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XEROGRAPHIC DEVELOPMENT ELECTRODE

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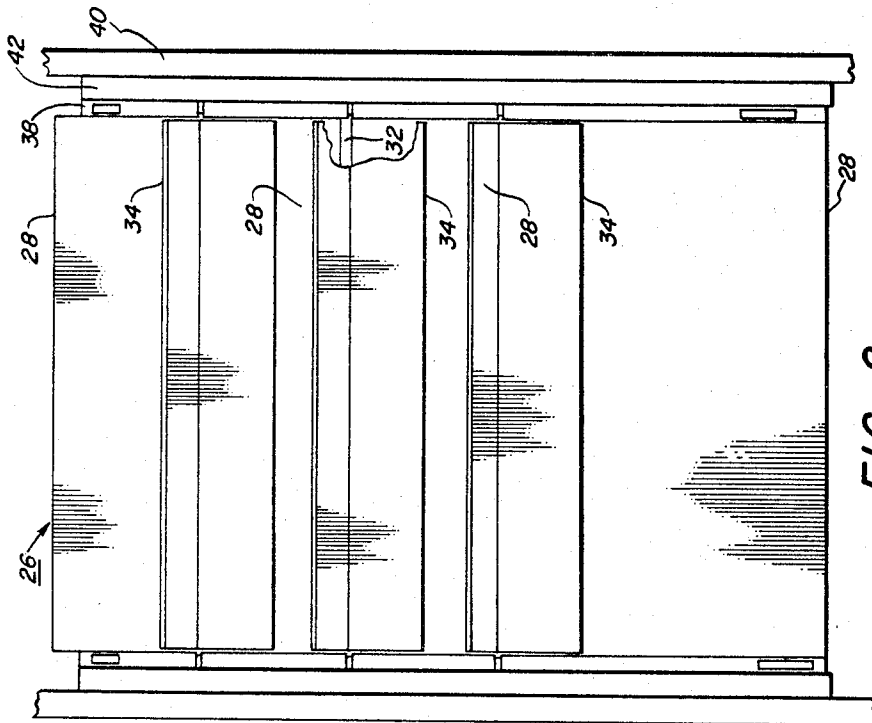


FIG. 2

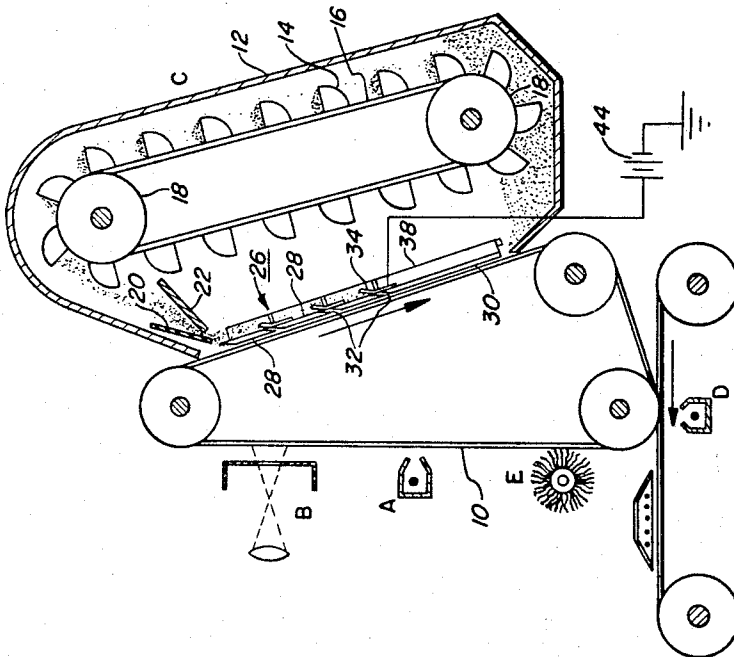


FIG. 1

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XEROGRAPHIC DEVELOPMENT ELECTRODE
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ABSTRACT OF THE DISCLOSURE

A development electrode comprising a plurality of conductive segments extending across a development zone adjacent a movable latent electrostatic image-bearing surface to be developed. The segments are spaced from each other to define developer supplementing apertures for the introduction of fresh, fully toned, two-component developer into the development zone at various locations along the development zone. Developer directing plates extend from the electrode segments on the side thereof remote from the development zone to direct the flow of developer into the apertures.

