

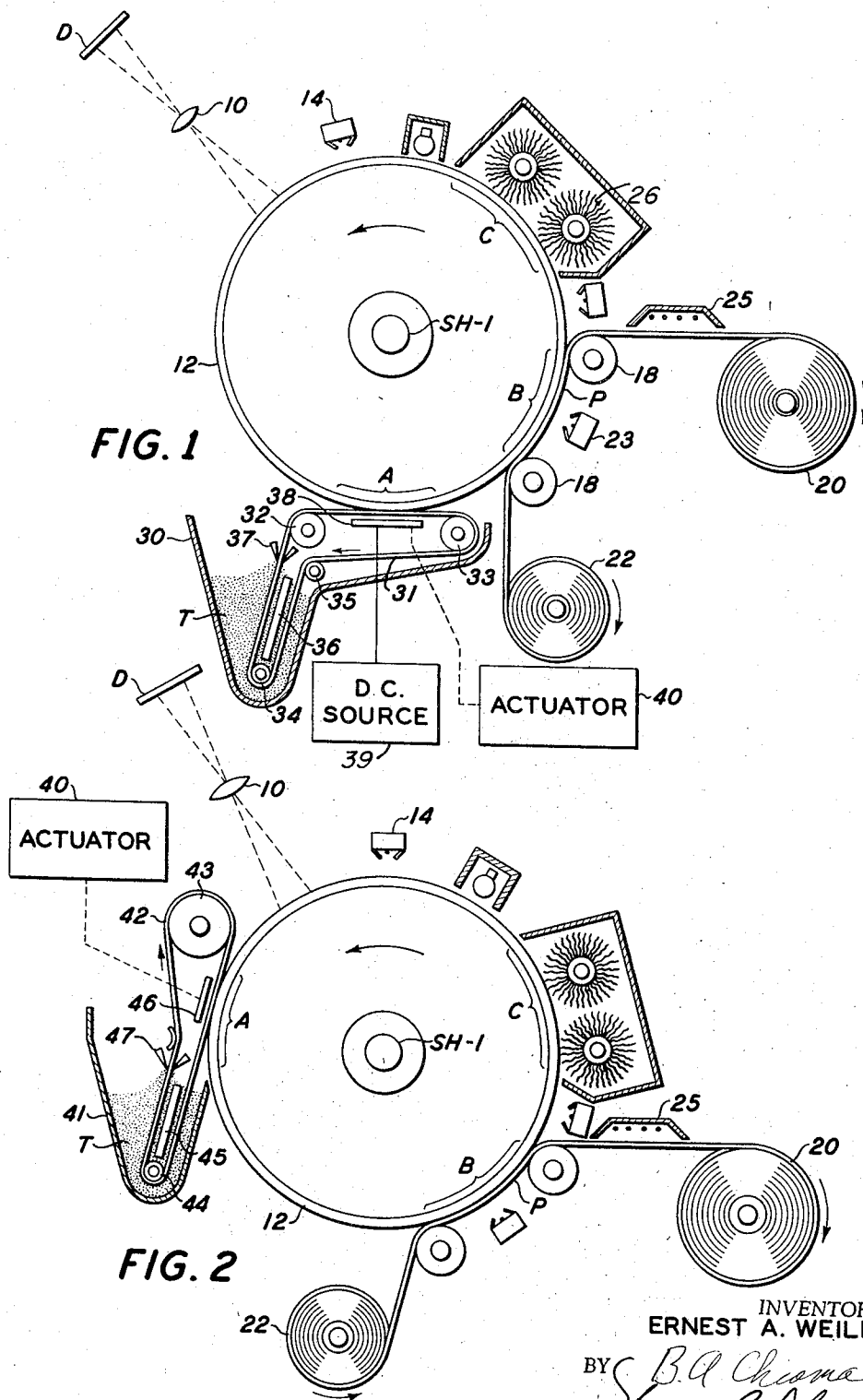
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E. A. WEILER

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DIELECTRIC BELT DEVELOPING

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INVENTOR.
ERNEST A. WEILER

BY *B. A. Chiono*
Simon P. Schenker
ATTORNEYS

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DIELECTRIC BELT DEVELOPING

Ernest A. Weiler, Pittsford, N.Y., assignor to Xerox Corporation, Rochester, N.Y., a corporation of New York

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ABSTRACT OF THE DISCLOSURE

An electrostatic developing apparatus having an endless belt made from dielectric screened material and adapted to be moved into contact with a photoconductor plate during development of a latent electrostatic image on the plate. A tribo-generator is used to cause toner particles to adhere to the belt electrostatically and scrappers are provided to scrape off excess toner and force toner into mesh of the belt. A development electrode and means for controlling its movement toward and away from the run of the belt adjacent the plate is provided in order to control the application of toner particles during development of solid area and line copy images.

