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(54) Development housing with simultaneous pickup and trim.

(57) An apparatus which advances developer material to an electrostatic latent image recorded on a photoconductive member (10). The apparatus uses a magnetic roll (85) having a rotating tubular member (80) with a stationary magnet (84) disposed interiorly thereof to attract developer material thereto. The magnet is substantially V-shaped and generates a strong magnetic field over one region (84c) to hold the developer material on the tubular member, and a weak magnetic field over the remaining region (84d) to release the developer material therefrom. Opposite polarity magnetic poles (84a,84b) are impressed on the legs of the magnet. A trimming blade (82), positioned adjacent the tubular member opposed from one of the magnetic poles (84a), regulates the thickness of the developer material as it is being loaded on the tubular member.

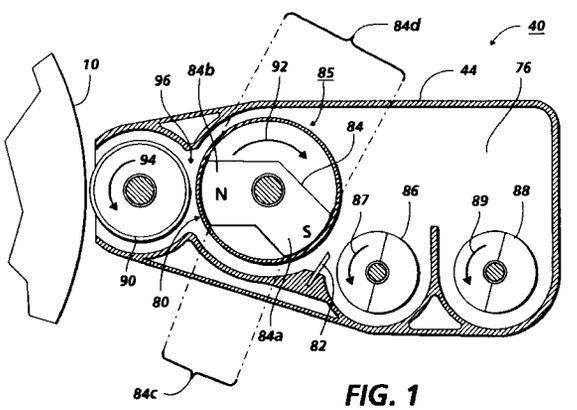

FIG. 1

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This invention relates generally to an electrophotographic printing machine, and more particularly concerns a development system having a magnet with a portion thereof being adapted to attract developer material in a region wherein developer material is trimmed therefrom.

Generally, the process of electrophotographic printing includes charging a photoconductive member to a substantially uniform potential so as to sensitize the photoconductive surface thereof. The charged portion of the photoconductive member is exposed to a light image of an original document being reproduced. This records an electrostatic latent image on the photoconductive member. After recording the electrostatic latent image on the photoconductive member, the latent image is developed by bringing a developer material into contact therewith. Two-component and single-component developer materials are commonly used. A typical two-component developer material comprises magnetic carrier granules having toner particles adhering triboelectrically thereto. A single component developer material typically comprises toner particles. Toner particles are attracted to the latent image forming a toner powder image on the photoconductive member. The toner powder image is subsequently transferred to a copy sheet. Finally, the toner powder image is heated to permanently fuse it to the copy sheet in image configuration.

In typical two component development housings, magnetic fields are used to attract developer material to a rotating sleeve from an auger. The rotating sleeve transports the developer material into a trimming region. At the trimming region, extraneous developer material is removed from the sleeve. After the extraneous developer material is trimmed from the sleeve, the remaining developer material is transported into the development zone. After development of the latent image, the unused developer is returned to the developer housing sump for mixing with the developer material therein. If an insufficient quantity of developer is ultimately conveyed to the development region catastrophic copy quality degradation results. However, if too much material is transported into the trim region, excessive torque and premature failure of the rotating sleeve end/or copy quality degradation can occur.

Various types of development systems have hereinbefore been used as illustrated by the following disclosures, which may be relevant to certain aspects of the present invention.

US-A-4,868,600 describes an apparatus wherein a magnetic roll transports two component developer material to a transfer region wherein toner from the magnetic roll is transferred to to donor roll. The donor roll transports toner to a region opposed from a surface on which a latent image is recorded. A pair of electrode wires are positioned in the space between the surface and the donor roll and are electrically biased to detach toner from the donor roll to form a toner cloud. Detached toner from the cloud develops the latent image.

US-A-4,984,019 discloses a developer unit having a donor roll with electrode wires disposed adjacent thereto in a development zone. A magnetic roller transports developer material to the donor roll. Toner particles are attracted from the magnetic roller to the donor roll.

US-A-5,010,367 describes a development system in which a pair of electrode wires are placed closely adjacent to a toned donor roll within the gap between the donor roll and photoconductive belt. The combination of an AC voltage on the donor roll with an AC voltage between the electrode wires and the donor roll permits efficient detachment of toner from the donor roll forming a toner powder cloud in close proximity to the photoconductive belt.