This invention relates to xerography and in particular, to an improved segmented development electrode for use in two-component cascade development systems.

In the practice of xerography, as described in U.S. Patent No. 2,297,691 to Chester F. Carlson, a xerographic surface comprising a layer of photoconductive insulating material affixed to a conductive backing is used to support electrostatic images. In the usual method of carrying out the process, the xerographic plate is electrostatically charged uniformly over its surface and then exposed to a light pattern of the image being reproduced to thereby discharge the charge in the areas where light strikes the layer. The undischarged areas of the layer thus form an electrostatic charge pattern in conformity with the configuration of the original light pattern.

The latent electrostatic image can then be developed by contacting it with a finely divided electrostatically attractable material such as a resinous powder. The powder is held in image areas by the electrostatic field on the layer. Where the field is greatest, the greatest amount of material is deposited; and where the field is least, little or no material is deposited. Thus, a powder image is produced in conformity with the light image of the copy being reproduced. The powder is subsequently transferred to a sheet of paper or other surface and suitably affixed to thereby form a permanent print.

The electrostatically attractable developing material commonly used in xerography consists of a pigmented resinous powder referred to here as "toner" and a "carrier" of larger granular beads formed with glass, sand or steel cores coated with a material removed in the triboelectric series from the toner so that a triboelectric charge is generated between the toner powder and the granular carrier. Such charge causes the toner to adhere to the carrier. The carrier also provides mechanical control so that the toner can be readily handled and brought into contact with the exposed xerographic surface. The toner is then attracted to the electrostatic image to produce a visible powder image on the xerographic surface.

Toner particles which are mixed with carrier adhere to and coat the surface of the carrier due to the electrostatic attraction between them. This two-component mixture of carrier and toner constitutes the developer mixture. During development the toner-coated carrier moves across the xerographic surface at which time toner particles are electrostatically pulled away from the carrier by the charged areas of the surface and are selectively deposited thereon to form a visible powder image. The

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partially denuded carrier then moves beyond the xerographic surface. As toner images are formed, additional toner powder is generally supplied to the developer mixture in proportion to the amount of toner deposited on the xerographic surface.

Many development systems have been proposed for bringing the charged toner into contact with the image bearing surface. One of such systems in wide use is the "cascade" development system. In cascade development the two-component developer is poured or cascaded across a xerographic surface under the action of gravity.

Not all toner particles which become attracted to the photoconductive image-bearing surface during cascading, remain there for transfer to the final copy. A great percent of such toner is removed by the "scavenging" effect of the carrier granules. Scavenging occurs when carrier particles move across a toner bearing surface after depositing their previously associated toner particles onto image areas. As there partially denuded carrier granules continue their movement across the surface, toner to carrier contact can attract those toner particles from the surface which are held thereto by weak electrostatic forces.

One approach to high speed xerographic development systems needed in today's high-speed machines has been longer development zones. But with the elongation of development zones, there has been the problem of increased time of scavenging by partially denuded carrier granules. As can be understood, fully toned developer gives up its toner to the image bearing surface being developed during the early stages of cascading thus leaving scavenging carrier granules more time and distance to remove toner from the image.

The present invention is directed to apparatus for introducing fully toned developer into the cascade zone at various spaced points along the zone. This is done by means of an apertured or segmented development electrode, which in addition to allowing the introduction of freshly toned developer, permits the development electrode effect to increase the development capabilities of the system.

Apertured development electrodes are known in the art and are described, for example, in U.S. Patent 3,011,474 to Ulrich and U.S. Patent 3,147,147 to Carlson. Both Ulrich and Carlson use their electrodes conventionally for improved development capabilities while the apertures minimize the tendency of developer to create developer jams or build-ups between the electrodes and the xerographic surface. The instant invention has these abilities but adds thereto, the ability to permit the introduction of freshly toned developer at spaced points along the cascade zone in a fashion unsuggested by the prior art. This is achieved through a minimum of structure which is readily incorporated into existing xerographic machinery.