This invention relates to improvements in electrostatic development devices and, particularly, to improvements wherein these devices are arranged to produce background free development during the making of electrostatic reproductions.

In conventional xerography, solid area electrostatic images can be reproduced on a xerographic selenium plate only after great care has been practiced and special apparatus added to conventional equipment. When the surface charge is uniform in density over a large area, electric fields are present in the air space only near the edges of the charge pattern where the variation in surface charge density or potential differential exists. In the central portions, the field is contained entirely within the dielectric or the photoconductive layer and, therefore, the central portion of such a charge pattern would exhibit no attraction for oppositely charged developer particles. Under these conditions, electric fields appear in the air space near the image surface where there are discontinuities or variations in surface charge density. Various components such as light screens, multiple development electrodes and circuits therefor are utilized to assist in solid area development. However, whatever cures the problem of solid areas generally adversely affects line copy.

Therefore, the principal object of the invention is to produce solid electrostatic image patterns in accordance with solid document areas to be reproduced that require a minimum of parts. A further object of the invention is to effect maximum solid image quality and minimum background conditions during xerographic processing. Another object of the invention is to produce solid area images while at the same time effecting line copy images in the event this use is desired.

These and other objects of the invention are attained by means of the application of a dielectric screen belt to an electrostatic plate at the development station of an electrostatic reproduction machine. Means are provided for applying toner in the screen belt openings continuously and for placing a charge on the toner. As the belt is brought into contact with an electrostatic image on the plate, the latent image is developed. A development electrode is utilized for controlling image density and solid area coverage and actuator means are arranged for moving the electrode a slight distance from the belt during line copy use.

The present invention is related to that disclosed in U.S. Patent No. 3,257,223 to P. F. King in that an endless

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toner carrying device is utilized to prevent toner to a latent electrostatic image. The present invention is much more simplified, requiring a simple screen belt instead of more complicated fabricated flexible conductor belt and powder cloud production and utilizes a movable electrode for effecting optimum development conditions for either line copy or solid area coverage.

A preferred form of the invention is shown in the accompanying drawings, wherein:

FIGURE 1 is a schematic sectional view of a typical xerographic reproduction machine embodying one embodiment of the principles of the invention; and

FIGURE 2 is a schematic view of the xerographic reproduction machine embodying another embodiment of the invention.

For a general understanding of a typical xerographic processing system in which the invention may be incorporated, reference is made to FIGURE 1 in which various components of a typical system are schematically illustrated. As in all xerographic systems, a light image of an original 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 with an oppositely charged developing toner material 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 such as a sheet of paper or the like to which it may be fused by a fusing device whereby the powder image is caused permanently to adhere to the support surface.

For purposes of the present disclosure, the xerographic reproduction machine includes an exposure station at which a light or radiation pattern of a document D to be reproduced is projected by a lens 10 onto an electrostatic surface, such as a xerographic drum 12.

The xerographic drum 12 is detachably secured to a shaft SH-1 mounted in suitable bearings in the frame of the machine and is driven in a counterclockwise direction by a motor at a constant rate that is proportional to the scan rate for the document being reproduced whereby the peripheral rate of the drum surface is identical to the rate of movement of the projected light image of the document. The drum surface comprises a layer of photoconductive material on a conductive backing that is sensitized prior to exposure by means of a corona generating device 14.

The exposure of the drum to the document light image discharges the photoconductive layer in the areas struck by light, whereby there remains on the drum an electrostatic latent image in configuration corresponding to the light image projected from the document. As the drum surface continues its movement, the electrostatic latent image passes through a developing station A in which there is positioned a developer apparatus in accordance with the present invention.

Positioned next and adjacent to the developing station is the image transfer station B which includes a pair of rollers 18 for holding a support material in the form of paper web P against the surface of the drum to receive the developed xerographic powder image therefrom. The web P is moved in synchronism with the rotation of the drum by means of a take-up roll 20 which drives the support material P from a supply roll 22. A suitable drive mechanism (not shown) is connected to the drum 12 for imparting rotation thereto at a continuous speed. This drive mechanism may be connected to the take-up roll 20 for imparting rotation thereto thereby producing movement of the web material P in the same peripheral direction and at the same speed as the peripheral surface of the drum. In order to insure identical movement of the

two co-acting surfaces, a suitable programming device may be utilized to effect continuous synchronous movement of these surfaces.

