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Hudson et al.
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[45] Jan. 8, 1974

[54] PRE-TRANSFER STATION

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[52] **U.S. Cl.** **355/3,** 96/1
[51] **Int. Cl.** **G03g 13/14**
[58] **Field of Search** 355/3; 96/1

[56] **References Cited**
UNITED STATES PATENTS
3,124,457 3/1964 Schwertz 96/1

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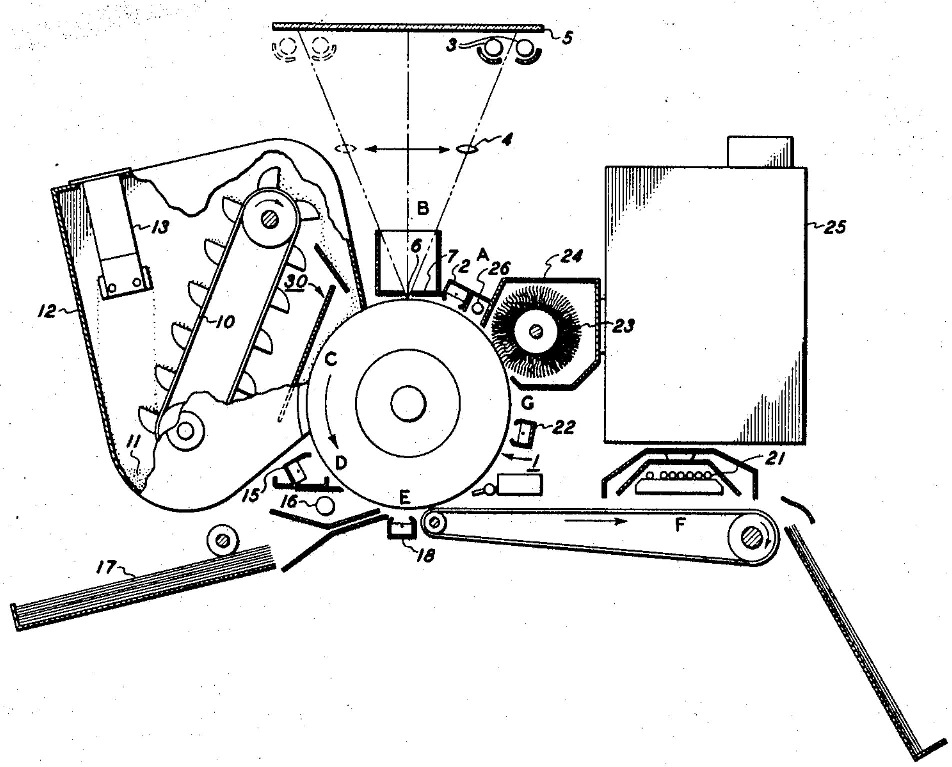
[57] **ABSTRACT**

A pre-transfer station is provided in a reusable xerographic imaging system. The pre-transfer station includes a pre-transfer corotron and lamp arranged such that the exposure of the system xerographic plate is subsequent and not simultaneous with the pre-transfer corona charging.