US-A-4,641,946 describes a developer system in which developer material is transported closely adjacent to a photoconductive belt having a latent image recorded thereon. A radial magnetic field is generated in the development zone to optimize the attraction of the toner particles from the carrier granules to the latent image. A tangential field is generated at the exit of the development zone to prevent carrier granules from adhering to the photoconductive belt. The magnitude of the tangential magnetic field at the exit of the development zone is greater than the magnitude of the radial magnetic field at the center of the development zone.

US-A-3,921,577 discloses a developer system having a resilient baffle for suppressing uncontrolled emissions of toner while leveling the profile of the magnetically entrained developer material.

In accordance with one aspect of the present invention, there is provided an apparatus for developing a latent image on a surface, including a housing defining a chamber storing a supply of developer material therein. Means are provided for transporting developer material from the chamber of the housing towards the latent image. The transporting means includes a first magnetic pole of a first polarity and a second magnetic pole, spaced from the first magnetic pole, of a second polarity opposed from the first polarity. The transporting means generates a strong magnetic field over one region between the magnetic poles to hold developer material therein and a weak magnetic field between the poles over the other region to release developer material therefrom. Means are provided for regulating the quantity of the developer material being transported by the transporting means adjacent the first pole so as to simultaneously load the transporting means with developer material and regulate the quantity thereof.

Pursuant to another aspect of the present invention, there is provided an electrophotographic printing machine of the type in which an electrostatic latent

image recorded on a photoconductive surface is developed to form a visible image thereof. The improvement includes a housing defining a chamber storing a supply of developer material therein. Means are provided for transporting toner from the chamber of the housing towards the latent image. The transporting means includes a first magnetic pole of a first polarity and a second magnetic pole, spaced from the first magnetic pole, of a second polarity opposed from the first polarity. The transporting means generates a strong magnetic field over one region between the magnetic poles to hold developer material thereon and a weak magnetic field between poles over the other region to release developer material therefrom. Means are provided for regulating the quantity of developer material being transported by the transporting means. The regulating means is adjacent the first pole of the transporting means so as to simultaneously load the transporting means with developer material and regulate the quantity thereof.

Other features of the present invention will become apparent as the following description precedes and upon reference to the drawings, in which:

Figure 1 is a schematic elevational view showing one embodiment of the development apparatus used in an electrophotographic printing machine; and

Figure 2 is a schematic elevational view showing another embodiment of the development apparatus.

Inasmuch as the art of electrophotographic printing is well known, the various processing stations employed in the electrophotographic printing machine will not be described in detail.

A typical electrophotographic printing machine uses a drum 10 having a photoconductive surface deposited on an electrically grounded conductive substrate. Drum 10 moves in the clockwise direction, as viewed in Figures 1 and 2, to advance successive portions of the photoconductive surface sequentially through the various processing stations disposed about the path of movement thereof.

The first two stations are a charging station, which charges the photoconductive surface of drum 10 to a relatively high, substantially uniform potential, and an exposure station which produces a light image on the charged portion of the photoconductive surface to selectively dissipate the charge thereon. This records an electrostatic latent image on the photoconductive surface.

After the electrostatic latent image has been recorded on the photoconductive surface, drum 10 advances the latent image to a developer unit, indicated generally by the reference numeral 40, which develops the latent image recorded on the photoconductive surface. The details of the embodiments of developer unit will be discussed with reference to Figures 1 and 2.

Referring now to Figure 1, there is shown one embodiment of developer unit 40. As shown thereat, developer unit 40 includes a housing 44 defining a chamber 76 for storing a supply of developer material therein. Donor roll 90 has electrical conductors positioned in grooves about the peripheral circumferential surface thereof. The electrical conductors are substantially equally spaced from one another and insulated from the body of donor roll 90 which is electrically conductive. Donor roll 90 rotates in the direction of arrow 94. A transport roller indicated generally by the reference numeral 85 is also mounted in chamber 76 of developer housing 44. Transport roller 85 includes a tubular member 80 adapted to rotate in the direction of arrow 92. An alternating voltage source (not shown) and a constant voltage source (not shown) electrically bias donor roll 90 in the toner loading zone. Transport roller 85 is electrically biased by AC voltage source and DC voltage source . Normally both of these voltages are set to zero. The relative voltages between donor roll 90 and transport roller 85 are selected to provide efficient loading of toner on donor roll 90 from the carrier granules adhering to tubular member 80 of transport roller 85. This insures that the donor roll is appropriately electrically biased relative to the electrical bias applied to the transport roller 85 in loading zone 96 so as to attract toner particles from the carrier granules on the surface of transport roller 85. Transport roller 85 advances a constant quantity of toner having a substantially constant charge onto donor roll 90. This insures that donor roller 90 provides a constant amount of toner having a substantially constant charge in the development zone. Augers 86 and 88 are mounted rotatably in chamber 76 to mix and transport developer material. The augers have blades extending spirally outwardly from a shaft. The blades are designed to advance the developer material in the direction substantially parallel to the longitudinal axis of the shaft. Auger 86 rotates in the direction of arrow 87 and auger 88 rotates in the direction of arrow 89. Transport roller 85 includes a non-magnetic tubular member 80 made preferably from aluminum, stainless steel or plastic, and having the exterior circumferential surface thereof roughened. An elongated "bent bar" or V-shaped magnet 84 is positioned interiorly of and spaced from the tubular member. The legs of the V-shaped magnet form an an obtuse angle. The magnet is mounted stationarily. The tubular member rotates in the direction of arrow 92 to advance the developer material adhering thereto into a loading zone 96. In loading zone 96, toner particles are attracted from the carrier granules on the tubular member to the donor roller. Trim blade 82 is positioned closely adjacent to transport roller 85 to maintain the compressed pile height of the developer material on transport roller 85 at the desired level. In this position, trim blade 82 is adjacent a magnetic pole 84a on magnet 84. The magnetic pole

