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Yamamoto

[11] **3,900,255**

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[54] **PADDLE-WHEEL DEVELOPMENT SYSTEM**

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Related U.S. Application Data

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[52] **U.S. Cl.** ..... **355/3 DD;** 117/17.5; 118/637

[51] **Int. Cl.** **G03g 15/00**

[58] **Field of Search** ..... 355/3 DD, 3 R, 15; 178/637, DIG. 24; 117/17.5

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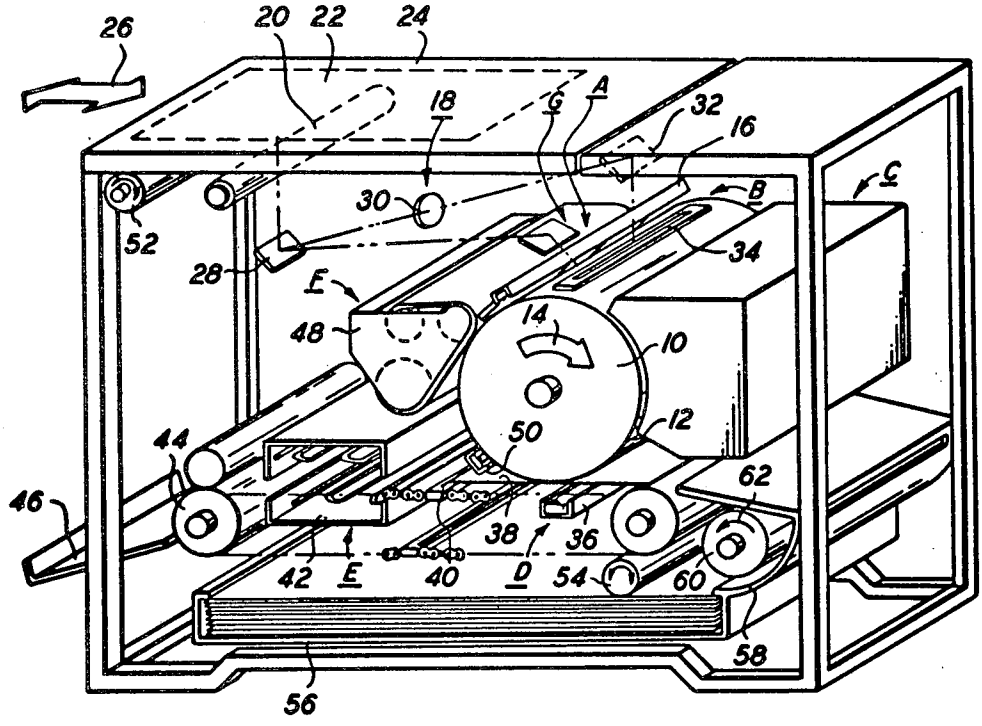
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Attorney, Agent, or Firm—H. Fleischer; C. A. Green; J. J. Ralabate

[57] **ABSTRACT**

An apparatus in which toner particles are deposited on an insulating medium for rendering visible an electrostatic latent image recorded thereon. A developer mix of carrier granules and toner particles is impelled from a first region to a second region. At the second region, the developer mix is guided so as to cascade over the electrostatic latent image depositing toner particles thereon.