7 Claims, 5 Drawing Figures



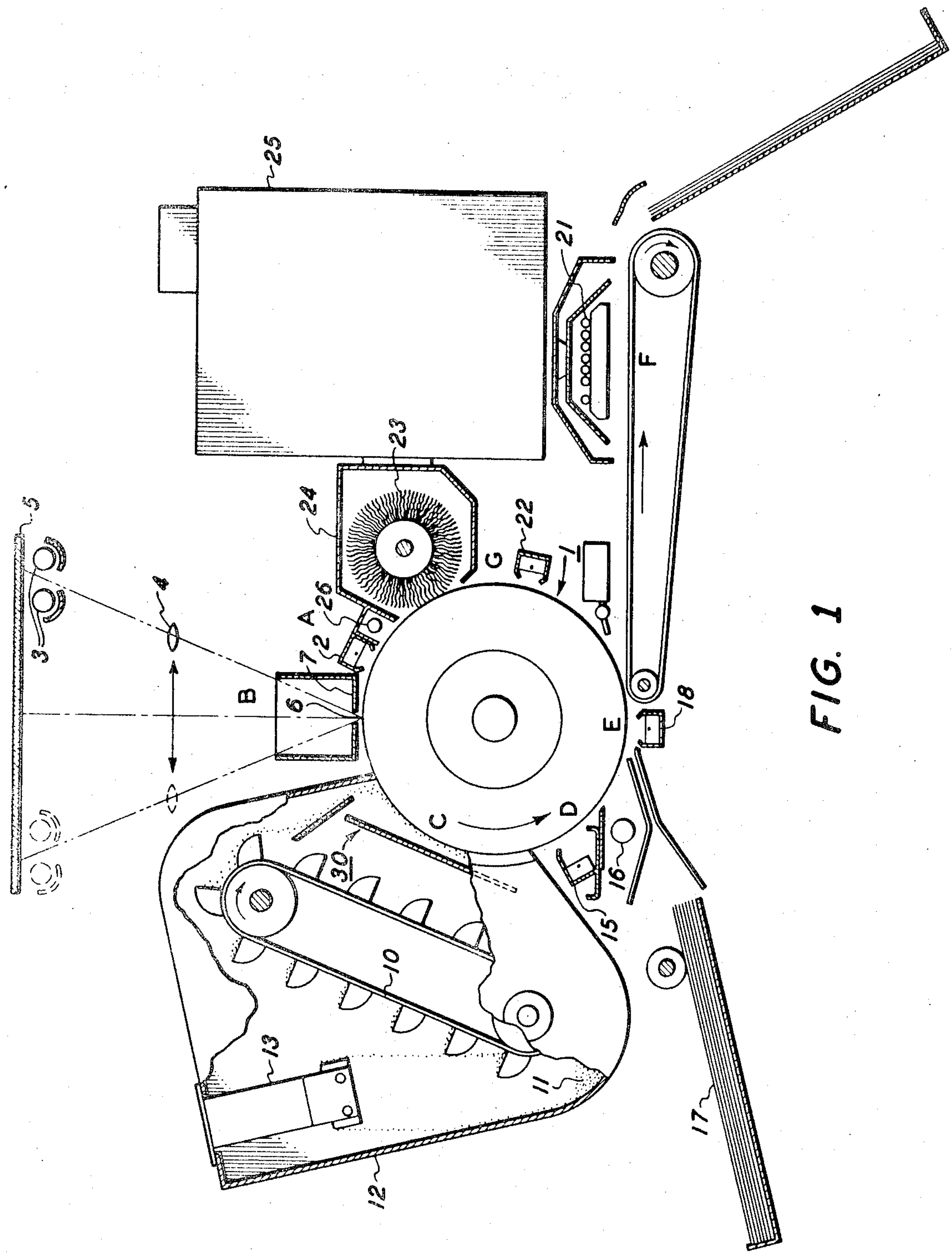


FIG. 1

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