84A in magnet 84 is adapted to attract, i.e. pickup, developer material. Since trim blade 82 is placed in the pickup region, the adjacent magnetic pole 84a functions as both pickup and trim magnetic pole. After the developer material is picked up and trimmed to the selected height, it is transported on tubular member 80 to loading zone 96. Magnet 84 has another magnetic pole 84b located adjacent the loading zone 96. Magnetic pole 84b is opposite in polarity to that of magnetic pole 84a. By employing the "bent bar" or V-shaped magnet 84 the tangential magnetic fields on the bottom side, i.e. region 84c, of the transport roller 85 are significantly stronger than those on the upper side, i.e., region 84d. These fields ensure that the developer material adheres to tubular member 80 in the region of strong tangential field, i.e. region 84c, while enabling release of the developer material in the region of weaker tangential field strength, i.e. region 84d as tubular member 80 rotates. The magnetic force, in this region, is of insufficient strength to hold the developer material on the tubular member. In this region, the centripetal force is greater than the magnetic force. In region 84c, the magnetic force is greater than the centripetal force holding the developer material on the tubular member. Thus, developer material will be released from the tubular member 80 in region 84d and returned to chamber 76 so as to be mixed with relatively fresh developer material by the augers. The south pole 84a of magnet 84 picks up the developer material in the trim region and the north pole 84b of magnet 84 releases the developer material at the loading zone 96. The flow of developer material in chamber 76 is split into two paths by trim blade 82. One path flows to the transport roller 85 and the other path flows to the augers, with the trim blade regulating the quantity of developer material being transported by the transport roller.

Another embodiment, shown in Figure 2, is a magnetic brush development system. This system employs a developer roll 130. The developer roller 130 picks up developer material from chamber 140 of housing 134. Developer roll 130 is adjacent photoconductive drum 10 to form a development zone 136 therebetween. Roll 130 advances developer material into contact with the electrostatic latent image at development zone 136. The latent image attracts toner particles from the carrier granules of the developer material to form a developed toner powder image on the photoconductive surface of drum 10. A toner dispenser (not shown) discharges unused toner particles into sump 132. Augers 120 and 122 are mounted rotatably in sump 132 to mix and transport developer material. The developer roll 130 includes a rotating tubular member 124 having an elongated "bent bar" magnet 126 disposed interiorly thereof. Tubular member 124 rotates in the direction of arrow 138 to advance developer material to development zone 136. Magnet 126 is mounted stationarily. The legs of the V-shaped magnet form an obtuse angle. The magnetic field generated by the magnet attracts developer material from chamber 140 of housing 134 to tubular member 124. In development zone 136, toner particles are attracted from the carrier granules on tubular member 124 to the electrostatic latent image recorded on photoconductive drum 10. Trim blade 127 is positioned closely adjacent developer roll 130 to maintain the compressed pile height of the developer material on developer roll 130 at the desired thickness. In this position, trim blade 127 is adjacent a magnetic pole 126a on magnet 126. Magnetic pole 126a on magnet 126 is adapted to attract, i.e. pick up, developer material. Since trim blade 127 is placed in the pickup region, the magnetic pole functions as both a pickup and trim magnetic pole. After the developer material is picked up and trimmed to the selected thickness, it is transported on tubular member 124 to development zone 136. Magnet 126 has another pole 126b located adjacent the development zone 136. Magnetic pole 126b is opposite in polarity to that of magnetic pole 126a. Once the developer material is in the development zone, toner particles are attracted from the carrier granules to the charged area latent image. In this way, the latent image is developed with toner particles.