The transfer of the xerographic powder image from the drum surface to the transfer material is effected by means of a corona transfer device 23 that is located at or immediately after the point of contact between the transfer material and the rotating drum. The corona transfer device 23 is substantially similar to the corona discharge device 14 in that it includes an array of one or more corona discharge electrodes that are energized from a suitable high potential source and extend transversely across the drum surface and are substantially enclosed within a shielding member.

In operation the electrostatic field created by the corona discharge device is effective to attract the toner particles comprising the xerographic powder image from the drum surface and cause them to adhere electrostatically to the surface of the transfer material.

Immediately subsequent to the image transfer station, the transfer material is carried to a fixing device in the form of a fuser assembly 25 whereby the developed and transferred xerographic powder image on the sheet material P is permanently fixed thereto. After fusing, the finished copy is preferably discharged from the apparatus at a suitable point for collection externally of the apparatus.

The next and final station in the device is a drum cleaning station C having positioned therein a corona precleaning device similar to the corona charging device 14 but of opposite polarity to impose an electrostatic charge on the drum and residual powder adherent thereto to aid in effecting removal of the powder and a drum cleaning device in the form of rotary brushes 26 adapted to remove any powder remaining on the xerographic drum.

In general the electrostatic charging of the xerographic drum in preparation for the exposure step and the electrostatic charging of the support surface to effect transfer are accomplished by means of corona generating devices whereby electrostatic charge on the order of from 700 to 800 volts is applied to the respective surface in each instance. Although any one of a number of types of corona generating devices may be used, a corona charging device of the type disclosed in Vyverberg Patent No. 2,836,725 is used for both the corona charging device 14 and the corona transfer device 23, each of which is secured to suitable frame elements of the apparatus and connected to a suitable electrical circuit.

At the developing station A there is positioned a developer mechanism comprising a housing 30 containing a quantity of toner material T at the bottom sump therefor and an endless dielectric screen belt 31 arranged for movement between a pair of rollers 32 and 33 positioned to apply the screen belt 31 against the periphery of the drum 12. The belt is also carried around a roller 34 suitably mounted for rotation within the bottom of the sump portion of the housing 30. Either of the rollers 32 or 33 may be connected to a drive system for imparting continuous movement of the belt 31. In order to form a path of movement for the belt 31 that will permit contact against the bottom portion of the drum and still permit the roller 34 to remain in the development housing, it is preferred that the roller 34 be combined with an idler roller 35, which contacts the outside surface of the belt 31, and to be arranged out of alignment relative to the axes of the rollers 32 and 33.

Between the lower runs of the belt 31 that extends into the toner, there is positioned a tribogenerator 36 which produces a triboelectric charge upon the toner particles in the sump.

The movement of the belt is in the direction indicated by the arrow and is such as to carry the belt into the toner sump after a development step. During the run of the belt, in the toner supply, the resultant friction charges

both the belt and the toner particles by means of the tribogenerator 36, which should be of the proper triboelectric material. On the return run of the belt toner is picked up on both surfaces thereof and within the holes or apertures formed by the strands or the mesh of the screen. Upon emerging from the level of the toner material, the belt passes between a pair of scrapers 37 which smooths out the toner upon the belt and forces some of the excess toner particles into the mesh of the screen. Any other remaining toner is scraped off the web and falls back into the sump of the developer housing 30.

The evenly toned belt now passes under the xerographic drum 12 either in direct contact with the drum or slightly below a tangent point thereon. As the latent image is moved into the developing station A, it becomes developed by the toner particles adhering to and within the mesh of the belt. The belt continues to return to pick up more toner in the developing housing 30 in a manner just previously described. It is preferred that the movement of the belt 31 be synchronized with the peripheral speed of the drum if the belt is made from coarse material and is in contact with the drum in order to minimize smudging or destruction of the latent image or the developed image thereon. However, if the belt is made from strands of material having bristles, such as strips of rabbit fur, then it is preferred that the belt be spaced slightly from the drum surface to permit only the bristle ends to graze the drum surface and that the speed of the belt be greater than that of the drum surface.

