

[54] IMAGING SYSTEM

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Related U.S. Application Data

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[58] Field of Search 355/3, 17; 96/1 R, 1.4, 1.5, 96/1 A

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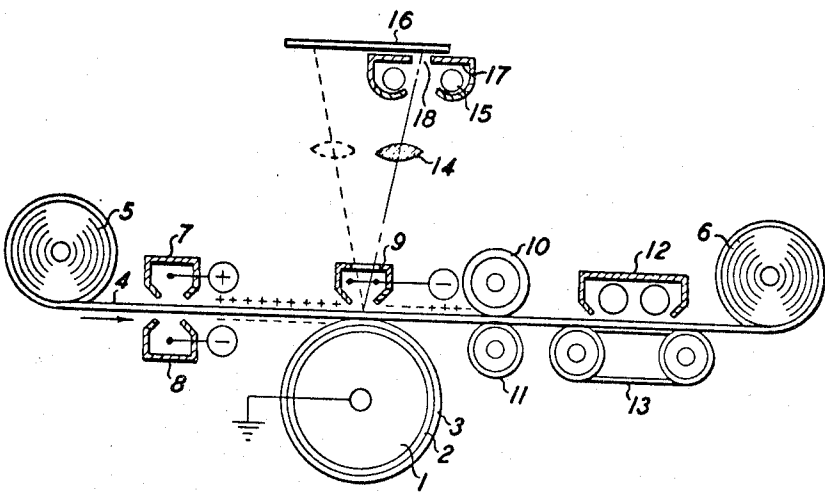
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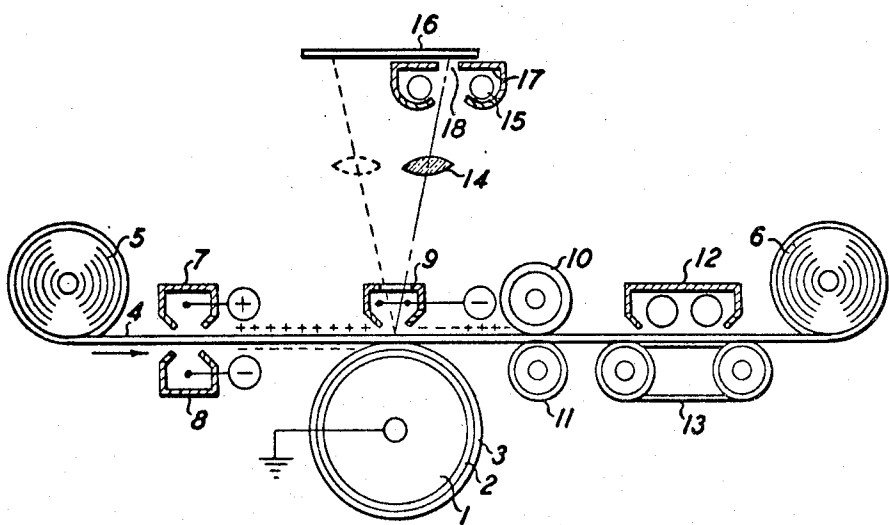
Primary Examiner—Robert P. Greiner

[57] ABSTRACT

An electrically insulating web is charged on a first side with an electrostatic charge of one polarity and charged on a second side with an electrostatic charge of a second polarity. The first side of the web is brought into contact with a photoconductive layer and the layer is then exposed to a light pattern. The second side of the web is subjected to ions having a polarity of charge opposite to the polarity of charge on the second side. The resulting electrostatic latent image formed on the second side of the web may be developed with electroscopic toner particles.

11 Claims, 1 Drawing Figure





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IMAGING SYSTEM

This application is a divisional application of co-pending application Ser. No. 121,052, now U.S. Pat. No. 3,719,481 filed March 4, 1971.

BACKGROUND OF THE INVENTION

This invention relates to imaging systems, and more particularly, to an improved electrophotographic imaging process and an apparatus for carrying out said process.

The formation and development of images on the surface of photoconductive materials by electrostatic means is well known. The basic electrophotographic process, as taught by C.F. Carlson in U.S. Pat. No. 2,297,691, involves placing a uniform electrostatic charge on a photoconductive insulating layer, exposing the layer to a light-and-shadow image to dissipate the charge on the areas of the layers exposed to the light and developing the resulting electrostatic latent image by depositing on the image a finely-divided electroscopic material referred to in the art as "toner." The toner will normally be attracted to those areas of the layer which retain a charge thereby forming a toner image corresponding to the electrostatic latent image. This powder image may then be transferred to a support surface such as paper. The transferred image may substantially be permanently affixed to the support surface as by heat. Instead of latent image formation by uniformly charging the photoconductive layer and then exposing the layer to a light-and-shadow image, one may form the latent image by directly charging the layer in image configuration. The powder image may be fixed to the photoconductive layer if the powder image transfer step is not desired. Other suitable fixing means such as solvent or overcoating treatment may be substituted for the foregoing heat fixing step.

Numerous methods are known for applying the electroscopic particles to the electrostatic latent image to be developed. Well known development techniques include brush development, magnetic brush development, powder cloud development and touchdown development.