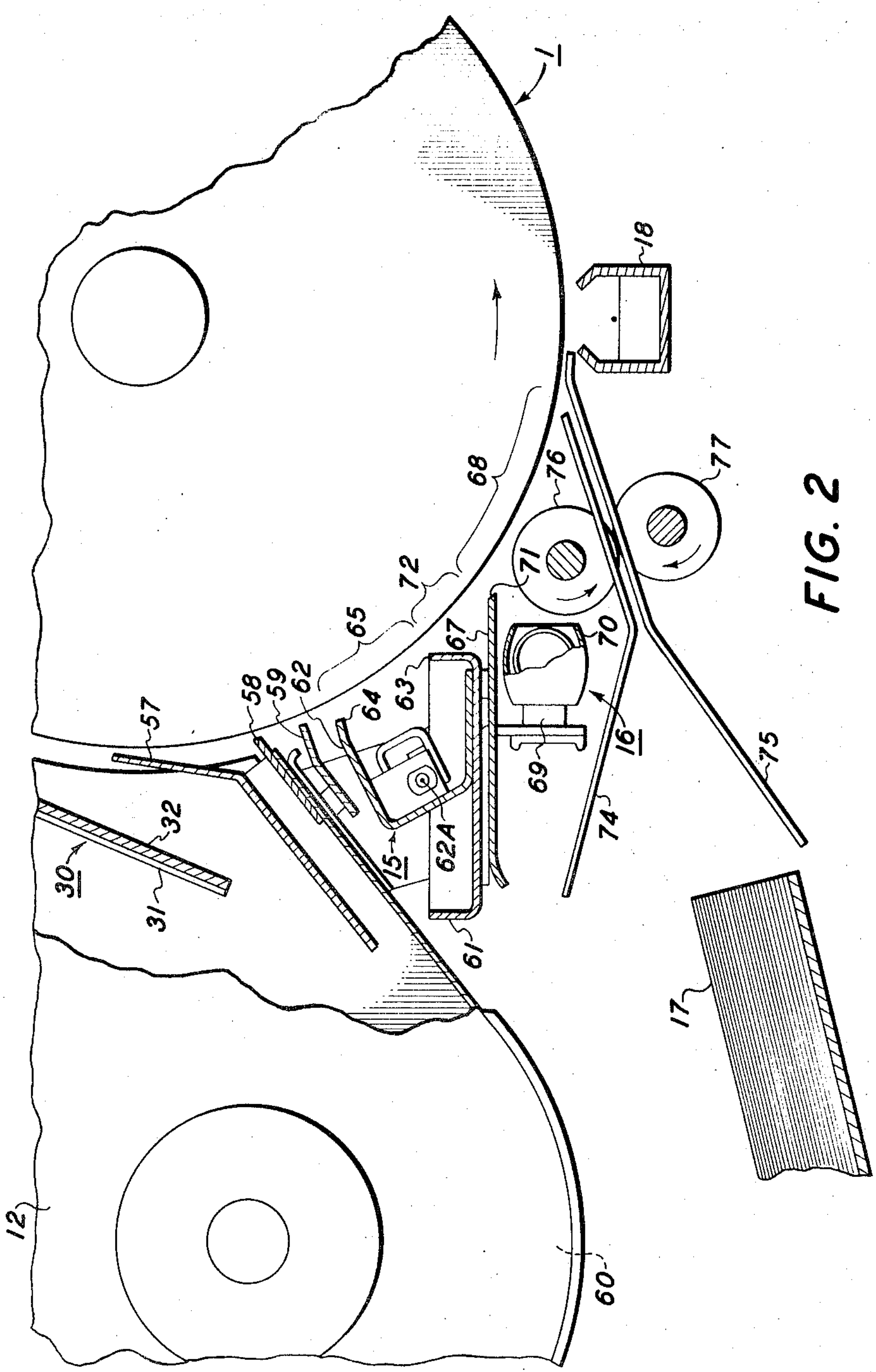
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FIG. 2