2 Claims, 3 Drawing Figures



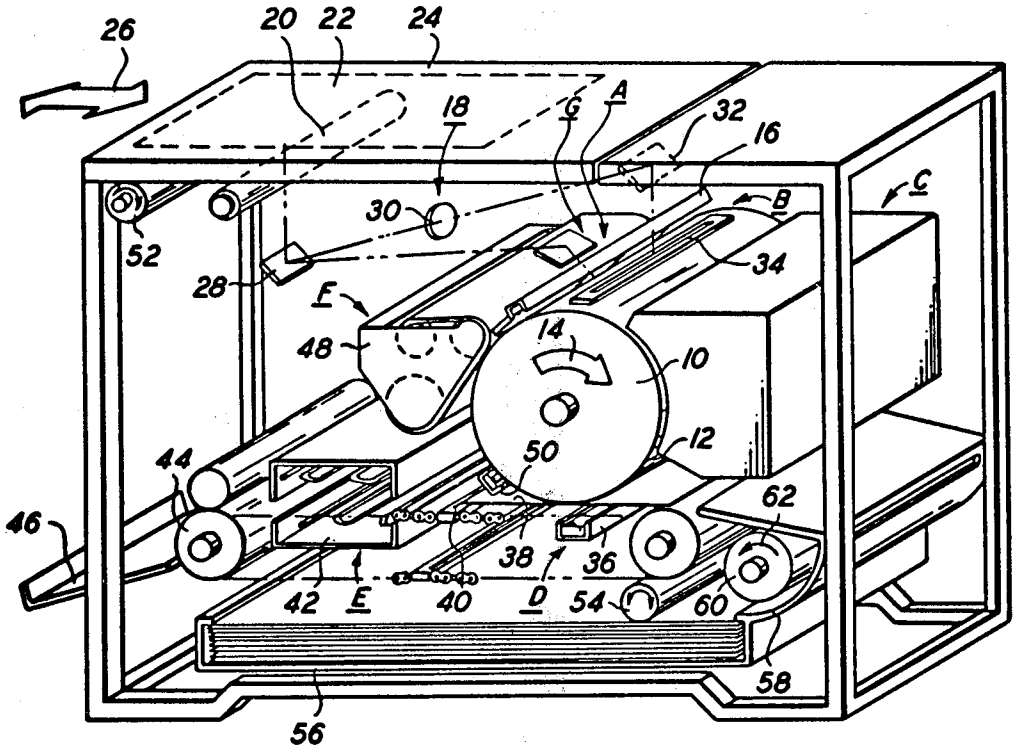

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FIG. 1

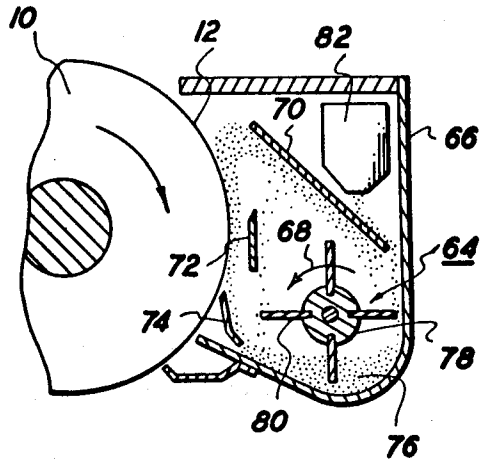


FIG. 2

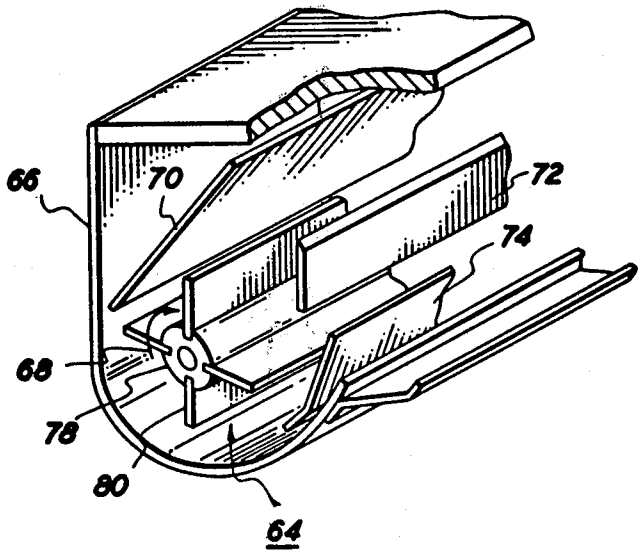


FIG. 3

PADDLE-WHEEL DEVELOPMENT SYSTEM

This is a division, of application Ser. No. **269,903,** filed July **7, 1972.**

BACKGROUND OF THE INVENTION

The foregoing abstract is neither intended to define the invention disclosed in the specification, nor is it intended to be limiting as to the scope of the invention in any way.

BACKGROUND OF THE INVENTION

This invention relates generally to electrostatographic printing, and more particularly concerns an apparatus for developing an electrostatic latent image recorded on an insulating medium.