It is, therefore, an object of the present invention to develop latent electrostatic images.

It is a further object of the invention to improve two-component cascade development systems.

It is a further object of the present invention to introduce freshly toned developer into two-component development systems at various spaced points along the cascade zone.

It is still a further object of the present invention to minimize scavenging in two-component xerographic development systems.

It is still a further object of the invention to develop latent electrostatic images in an electroded system with fully toned developer.

These and other objects of the present invention are achieved by a development electrode formed of a plurality of conductive segments extending across the development zone adjacent the latent electrostatic image to be developed. The segments are spaced from each other to

define developer supplementing apertures for the introduction of fresh, fully toned two-component developer into the development zone at various locations therealong. Developer directing plates extend above the electrode segments on the side thereof removed from the development zone to direct developer into the apertures for the introduction of the developer into the zone at various stages along the zone.

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:

FIG. 1 is a diagrammatic side, cross-sectional view of a xerographic machine adapted for continuous and automatic operation embodying the development electrode of the instant invention; and

FIG. 2 is a horizontal plan view of the development electrode shown in FIG. 1.

Shown in FIG. 1 is a xerographic machine constructed for continuous and automatic operation and embodying the principles of the instant invention. All of the processing stations referred to by letters are conventional in the xerographic art except for the development station C which forms the basis of the instant invention. For the purpose of the present disclosure, the several xerographic processing stations in the path of movement of the xerographic drum may be described as follows:

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

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

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

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

A drum cleaning station E, at which the drum surface is brushed to remove residual toner particles remaining thereon after image transfer.

As stated above, all of these stations are conventional in the xerographic art except for the development station C.

The developing instrumentalities are positioned adjacent the xerographic surface 10 upon which the images are adapted to be formed. The xerographic surface is shown in the illustrated embodiment as an endless rotating belt movable to sequentially move its surface portions in a path through the various processing stations for an automatic and continuous cycle of operation. Power may be applied for rotating the belt, as well as for initiating the cycle of operation for the various processing stations by any conventional power source, not shown. A xerographic surface with any cylindrical cross section, as for example a drum, could be used.

The developing instrumentalities are housed within a general developer housing 12. The lower or sump portion of the developer housing is adapted to be filled with a quantity of two-component developer material. The developer may be raised to an elevated position for cascading down the xerographic surface by a series of buckets 14 movable on a belt 16 and guided for its motion by rollers 18. Power may be imparted to the rollers by any conventional power source, not shown, to move the buckets in the direction as indicated by the arrows.

As the buckets reach their uppermost position they

are adapted to drop the developer into a hopper defined by a pair of plates 20, 22 for guiding the developer onto the belt surface. The sump, buckets, and plates extend a length approximately equal to the length of the drum to insure the cascading of developer across the length of the belt. As the developer cascades down the arc of the belt, it develops the latent electrostatic images on the belt which it contacts.

Positioned in close proximity to xerographic surface is the development electrode designated generally as 26. The electrode is constructed of a plurality of development electrode segments 28 of widths at least equal to the width of the xerographic surface to be developed. Each segment is suitably secured at its outer end to opposite frame portions of the machine to hold them adjacent the development zone 30 with developer supplanting apertures 32 formed therebetween. Developer directing plates 34 are secured as by bolts 36 or other suitable securement means to the side of the electrode segment remote from the development zone 30 for a purpose later to be explained.

Since the development electrode segments 28 are to be biased or grounded with respect to the substrate of the photoconductive being developed, it is necessary to insulate the electrode segments from the rest of the machine. This is done in the instant embodiment through conductive side bars 38 on each side of the electrode segments. This assures that each segment will be of a common electrical potential. The side bars 38 are then mounted to the machine frame 40 through an insulating barrier 42 to allow a potential to be held on the electrode segments independent of the machine frame. Thus, an electrical lead to a single segment will bias the entire development electrode to a common potential.