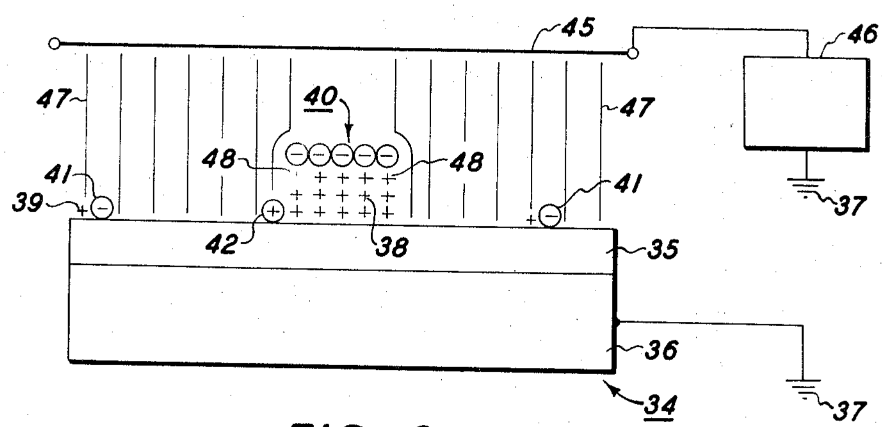

FIG. 3

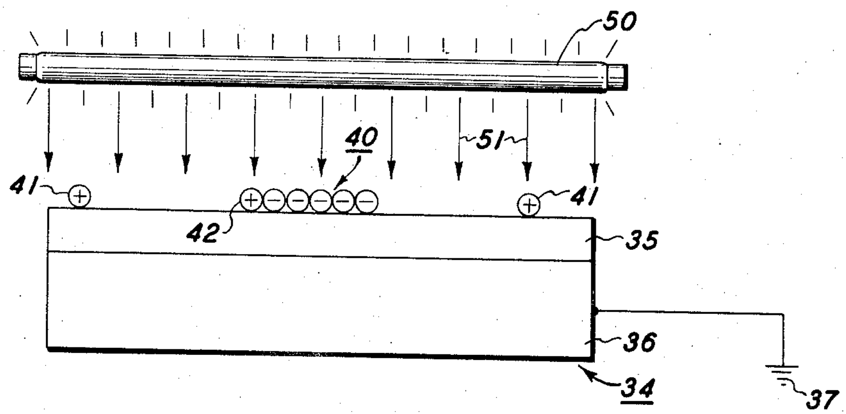

FIG. 4

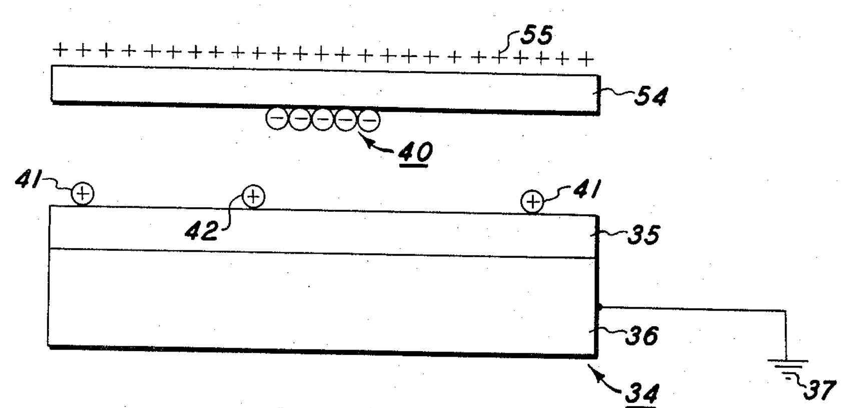

FIG. 5

PRE-TRANSFER STATION

BACKGROUND OF THE INVENTION

This invention relates to xerographic imaging systems and in particular to new methods and apparatus for enhancing the quality of xerographic images for transfer xerography.

In direct xerography, vis-a-vis transfer xerography, a visible toner image is created directly on the member used to form the toner image. This "member" is normally paper that is coated with or otherwise includes a layer that is sensitive to light in electric fields. Technically, the coated paper is an electrically photosensitive member which is referred to herein as a xerographic plate or member. The visible toner image is created by steps including charging the photosensitive paper, exposing the charged paper to a light image and depositing charged toner particles over the paper. The tone particles adhere in the areas of a latent electrical image created by the charging and exposing steps. The resultant or developed toner image may be permanently fixed to the paper. When the toner is heat softenable, the toner image can be permanently fixed by heating the toner to allow it to form a bond with the paper.

In transfer xerography the toner image is created on an intermediate xerographic member and is thereafter transferred to a separate support such as ordinary paper. Ordinary refers to the fact that the paper has no special photosensitive property. In most, but certainly not all transfer xerographic systems, the intermediate xerographic member is reusable. This means that the xerographic plate is cleaned, recharged and exposed to light on one or more subsequent occasions to form other toner images each of which is transferred away to some permanent support member.

With both direct and transfer xerography, the quality of the final copy or image is measured in terms of optical density in image and non-image, i.e., background, areas. High quality copies include optical densities of about D=1.2 in image areas and D=0.005 in background areas. D is a dimensionless expression for optical density mathmatically defined as $D=\log_{10}1/R$ where R is the ratio of reflected light to incident light. The foregoing formula quite obviously relates to reflective copies. For transparancies, high quality usually means optical densities of about D=0.8 to about D=1.0 in image areas and D=0.005 in background areas. The formula $D=\log 1/R$ still applies for transparencies but R equals the ratio of transmitted light to incident light.