In the process of electrostatographic printing, an insulating medium is charged to a substantially uniform level and, thereafter, selectively discharged to form an electrostatic charge pattern or latent image corresponding to an original document to be reproduced. The electrostatic latent image is then developed or rendered viewable by depositing particles thereon. The visible powder image may be fused to the insulating medium, or transferred to a secondary support sheet to which it may be fused.

Electrostatographic printing includes both electrographic printing and electrophotographic printing. These processes are similar to one another in that they both create an electrostatic latent image corresponding to the original document. Electrophotography is disclosed in U.S. Pat. No. **2,297,691** issued to Carlson in **1942.** As described therein a photosensitive element having a photoconductive insulating layer is charged to a substantially uniform potential. The charged photoconductive surface is exposed to a light image of the original document. This light image irradiates the photoconductive surface to selectively dissipate the charge and record the electrostatic latent image thereon. Electrographic printing differs from electrophotographic printing in that an electrostatic latent is formed without the use of photosensitive materials.

Regardless of the printing technique employed, development is usually achieved by bringing the electrostatic latent image into contact with a developer mix. Generally, the developer mix comprises dyed or colored thermoplastic powder, known in the art as toner particles, which are mixed with coarser carrier granules, such as ferromagnetic granules amongst others. The toner particles electrostatically adhere to the carrier granules. As the developer mix contacts the latent image, the greater attractive force of the electrostatic latent image causes the toner particles to transfer from the carrier granules and adhere thereto.

Various types of development systems are well-known in the art and include, amongst others, cascade development, magnetic brush development, powder cloud development, and liquid development. In cascade development the developer mix is transported from a sump or lower region to an upper region where it is discharged into a hopper to cascade in a downwardly direction over the latent image. A conveyor system is arranged to advance the developer mix from the sump to the discharge region. Typical conveyor systems employ buckets secured to an endless belt entrained about a pair of spaced rollers. The buckets pass through the sump and are filled with developer mix which is transported in an upwardly direction from the sump to the hopper. At the hopper, the buckets discharge the mix enabling it to cascade in a downwardly direction developing the latent image. Bucket conveyor type cascade development systems are large and generally unsuitable for a small size electrostatographic printing machine.

Accordingly, it is the primary object of the present invention to improve cascade development systems so as to be suitable for a small size electrostatographic printing machine.

SUMMARY OF THE INVENTION

Briefly stated and in accordance with the present invention there is provided an apparatus for depositing toner particles on an electrostatic latent image recorded on an insulating medium.

In the preferred embodiment, means are provided for impelling a developer mix having carrier granules with toner particles adhering thereto from a first region to a second region. As the flow of developer mix reaches the second region it contacts guide means which directs the flow so that the mix cascades over the insulating medium. The cascading developer mix deposits toner particles on the electrostatic latent image producing a powder image thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will become apparent upon reading the following detailed description and upon reference to the drawings, in which:

FIG. **1** is a schematic perspective view of an electrophotographic printing machine embodying the features of the present invention;

FIG. **2** is a sectional elevational view of a development apparatus utilized in the FIG. **1** printing machine; and

FIG. **3** is a fragmentary perspective view of the FIG. **2** development apparatus.

While the present invention will be described in connection with a preferred embodiment, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary it is intended to cover all alternatives, modifications and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

With continued reference to the drawings, wherein like reference numerals have been used throughout to designate like elements, FIG. **1** illustrates an electrophotographic printing machine for reproducing an original document. Typical printing machines of the type illustrated produce a light-image of the original document and project this image onto a charged photoconductive surface to record an electrostatic latent image thereon. Toner particles are, thereafter, deposited on the electrostatic latent image to form a powder image corresponding to the original document. Subsequently, the powder image is electrostatically transferred to a final support material, e.g. plain paper, to which it may be permanently fixed by a suitable fusing device.

FIG. **1** depicts an electrophotographic printing machine employing a photoconductive member, such as rotatably mounted drum **10,** having photoconductive

surface 12 thereon. Photoconductive surface 12 is moved sequentially through a series of processing stations as drum 10 rotates in the direction of arrow 14.