When a quantity of fully toned two-component developer is fed from the hopper, through the developer guiding plates 20, 22, only a portion of the developer can pass between the relatively restricted opening between the upper segment of the electrode and the xerographic surface. The remainder of the developer will pass above the first segment out of contact with the xerographic surface. This portion of developer flowing above the upper or first electrode segment will then be at least partially deflected by the first developer directing plate 34 so that a portion thereof will flow down the developer supplementing aperture 32 into the stream of developer already in the development zone 30. As can be understood, no developer directing plate need be employed at the upper edge of the first electrode segment. A portion of the developer will also pass over the first developer directing plate to enter the development zone at various spaced points along the zones. The remaining developer supplementing apertures 32 and developer directing plate 34 act in a similar fashion for introducing fresh developer into the development zone at various spaced points thereon. Any number of electrode segments and apertures can be employed depending on the length of the zone and other variable parameters.

In some instances, all of the developer will not enter the development zone through one of the apertures 32. A slight remainder of the developer may pass over all of the apertures to recombine with the developer from the development zone in the sump region.

The mass flow of developer in the development zone increases as fresh developer is added to the system through the apertures. This creates no jamming problem if the apertures and developer inlet areas are properly proportioned. It should also be noted that the developer flowing through the development zone is increasing in velocity under the influence of gravity as it is being cascaded. The increased velocity increases the inter-particle spacing of the original developer in the development zone to further accommodate the added developer being introduced.

The development electrode segments 28 are constructed of a conductive material, aluminum for example, and positioned closely spaced from the xerographic surface

being developed. The segments are electrically secured with respect to each other adjacent their ends through conductive side bars 38. The electrode segment may be biased, as by potential source 44 to a common potential about the same as that on the image and non-image areas of the xerographic surface for conventional development as suggested in U.S. Patent No. 2,952,241 to Clark et al. This would be of a polarity opposite from the toner particles. The potential on the electrode should be of a slightly greater magnitude than that in background areas of the latent electrostatic image for attracting toner away from such non-image areas to minimize background.

The individual segments may also be provided with individual biases from individual potential sources. In this case, however, bars 38 would have to be constructed of an electrical insulator.

In operation, the machine is set in motion through a general cycle initiating means, not shown. This would act to set the xerographic belt in motion to sequentially pass it through the various xerographic processing stations described above. The cycle initiating means would also render the various stations operative. As the surface is charged and exposed at stations A and B, it then sequentially passes in the direction of the arrow as shown in FIG. 1 through the cascade development zone 30. At this point, the buckets 14 are continually raising developer from the sump into the hopper and through the developer driving plates 20 and 22 both above and beneath the first electrode segment 26. The split flow of developer will act to cascade developer across the xerographic surface and also on the back side of the electrode for permitting the introduction of fresh developer at spaced points along the development zone, as defined by the developer supplementing apertures 32. By the time the developer has passed through the development zone, it will continuously be redeposited in the lower sump portion of the developer housing 12. A conventional toner dispenser may be employed to add toner into the housing to replace the toner lost from the system through the development of images.

It should be understood that the development electrode of the instant invention may be employed with the xerographic surface moving in either an uphill or downhill direction with respect to the flow of cascading developer. It may also be employed on a xerographic surface of any shape including that of the drum. When a drum-shaped xerographic surface is employed, the development elec-

trode would take on an arcuate cross-sectional configuration to conform with the curvature of the drum.

The instant invention is described herein as usable in commercial machines employing positive charging of the xerographic surface, negative toner and positive electrodes. It should be understood, however, that the selection of such polarities has been done merely for illustrative purposes since these polarities could readily be reversed.

While the present invention as to its objects and advantages, has been described herein as carried out in specific embodiments thereof, it is not desired to be limited thereby; but it is intended to cover the invention broadly within the scope of the appended claims.

What is claimed is:

1. A development electrode for use in a two-component cascade development zone comprising:
 - a plurality of conductive development electrode segments in the form of conductive bars extending across the development zone transverse to the flow of cascading two-component developer,
 - means to secure the electrode segments in a development zone closely spaced from the xerographic surface to be developed with the electrode segments being spaced from each other to define developer supplementing apertures therebetween,
 - and means positioned on the electrode segments adjacent the developer supplementing apertures for directing developer flowed above the electrode segments into the development zone.
2. A development electrode as set forth in claim 1 and further including means to apply an electrical potential to the electrode segments.

References Cited

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PETER FELDMAN, *Primary Examiner.*

U.S. Cl. X.R.

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