Direct xerography is less versatile than transfer xerography when it comes to controlling the optical density of copies. The reason is quite simple. In direct xerography, the image and background areas of a copy are subject to one less step affecting their optical densities. The extra step is of course the transfer step itself.

The pre-transfer charging method set forth in U. S. Pat. No. 3,444,369 to Malinaric takes advantage of the transfer step to obtain substantially high quality images for transfer xerography. The patent teaches method and apparatus for changing the polarity of the charge on the background particles, thereby preventing their transfer in an electric field designed to transfer the oppositely charged imaged particles.

It is a principal object of this invention to enhance final image quality in transfer xerography.

Specifically, it is an object of the instant invention to devise methods and apparatus for transfer xerography

wherein the transfer of image area toner particles is greatly assisted and the transfer of background toner particles is highly suppresed.

Another object of the invention is to combine the pre-transfer corotron disclosed in the Malinaric patent with means for altering the electrical potentials associated with the latent image without adversely affecting the operation of the pre-transfer treatment taught by the Malinaric patent.

The foregoing and other objects of this invention are realized by combining in a specific manner a pre-transfer lamp with a pre-transfer corotron. The pre-transfer corotron is used to change the polarity of the charge associated with particles in the background area without changing the polarity of the image area toner particles. The pre-transfer lamp is used to substantially lower the potential on the surface areas of the xerographic plate carrying the image toner. This in turn helps transfer by making the toner easier to be pulled away from the xerographic plate. The special manner referred to includes means and method for insuring that the polarity changing treatment occurs before, never simultaneously with or subsequently to, exposing the xerographic plate to the light of the pre-transfer lamp.

DESCRIPTION OF THE DRAWINGS

The above and other features of the instant invention wil be apparent from this description and from the drawings which are:

FIG. 1 is a side elevation, partly in section, of a transfer xerographic system utilizing a pre-transfer corotron and pre-transfer lamp according to the instant invention.

FIG. 2 is an enlarged view of the apparatus of the xerographic system of FIG. 1 in the vicinity of the pre-transfer corotron and lamp.

FIG. 3 is a functional schematic of a xerographic plate having a developed latent image including high concentrations of toner particles in latent electrical image areas and low concentrations of toner particles in background areas and of the field lines between a pre-transfer corotron and the xerographic plate.

FIG. 4 is a functional schematic illustrating the consequence of exposing the plate of FIG. 3 to light.

FIG. 5 is a functional schematic illustrating the transfer of the image toner of FIGS. 3 and 4 to a transfer support member.

DETAILED DESCRIPTION

The transfer xerographic system of FIG. 1 has the drum 1 which includes a photoconductive layer coated onto an electrically grounded metal cylinder. The drum as described defines a continuous, reusable xerographic plate or member. The drum is journaled in a frame to rotate in the direction indicated by the arrow to cause the free or image forming surface of the drum to sequentially pass a plurality of xerographic processing stations.

The charging station A includes the corotron 2, e.g., that described in U. S. Pat. No. 2,836,725, coupled to an appropriate electrical potential and positioned relative to the drum to deposit charge on the free surface of the drum so as to elevate the free surface to substantially uniform electrical potential, e.g., 800 volts.

The exposure station B includes appropriate lamps 3 and lens 4 mounted to cooperate for a line by line scan of an original placed face down on copyboard or platen **5.** The light image created by the scanning of an original is projected onto the free surface of drum **1** through the aperture **6** in the light stop **7.** The electrical potential of the drum drops substantially in the areas of the xerographic plate absorbing the incident light. The areas absorbing the light, in the present positive to positive copying system are referred to herein as the background areas. An example of a background potential is 200 volts when the drum is charged as in the earlier example of 800 volts. The areas of lower potential may comprise the image area in a negative to positive copying system. This later copying system is not discussed in detail to avoid redundancy because the present description applies except for logically necessitated changes.