Initially, photoconductive surface 12 passes through charging station A which has positioned thereat a corona generating device, indicated generally at 16, extending transversely across photoconductive surface 12. Corona generating device 16 charges photoconductive surface 12 to a relatively high and substantially uniform potential. A suitable corona generating device is described in U.S. Pat. No. 2,836,725 issued to Vyverberg in 1958.

Photoconductive surface 12 is, thereafter, rotated to exposure station B. Exposure station B includes exposure means having a stationary lens system, indicated generally by the reference numeral 18, and a light source or scan lamp 20. An electrophotographic machine of the type illustrated in FIG. 1 scans original document 22 and produces a flowing light-image thereof which irradiates photoconductive surface 12. Original document 22 is placed face down upon reciprocating platen 24 which moves in a generally horizontal plane as indicated by arrow 26. Platen 24 is transparent and scan lamp 20 is disposed therebeneath to illuminate incremental portions of original 22 as it moves thereover. A rotary driven roller 52 mounted fixedly on the machine frame is positioned against the undersurface of platen 24 and arranged to reciprocate platen 24 in a direction indicated by arrow 26. The rotation of drum 10 in the direction of arrow 14 is sychronized with the movement of platen 24 in the direction of arrow 26.

Light rays reflected from original document 22 are transmitted by object mirror 28 through lens 30 to form a flowing light-image of the original document. Image mirror 32 directs the flowing light-image through exposure slit 34 onto charged photoconductive surface 12. The flowing light-image selectively dissipates the charge on photoconductive surface 12 to record thereon an electrostatic latent image corresponding to original document 22.

Drum 10 is next rotated to development station C where the electrostatic latent image recorded on photoconductive surface 12 is rendered viewable. The development apparatus of station C will be described hereinafter in more detail in conjunction with FIGS 2 and 3. In general, however, the development apparatus is arranged to move the mix from a sump to a region where it cascades over the electrostatic latent image so that toner particles are electrostatically attracted thereto rendering the image visible.

After development, the now visible powder image electrostatically adheres to photoconductive surface 12 and advances therewith to transfer station D. A transfer corotron 36 located at transfer station D attracts the toner powder image from photoconductive surface 12 to a sheet of final support material 38. Transfer corotron 36 extends transversely across photoconductive surface 12 and applies a charge sufficient to attract toner particles therefrom to support material 38.

Support material 38 with the powder image thereon is advanced by gripper bars 40 attached to an endless chain entrained around a system of rollers to fixing station E having fuser 42 positioned thereat. Fuser 42 includes radiant heat elements and suitable control circuit means for maintaining the fuser at a temperature adapted to permanently fix the toner powder image to final support material 38. Gripper bars 40 then move support material 38 to a pair of feed-out rollers 44 which advance support material 38 to catch tray 46. Once the final support material 38 is in catch tray 46 it may be readily removed therefrom by a machine operator.

Additional processing stations in the direction of rotation of drum 10, as indicated by arrow 14, are cleaning station F and discharge station G. Cleaning station F includes a web clean system 48 and a pre-clean corotron 50. Pre-clean corotron 50 extends transversely across photoconductive surface 12 and applies a charge potential thereto which loosens and repels the unused toner particles on photoconductive surface 12. This allows web cleaning system 48 to readily remove the residual image.

Prior to charging drum surface 12, for the next subsequent copy, any residual charge remaining thereon is removed therefrom. In order to insure that residual charge or unwanted background potential is removed from photoconductive surface 12, discharge station G directs light rays from scan lamp 20 onto photoconductive surface 12 intermediate web cleaning system 48 and corona generating device 16. The light rays from scan lamp 20 dissipate the unwanted background potential remaining on photoconductive surface 12.

Each sheet of final support material is advanced by a sheet advancing mechanism utilizing a suitable reverse buckle type of sheet feeder. The sheet feeder includes a feed roll 54 adapted to engage the uppermost sheet of support material in tray 56. Feed roll 54 rotates so as to initially advance the leading marginal edge portion of the sheet in a rearwardly direction. This rearward movement of the uppermost sheet frees the leading marginal edge portion thereof from beneath snubber 58. Thereafter, feed roll 54 reverses rotation so as to advance the uppermost sheet in a forwardly direction over snubber 58 into engagement with roll 60. Roll 60 rotates in the direction of arrow 62 and advances the uppermost sheet into engagement with gripper bar 40 which secures the sheet thereto and moves it to transfer station D. After transfer, the sheet is advanced to fuser 42 where the toner powder image is fixed thereto, and, then, to catch tray 46 for removal by the operator.

