided at the lower end of the chutes **44** and **46,** respectively, and are spaced from a respective roller **30** and **26.** The electrodes are so located relative to the chute openings that the developer discharged through the openings will pass between a respective roll and electrode. A duct member **59** is positioned to direct the developer flowing between the electrode **56** and roller **30** to the chute **46** where the developer joins the developer stream in chute **46** and passes between the electrode **58** and roller **26.** The electrodes are electrically separated from their respective chutes by an insulating member **60.**

The electrodes **56** and **58** are coupled to a high voltage source of suitable electrical potential V whereby triboelectrically charged toner from the developer material emerging from openings **52** and **54** and passing between the electrodes **56** and roll **30** and between electrode **58** and roll **26** will be stripped from the carrier beads to develop or adhere to the rollers **30** and **26.** The rollers **26** and **30** are coupled to a suitable electrical potential V2 of a magnitude and polarity that in conjunction with the electrodes, they will attract the toner from the carrier beads and that the toner will be deposited on the charged latent image while suppressing background deposition of the toner. For instance, the potential on the electrode V1 may be −800 volts, the potential on the rollers V2 may be +300 volts, the latent image charge may be +800 volts and the background charge may be +200 volts and the polarity of the triboelectrically charged toner may be negative. Obviously, the voltage polarities may change in accordance with the polarity of the charge on the image and toner.

In operation, as the roller **26** rotates, the developed portion thereof enters the developer mix **24** and as the surface thereof approaches the magnetic field imposed by magnet **36,** carrier particles with their associated toner particles are attracted to the roller surface and then presented to the electrostatic latent image on the photosensitive belt **10** for development whereby toner will be stripped from the roller surface and from the carriers. Continued rotation of the roller **26** brings the same surface to an attracting magnetic field of the conveying roller **28** whereby the excess developer on roll **26** is transferred thereto and the rest of the rollers as described previously. The developer remaining on the upper roller **34** is discharged onto the plate **38** and is allowed to mix with the toner **42** and flow by gravity into the chutes **44** and **46** or off the plate **38** whereby the toner becomes properly charged, the denuded carriers are retoned and the back portions of the development rolls **26** and **30** are developed with toners.

From the above it can be seen that since the surface of roller **26** is precoated with toner particles, the rotational speed thereof through the developer mix can be increased and still the same total amount of toner will be presented to the latent image as a roller rotated at a normal speed which solely relies upon picking up toner when rotated through the developer mix. By the time excess developer has passed to roller **30,** the carrier beads are substantially stripped of toner. Thus, it is especially advantageous to precoat the roller **30** with toner. Also, by utilizing the principle of this invention, development of the image is enhanced when utilizing rotational speeds equal to or slightly greater than the speed normally used.

Referring to FIG. **3,** the embodiment of FIGS. **1** and **2** is modified. All elements which are the same as the previous embodiment are designated by the same reference numeral only with an *a* affixed thereto. In this embodiment a bucket conveyor **100** is utilized to convey a portion of the developer mix to an inlet opening of a split chute **104.** The developer is split into two streams, one down chute **104** and between the roller **26***a* and electrode **58***a* and the other down chute **106** directly to the developer mix **24***a*. Since only one magnetic roller is used, the bucket conveyor is utilized for circulating and mixing the developer mix. The magnetic roller **26***a* is developed with toner in the same manner as the previous embodiment.

It should be realized that any number of magnetic rollers may be utilized with this invention and that in the embodiment of FIGS. **1** and **2** either the roller **26** or the roller **30** may be developed with toner without the other being developed with toner although it is preferred to develop each roller. Also, all of the rollers may be rotated in the same direction and each roller may present developer to the latent image.

I claim:

1. A magnetic brush development system for an electrostatic processor to develop latent electrostatic images carried by a movable photosensitive surface through the use of a developer containing oppositely charged toner and carrier particles; said system comprising the combination of

a sump for storing a supply of developer;

a rotatable member positioned between said sump and said photosensitive surface for transporting developer in a predetermined direction from said sump to said photosensitive surface, said rotatable member having a magnetic field emanating therefrom for loading developer on said member as it advances past said sump and for retaining said developer on said member as it advances past said photosensitive surface;

an electrode positioned adjacent said rotatable member on a side thereof remote from said photosensitive surface, whereby successive portions of said rotatable member are sequentially advanced past said electrode, sump and photosensitive surface when said member is rotated in said predetermined direction; and

means coupled to said electrode and said rotatable member for establishing a potential difference therebetween of a polarity tending to cause toner particles to adhere to said rotatable member prior to the loading thereof with developer.

2. The development system of claim **1** wherein excess developer is released from said rotatable member after passing said photosensitive surface; said system further including a toner dispenser for supplying additional toner for said developer, and means for guiding at least a part of said excess developer and a part of said addi-

tional toner between said electrode and said rotatable member.

3. The development system of claim **2** wherein all of the excess developer is guided between the rotatable member and said electrode.

4. The development system of claim **2** wherein only a portion of said excess developer and a portion of said additional toner are guided between the rotatable member and said electrode; and further including means for guiding the remainder of the excess developer and additional toner directly to the sump.

5. A magnetic brush development system for an electrostatic processor to develop latent electrostatic images carried by a movable photosensitive surface through the use of a developer containing oppositely charged toner and carrier particles; said system comprising the combination of

a plurality of rotatable members extending in series from said sump along said photosensitive surface, each of said members having a magnetic field emanating therefrom and being rotatable in a predetermined direction for transporting developer from said sump along a path running between said photosensitive surface and successive ones of said members;

a first electrode mounted adjacent one of said members remotely from said photosensitive surface,

a second electrode mounted adjacent another of said members remotely from said photosensitive surface, said other member being separated in said series from said one member by at least one intervening member;

means for guiding developer between said first electrode and said one rotating member and between said second electrode and said other rotating member;

means coupled to said first electrode and said one member for establishing a potential difference therebetween of a polarity tending to cause said one member to attract toner from the developer guided therebetween; and

means coupled to said second electrode and said other member for establishing a potential difference therebetween of a polarity tending to cause said other member to attract toner from the developer guided therebetween.

6. The development system of claim **1** further including another rotatable member positioned between said sump and the first mentioned rotatable member for transporting developer from said sump to said first mentioned member.

7. The structure as recited in claim **6** wherein excess developer is released from said rotatable member after passing said photosensitive surface; and further including means for routing at least a portion of said excess developer between said rotatable member and said electrode.

8. The development system of claim **1** further including at least two additional rotatable members in series with the first mentioned rotatable member, each of said additional members having a magnetic field emanating therefrom to assist in transporting developer from said sump to said photosensitive surface.

9. The development system of claim **8** wherein excess developer is released from a final rotatable member of said series after passing said surface; and further including means for adding additional toner to said developer, and guide means for guiding at least a portion of said excess developer and a portion of said additional toner between said first mentioned rotatable member and said electrode.

10. The development system of claim **9** wherein said guide means guides a part of said excess developer and a part of said additional toner directly to said sump.

11. The structure as recited in claim **1** wherein said rotatable member comprises a roller and a permanent magnet.

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