Image density and solid area coverage are controlled by means of a movable development electrode 38 positioned for movement under the run of the belt immediately below the tangency point relative to the drum 12. A D.C. electrical power source 39 is electrically coupled to the electrode 38 for supplying thereto a D.C. bias of a polarity the same as that of the charge on the toner material. An actuator 40 is mechanically coupled to the electrode 38 for moving the same closer or further away from the adjacent run of the belt and may be controlled by a suitable knob on the reproduction machine for affecting positioning of the electrode. When the electrode is brought relatively close to the belt, solid area coverage is obtained and when the electrode is moved a slight distance away from the belt run, line copy is enhanced. Between these two extreme positions the electrode may be moved by the actuator 40 to control the intermediate density range of the developed latent image, or the various density requirements for either solid area coverage or line copy, as the case may be.

In the embodiment of FIGURE 2, the developing technique of the present invention is shown applied to some other point on the drum 12 other than the lower regions thereof. In FIGURE 2 the image forming devices, the transfer function and the drum cleaning and charging devices are the same as those in FIGURE 1 and these have been indicated by the same numerals as utilized in FIGURE 1. At the development station A in FIGURE 2, a developing housing 41 is shown at a point approximately lateral of the drum axis. The developing housing 41 contains a supply of toner particles T and a dielectric screen belt 42 is shown at a point of tangency relative to the drum periphery at some point near the top portion of the drum. The belt 42 is driven between two pulleys 43 and 44 with the upper pulley 43 being connected to a suitable drive means for imparting continuous movement of the belt. The lower pulley 44 extends deep into the sump of the developer housing 41 within the toner material therein. A tribogenerator similar to the tribogenerator 36 is positioned for operation between the runs of the belt. At the point of tangency of the web 42 with the drum 12 and slightly spaced therefrom is a development electrode 46 which performs in exactly the same manner as the electrode 38 in the embodiment of FIGURE 1.

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The operation of the embodiment of FIGURE 2 is exactly the same as that in FIGURE 1 in that the movement of the belt through the toner supply, as indicated by the arrow, is such as to pick up toner, which adheres electrostatically to the belt. The moving belt while in contact with a pair of scrapers 47 has toner particles forced into the mesh of the screen which then is applied to the periphery of the drum 12 in order to develop the latent image thereon.

From the foregoing it will be appreciated that the embodiments of both FIGURES 1 and 2 are capable of providing solid area coverage and line copy coverage merely by actuating a development electrode relative to a moving dielectric developing belt. By this arrangement, it will be appreciated that the developing process for electrostatic machines embodying the invention may be relatively compact and will not need elaborate sealing devices that generally are needed to prevent the leakage of toner material from a developing housing. It will be also be appreciated that the present invention is adapted to be applied to any point on the surface of an electrostatic drum in the conventional electrostatic reproduction machine.

While the invention has been described and carried out with two embodiments, it is not desired to be limited thereby but is intended to cover the invention broadly within the scope of the appended claims. It is to be realized also that other modifications and combinations will readily occur to those skilled in the art. Such modifications and combinations are intended to be included herewith.

What is claimed is:

1. An electrostatic development apparatus for developing latent electrostatic images on a moving photoconductor plate with finely divided electrostatic toner particles comprising

a belt of dielectric material constructed in screen configuration arranged for movement in at least close proximity to the latent electrostatic image during movement thereof,

means for applying the finely divided toner particles to the belt and to effect adhesion of the particles thereto,

an electrode arranged adjacent to the photoconductor plate with said belt moving therebetween,

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electrical biasing means connected to said electrode and adapted to bias the electrode to the same polarity as that on the toner particles in order to repel the same from the belt and direct them to the latent image in said plate, and

an actuator means operatively connected to said electrode for moving the same toward or away from the portion of the moving belt adjacent the plate for controlling the amount of toner particles being repelled from the belt and being attracted to the latent image.

2. The apparatus in claim 1 wherein said screened belt is supported around and driven by a plurality of rollers to form a first portion of a run of the belt and to position the same in at least said close proximity to said plate and a second portion of a run extending into a supply of the toner particles.

3. The apparatus in claim 1 wherein said means for applying the toner particles to the belt includes a tribo-generator for electrostatically holding some of the toner particles thereto and a spreader device adapted to force some toner in the mesh of the screen web.

4. The apparatus in claim 1 wherein said actuator is adapted to move said electrode closer to said belt during development of latent images having relatively large areas of solid copy and further away from the belt during development of line copy.

5. The apparatus in claim 1 wherein said photoconductor plate is in the form of a drum and the belt is arranged for movement in continuous tangency to the drum where toner development occurs, said electrode being positioned on the side of the belt away from the drum at the point of tangency.

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CHARLES A. WILLMUTH, *Primary Examiner.*

45 P. FELDMAN, *Assistant Examiner.*