By using the "bent bar" or V-shaped magnet 126, the tangential magnetic fields on the underside, region 126c, are stronger than those on the upper side, region 126d. Thus, the developer material is released from tubular member 124 in region 126d so as to return to chamber 140 to be mixed by augers 120 and 122 with fresh developer material. In this way, south pole 126a picks up the developer material in the trim region, and the north pole 126b releases it in the development zone 136. The flow of developer material in chamber 140 is split in two paths by trim blade 127. One path flows to developer roll 130 and the other path to the augers.

In recapitulation, it is evident that the developer unit of the present invention includes a magnetic roll having a V-shaped magnet with two magnetic poles. One pole is for development or reload and the other pole combines the functions of pickup and trim. Trimming is accomplished with a blade which cuts the developer in a radial field. The magnetic poles are positioned so that the material is transported on one side of the roll but released on the other to facilitate cross mixing.

Claims

1. An apparatus for developing a latent image on a surface (10), including;

a housing (44) defining a chamber (76) storing a supply of developer material therein;

means (85) for transporting developer ma-

terial from the chamber of said housing towards the latent image, said transporting means including a first magnetic pole (84a) of a first polarity and a second magnetic pole (84b), spaced from the first pole, of a second polarity opposed from the first polarity, said transporting means generating a strong magnetic field over one region (84c) between the first magnetic pole and the second magnetic pole to hold developer material thereon and a weak magnetic field over the other region (84d) between the first magnetic pole and the second magnetic pole to release developer material ; and

means (82) for regulating the quantity of developer material being transported by said transporting means (85), said regulating means being adjacent the first pole (84a) of said transporting means so as to simultaneously load said transporting means with developer material and regulate the quantity thereof.

2. An apparatus according to claim 1, wherein said transporting means (85) includes:

a tubular member (80);

a magnetic member (84) disposed interiorly of said tubular member; and

means for rotating said tubular member so as to release developer material from said tubular member over the other region (84d) while adhering thereto over the one region (84c).

3. An apparatus according to claim 2, wherein said magnetic member (84) includes a substantially V-shaped magnet having the first magnetic pole (84a) impressed on one leg thereof and the second magnetic pole (84b) impressed on the other leg thereof.

4. An apparatus according to any one of claims 1 to 3, wherein said regulating means (82) includes a trim blade having the free end thereof adjacent said tubular member (80) and adjacent the first magnetic pole (84a) on said magnetic member.

5. An apparatus according to claim 4, further including means (86,88) for mixing the developer material released from said tubular member (80) with developer material in the chamber of said housing.

6. An apparatus according to claim 4 or claim 5, wherein said tubular member (124) is positioned adjacent the surface (10) with the second pole (126b)of said magnet being adjacent the surface.

7. An apparatus according to claim 4 or claim 5, further including a donor roll (90) interposed between said tubular member (80) and the surface (10) with the second pole (84b) of said magnet being adjacent said donor roll.

8. An electrophotographic printing machine of the type in which an electrostatic latent image recorded on a photoconductive surface is developed to form a visible image thereof, including a development apparatus in accordance with any one of claims 1 to 7.