Adjacent the exposure station is the development station C which contains the toner particles for making the latent electrostatic image visible. FIG. **1** shows a cascade development system, by way of example, which includes a motor driven bucket-type conveyor **10.** The developer material **11** includes carrier particles and toner particles and is stored in a sump in the bottom of the housing **11.** The buckets scoop up the developer and carry it to the upper portion of the housing where the developer is poured or cascaded over the hopper chute onto the drum **1.**

As the developer cascades over the free surface of the drum, the toner particles adhere to the latent electrostatic image because of the electric fields associated with the latent image. The toner is electrostatically charged triboelectrically due to a mixing action with the carrier particles. Toner particles consumed during the development process are replenished by a toner dispenser **13** mounted within housing **11.**

The pre-transfer station D is the subject of the instant invention. Station D includes the pre-transfer corotron **15** and pre-transfer lamp **16** whose operation is discussed in more detail below. Functionally, the pre-transfer station conditions the xerographic plate and toner thereon such that only image toner particles are transferred to a transfer member **17** at station E.

The transfer station E includes, by way of example, means for feeding a transfer member **17** in registration and a transfer corotron **18** which charges the backside or non-image carrying side of a transfer member to a high potential, e.g., +2,000 volts for the earlier given examples of +800 volts and +200 volts at the free surface of drum **1.** The electric field established by the charge deposited by corotron **18** and the potentials associated with the drum cause the toner particles im image areas to transfer to member **17.** Other transfer stations employ biased rollers and the present invention also is applicable to them.

The transferred toner image is permanently fixed to member **17** at the fixing station F. Station F includes, by way of example, electrical heating elements **21** that heat soften the toner particles to bond them to the transfer member.

The cleaning station G includes a cleaning corotron **22** and the rotating brush **23** positioned within vacuum housing **24.** Corotron **22** is coupled to an alternating potential source to neutralize any non-transfered toner, that is, charge the remaining toner to a rear ground potential when the drum is grounded. The brush sweeps up the remaining particles while the vacuum drawn on the housing **24** pulls the toner into a filter located in box **25.**

The cleaning station also includes a lamp **26** for flooding the free surface of the drum with light. Thereafter, the drum once again passes station A and the next cycle begins.

The development station C also includes a background electrode **30** positioned inside housing **12** spaced about a half inch from the drum at their closest points. Electrode **30** is electrically biased but because it is relatively greatly spaced from the latent image on the drum and because the bias is properly selected, it does not act like a development electrode as taught in Carlson U.S. Pat. No. 3,147,147. Electrode **30** is biased so as to suppress toner powder clouds which means that fewer toner particles adhere to the drum in the background areas in the first instance. (See for example Robinson U.S. Pat. No. 3,412,710 and Aser et al., U.S. Pat. No. 3,424,131 the disclosures of which are incorporated herein by reference). The electrode **30** includes a conductive surface facing the drum which is coupled to the high electrical potential. The electrode also includes insulating means to electrically insulate the conductive surface from the housing **12.** The electrode **30** may include an epoxy glass board **31** coated with copper **32** and mounted in cantilever fashion inside housing **12** (See FIG. **2**).

Turning now to the subject matter of station D, reference is made to FIGS. **3 – 5** which include a transverse section of a xerographic plate **34,** e.g., a transverse section of the drum of FIG. **1.** The plate includes the photoconductive layer **35** carried by the conductive backing electrode **36.** Electrode **36** is shown coupled to a ground potential **37** which is a convenient and safe reference potential level for a machine.

In FIG. **3,** the triple layer of plus signs **38** represent the high potential, i.e., charge density, of the latent electrostatic image areas on plate **34.** The plus signs **39** represent the lower potential in the exposed or background areas of the plate. The circles **40** represent negatively charged toner particles tacked to the plate because of fields associated with the latent image while circles **41** represent background toner. All toner is assumed negatively charged by appropriate means, e.g., carrier beads, before or during the development of the latent image. A few positively charged particles, represented by circle **42,** may also inadvertantly be present. (At this point it is noted that the polarities shown, described and intimated are for illustration purposes and the present description applies equally to systems using different polarity schemes). As taught by the Malinaric patent supra, the polarity of the negatively charged background particles **41** can be changed without disturbing the polarity of the image particles **40.** (The description of the Malinaric patent is incorporated herein by reference.) Briefly, the background toner can be affected by passing the corona wire **45** over the latent image. The D.C. potential **46** coupled to wire **45** is selected to generate a low corona current. For example, the pre-transfer corotron (e.g., wire **45**) current may be about 0.3 microamps per inch (along the length of the wire) whereas the charging current generated by corotron **2** supra may be about 2.3 micramps per inch. The lines **47** represent the path of corona current and/or the direction of the electric field. The bias **46** is selected to prevent corona current flow between the wire and the high potential image areas represented by charge **38** and to obtain the low corona current flow between the wire and the background areas.