Referring now to FIGS. 2 and 3 there is illustrated, in detail, the development apparatus utilized in station C of the electrophotographic printing machine depicted in FIG. 1. The development apparatus includes impelling means or a rotary impeller, designated generally at 64. Impeller 64 is mounted rotatably in developer housing 66. Drive means, such as a suitable drive motor (not shown) is arranged to rotate impeller 64 about its longitudinal axis in the direction of arrow 68 at an appropriate speed. For example, impeller 64 preferably rotates at a speed of about 500 rpm to produce a flow of developer mix. Positioned above impeller 64 and adjacent photoconductive surface 12 is means for guiding the flow of mix such that it cascades over the latent image. Developer mix is flung into engagement with the guide means by rotating impeller 64 and cascaded in a downwardly direction over photoconductive surface 12, thereby developing the electrostatic latent image recorded thereon. The guide means includes a deflection plate 70, a control plate 72, and a recovery plate 74. Deflection plate 70 is disposed above impeller 64 and mounted transversely thereto so that it is di-

rected in an upwardly direction toward drum **10.** Control plate **72** is positioned closely spaced from and opposed from a portion of photoconductive surface **12** on drum **10.** Recovery plate **74** is located in close adjacency to the lower portion of drum **10.** The lower portion or sump of developer housing **66** stores developer mix **76** therein. Impeller **64** includes a hub member **78** having a plurality (in this case four) of substantially equally spaced longitudinally extending vanes secured to the circumferential surface therof. Hub member **78** is secured to the drive motor and journaled for rotary movement in developer housing **66.**

In operation, as hub member **78** rotates, vanes **80** scoop up developer mix **76** from the sump of developer housing **66** and fling it in an upwardly direction against deflection plate **70.** Developer mix **76** flows into the gap between photoconductive surface **12** of drum **10** and control plate **72** to cascade in a downwardly direction over the electrostatic latent image recorded on photoconductive surface **12.** The toner particles adhering to the carrier granules are electrostatically attracted to the latent image to form a viewable powder image thereon. Control plate **74** regulates the amount of developer mix **76** reaching the surface of drum **10** and indirectly prevents the escape of excess developer mix therefrom. The excess developer mix and denuded carrier granules (carrier granules which have had toner particles stripped therefrom during the development process) are guided to the sump of developer housing **66** by recovery

What is claimed is:

1. An electrophotographic printing machine, including:

a photoconductive member;

corona generating means for charging said photoconductive member to a substantially uniform level;

exposure means for producing a light image which irradiates said photoconductive member to selectively discharge portions thereof recording an electrostatic latent image thereon of an original document to be reproduced;

a housing member storing a supply of developer mix comprising carrier granules and toner particles;

a hub member mounted rotatably in said housing member;

a plurality of substantially equally spaced longitudinally extending vanes mounted fixedly on the circumferential surface of said hub member;

drive means for rotating said hub member to form a flow of developer mix moving from a first region below said hub member to a second region above said hub member;

a deflection plate disposed above said hub member and within said deflection plate having an undersurface extending transversely to said photoconductive member for intercepting and directing the flow of developer mix impacting thereon towards the electrostatic latent image recorded on said photoconductive member;

a control plate having opposed end portions, said control plate being disposed in closely spaced relation to said photoconductive member with one end portion in an adjacent spaced relation to the portion of the undersurface of said deflection plate closest to said photoconductive member such that the developer mix directed by the undersurface of said deflection plate towards said photoconductive member cascades within the space defined by the control plate and the photoconductive member and over the electrostatic latent image recorded on said photoconductive member; and

a recovery plate disposed adjacent the end portion of said control plate opposed from the undersurface of said deflection plate and arranged to direct the flow of unused developer mix and carrier granules into the first region of said housing member for subsequent re-use.

2. A machine as recited in claim **1,** wherein said drive means rotates said hub member preferably at about **500** rpm.

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