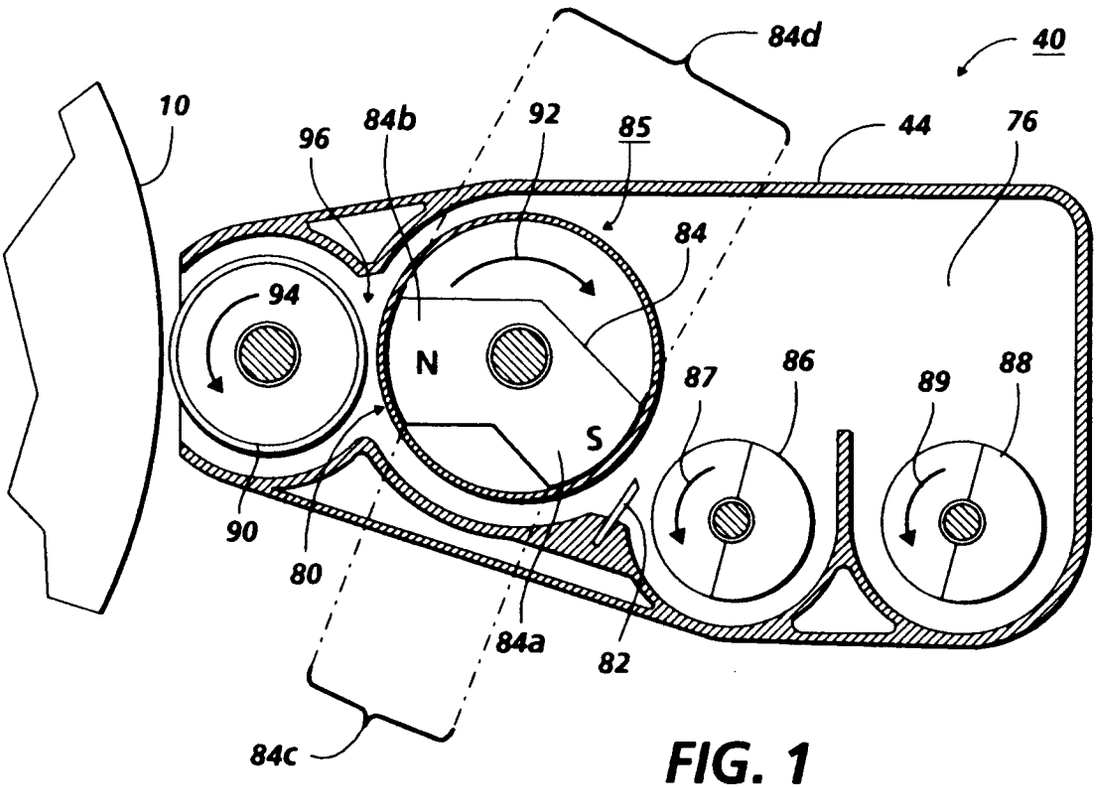
84d
40
10
96
84b
92
85
44
76
84
94
N
87
86
89
88
S
90
80
84a
82
84c

FIG. 1

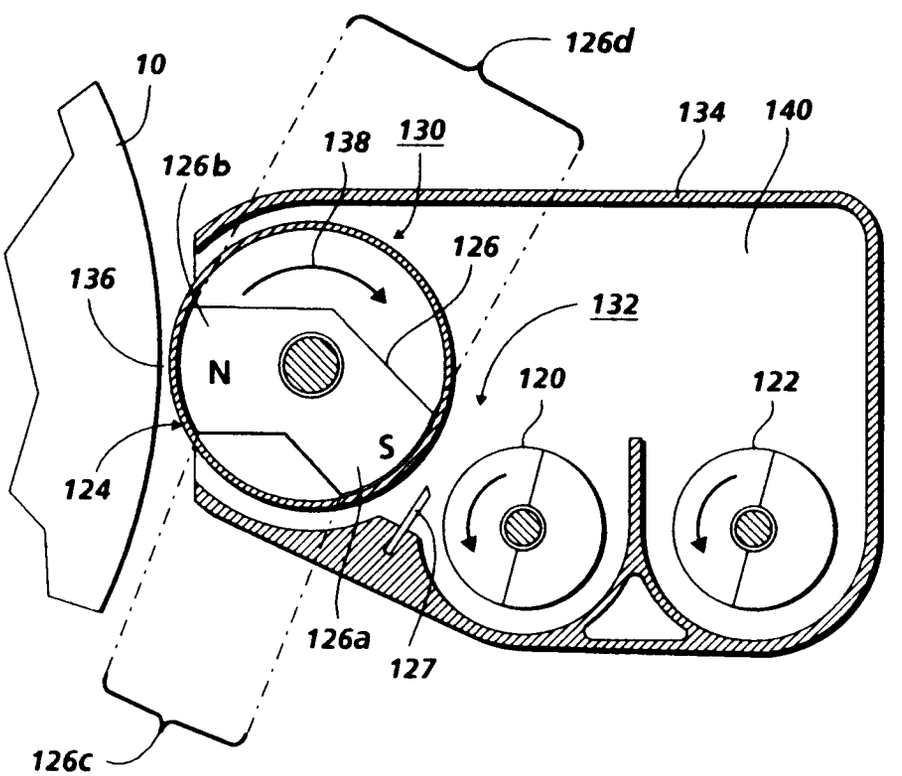
126d
10
134
140
126b
138
130
126
136
132
N
120
122
S
124
126a
127
126c

FIG. 2