The corona current, for the example given, is of positive charge so that the charge associated with the background toner **41** is changed from negative to positive. This positive charge on the corona wire **45** current is actually detoured from the image toner **40** because of the lateral field components associated with the edges **48** of the latent image.

The above description applies to the pre-transfer corotron **15** of FIG. **1.** Similarly, the following description of FIG. **4** applies to the pre-transfer lamp **16** of FIG. **1.** Lamp **50** is an illuminator extending transverse the xerographic plate **34.** It radiates electromagnetic radiation to which the photoconductor **35** is responsive which is herein simply referred to as light. The wavy lines **51** represent light emitted by lamp **50** which is substantially uniform over the entire pate **34.** The light incident upon background areas acts to lower even further the background potential of the plate. Likewise, the light incident upon toner **40** substantially lowers the potential of the latent image or charge **38.** The potential on the plate under toner **40** may be slightly greater than that in background areas but the contrast in potential between the two areas is drastically reduced. In fact, the exposure to light so lowers the potential in image areas that wire **45** can not be biased to selectively deposite charge in the background areas.

The exposure of image areas to light is effective to dissipate charge **38** because of several reasons. For one, the toner is not tightly packed on plate **34** after development and light passes between toner particles to the photoconductor **35.** Also, the toner particles are often transparent plastic material rendered opaque or visible because of an impregnated or attached colorant and the colorant does not absorb all the light incident upon the toner.

FIG. **5** is convenient to illustrate the transfer process. The transfer member **54** has its non-image side charged to a high potential, e.g., +2,000, by means such as corotron **18** in FIG. **1.** Plus signs **55** represent the deposited charge. The field established between member **54** and the free surface of plate **30** pulls the negatively charged image particles **40** toward member **54.** Conversely, the positively charged background particles **41** are repelled toward the plate. It is apparent from this description, that the transfer field strength is greater in image ares than it would be had not the lamp **50** dissipated the latent image charge **38.** Accordingly, the transfer operation is greatly assisted without raising the potential level (i.e., charge density) of charge **55** deposited on the transfer member.

Cleaning of plate **34** is also enhanced by the pre-transfer corotron and lamp. For example, a particle **42** (FIG. 3) tightly tacked to plate **34** by the field at the edges of the latent image may now be conveniently removed because the laterial field associated with the edge **48** is no longer present. Similarly, other background and non-transferred toner particles are no longer as forcibly tacked to the plate. In addition, the cleaning corotron **22** in FIG. **1** is able to more efficiently neutralize the toner particles remaining in both image and background areas. The reason for the improved cleaning corotron operation, whether an A.C. or D.C. biased corotron, is the fact that the neutralizing current of the cleaning corotron is no longer deviated from toner particles when the edges **48** or potential discontinuities are eliminated.

The details of shielding the pre-transfer corotron and lamp from one another is best reviewed in light of FIG. **2.** Remember, the pre-transfer corona charging must be before and not simultaneous with the pre-transfer exposing to light.

Baffles **57, 58** and **59** are coupled near the bottom of the developing housing **12.** Each of these baffles is closely spaced to drum **1.** Baffle **57** is the main developer pick-off baffle and diverts the bulk of the developer cascaded over the drum back into the sump **60** near the bottom of the housing. In fact, baffle **57** and the lower end of the background electrode **30** define a chute for guiding developer into the sump. Baffle **58** is primarily a seal between the housing **12** and drum **1.** Baffle **58** deflects most of the developer getting by baffle **57** down into the sump **60.** Baffle **59** is an additional baffle positioned to protect the pre-transfer corotron **15** from developer that may escape the first two baffles. Baffle **59** deflects the developer into catch pan **61** which is suitably mounted on the frame of the machine.

Corotron **15** is mounted in the catch pan. It includes the shield plate **62** and the corona wire **62***a* (only the end of the wire is shown) which extends within the shield plate across the width of the drum. Plate **62** is mechanically and electrically coupled to the catch pan both of which are conductive and coupled to a bias such as ground. The lip **63** on the pan along with the end **64** of the shield plate insure that the corona current flows to the drum only in the area between them as indicated by the bracket **65.**

Beneath the catch pan is positioned the light baffle **67** which is an opaque member that keeps the radiation emitted by lamp **16** from the drum vicinity defined by bracket **65.** Lamp **16** is a florescent lamp that floods the drum **1** with light over the area indicated by bracket **68.** The radiation emitted by lamp **16** includes that which the photoconductive material on drum **1** is sensitive. The lamp is supported to the frame of the machine by suitable means including the end braces **69.** The shield **70** is an opaque member or reflector that limits the emission of light in the direct of drum vicinity **68.** The lamp is positioned sufficiently back from the lip **71** such that baffle **68** and shield **70** prevent light from affecting the drum in areas defined by bracket **65.** In addition, the separation **72** between brackets **65** and **68,** i.e. between corotron pan lip **63** and light baffle lip **71,** is deliberately provided to allow for diffraction of light at lip **71.** In other words, space **72** is provided to insure that light diffraction by the lip **71** will not reach the vicinity of bracket **65.**

The transfer member **17,** e.g., paper, is fed by appropriate means including guides **73** and **74** to the registration rollers **76** and **77.** Rollers **76** and **77** are rotated at the exact time necessary to advance a sheet **17** into contact with the drum in registration with the developed toner image. The toner is transferred to the sheet **17** as the sheet passes under the corotron **18.** Any non-transferred toner from background and/or image areas is removed from the drum at the cleaning station G (FIG. **1**). The transfer toner is fixed to the sheet **17** at the fusing station F.

Several modifications to the foregoing described embodiments may be made without departing from the scope of the present invention. Accordingly, any such modifications are intended to be encompassed by the present invention.

What is claimed is:

1. In an electrostatic reproduction machine having a moving photoconductive surface adapted to be uniformly charged and to carry an electrostatic latent image thereon; a developing means positioned at a development zone to apply toner particles to the latent image and thereby develop the moving electrostatic image on said surface; and a transfer means to transfer the developed image to a receiving member; the improvement comprising:

a. a corona discharge device positioned between said developing and transfer means for applying corona emissions on said photoconductive surface; and
b. an illuminating device positioned between said corona discharge device and said transfer means for exposing said photoconductive surface, said illuminating device having an intensity sufficient to discharge the photoconductive surface beneath the developed image;
c. said corona discharge device and said illuminating device being so constructed and arranged that the exposure of a portion of said photoconductive surface to said corona discharge device will be completed prior to exposure thereof to said illuminating device.

2. The apparatus of claim **1** wherein said corona discharge device is a D. C. corona discharge device.

3. The apparatus of claim **1** wherein a baffle is interposed betweeen said corotron discharge device and said illuminating device to shield said portion of said photocontive surface being exposed to said corona discharge device from said illuminating device.

4. The apparatus of claim **1** wherein said corona discharge device includes a corotron having a shield for limiting corona current to the photoconductive surface within a region defined by the shield.

5. The apparatus of claim **1** wherein said illuminating device comprises a lamp extending transverse the photoconductive surface having a shield for limiting light exposure of the photoconductive surface within a region defined by the shield.

6. In an electrostatic reproduction process wherein an electrostatic latent image on a moving photoconductive surface is developed by toner particles in a developing zone, and the developed image is transferred to a receiving member, the improvement comprising the following steps performed after development of the image and prior to the transfer thereof to a receiving member:

a. exposing a portion of said photoconductive surface including the developed image to corona emissions thereby decreasing the range of charged differentials between the image and non-image areas on said photoconductive surface; and
b. after exposure of said portion of said photoconductive surface to corona emission is completed, illuminating said photoconductive surface including the developed image with an intensity sufficient to discharge said photoconductive surface beneath said developed image.

7. The method as recited in claim **6** wherein the level of corona emissions is so controlled that a charge is deposited onto background areas of the photoconductive surface only and the polarity of the charge associated with toner particles in the background areas is changed.

* * * * *