Generally, in carrying out the above described processes, the photoconductive insulating layer must be able to retain the electrostatic charge in the dark at least until the electrostatic latent image is developed or transferred to a receiving sheet. The photoconductive insulating layer therefore must be electrically insulating in the dark. The photoconductive insulating layer must also exhibit good electrical conductivity upon exposure to light. Thus, in conventional electrophotographic imaging systems, the photoconductive insulating layer must have what may be considered to be mutually inconsistent properties, i.e., highly insulating in the dark and highly electrically conductive when exposed to illumination. In view of the foregoing, extensive studies have been made of photoconductive materials with emphasis being placed on how to increase the light sensitivity of the photoconductive materials while maintaining its insulating properties in the dark within a practical range. Usually, when efforts are made to increase the light sensitivity of highly panchromatic photoconductive layers, an increase in thermally generated free carrier density occurs thereby contributing to a resulting decrease in dark resistivity of the photoconductive layer. The increase of the mean life-

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time and the drift mobility of the free carrier generated by irradiation for increasing the sensitivity of the photoconductive layer also causes a reduction in the dark resistivity. More specifically, the increase in the mean lifetime and drift mobility of the free carrier is caused by thermal generation or injection from an electrode or surface in the dark. As described above, the increase in light sensitivity of the photoconductive layer results in a reduction of the dark insulating resistivity and a reduction of the ability of the photoconductive layer to store electrostatic charges in the dark. Thus, if it were possible to reduce the high dark insulating resistivity requirement of photoconductive layers, a remarkable number of heretofore unusable highly photoconductive materials will then become available for electrostatic imaging.

At the present time, there are numerous electrophotographic imaging processes known to the art. Generally, the image formed from electroscopic toner particles is fixed directly to the electrophotographic insulating layer, or is transferred from the photoconductive insulating layer to a receiving sheet upon which the transferred toner image is subsequently fixed, or, where the electrostatic latent image on the photoconductive insulating layer is transferred to an imaging sheet, the toner image is formed on and fixed to the imaging sheet. Unfortunately, there are a number of disadvantages attributable to these methods. For example, it is very uneconomical to fix the ultimate toner image directly on the photoconductive insulating layer because the photoconductive insulating layer cannot thereafter be reused. When toner images are formed on a photoconductive insulating layer and thereafter transferred to a receiving sheet, the residual toner particles remaining on the photoconductive insulating layer must be removed before the photoconductive insulating layer can be reused. Further, the cleaning process erodes and degrades the imaging surface of the photoconductive insulating layer. In all of the techniques discussed above, the requirement that the photoconductive layer be highly insulating in the dark significantly limits the number of photoconductive materials which can be employed for imaging, particularly photoconductive materials which exhibit high sensitivity to illumination. Thus, there is a continuing need for improved electrophotographic imaging systems.

SUMMARY OF THE INVENTION

It is therefore, an object of this invention to provide an imaging system overcoming the above noted deficiencies.

It is another object of this invention to provide an imaging system capable of utilizing a greater number of photoconductive materials.

It is a further object of this invention to provide an imaging system which eliminates the need for photoreceptor cleaning.

It is still another object of this invention to provide an imaging system capable of providing an electrostatic latent image which is stable even upon exposure to light.

It is another object of this invention to provide an imaging system superior to those of other known systems.

The above objects and others are accomplished, generally speaking by forming an electrostatic latent image on an electrically insulating web by electrostatic

cally charging a first side of the web with an electrostatic charge of one polarity and the second side of the web with an electrostatic charge of the opposite polarity, contacting the surface of a photoconductive layer with the first side of the web, and simultaneously exposing the photoconductive layer to a light-and-shadow image and applying ions to the second side of the electrically insulating web opposite the portion of the first side of the web in contact with the photoconductive layer, the ions being of a polarity opposite to that of the electrostatic charge carried on the second side of the web. The electrostatic charges deposited upon the opposite sides of the electrically insulating web may be achieved by conventional double corona charging. The ions deposited simultaneously with exposure to a light-and-shadow image may be generated by a conventional corona discharge device. The electrostatic latent image formed by the process of this invention may be developed by application of finely divided electroscopic toner particles or the electrostatic latent image may be transferred to another member and subsequently developed with finely divided electroscopic toner particles.

BRIEF DESCRIPTION OF THE DRAWING

The advantages of the improved electrophotographic imaging system of this invention will become further apparent upon consideration of the following disclosure of the invention particularly when taken in conjunction with the accompanying drawing which illustrates a sectional side view of a device of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

For a better understanding of the imaging system of this invention, the apparatus illustrated in the drawing will be briefly described below.

A support cylinder 1 having an electrically conductive layer 2 and a photoconductive layer 3 around the periphery thereof is rotated by suitable means, not shown, in a clockwise direction. Conductive layer 2 is grounded through support cylinder 1. An electrically insulating web 4 is supplied from a supply roll 5. This insulating web 4 is transported in the direction shown by the arrow and it is taken up by take-up roll 6. Insulating web 4 is transported at a speed which is synchronized with the peripheral speed of the outer surface of photoconductive layer 3. More specifically, the relative speed between insulating web 4 and the outer surface of photoconductive layer 3 is substantially zero along the line of contact. The insulating web 4 supplied from supply roll 5 is charged with double corona discharge electrodes 7 and 8. The polarity of the electrostatic charge deposited on one side of insulating web 4 is opposite to polarity of the electrostatic charge deposited on the other side. Since the double corona charging technique is well known in the arts, further details of the charging process are deemed unnecessary. As illustrated in the drawing, the upper surface of insulating web 4 is charged with a positive charge by corona discharge electrode 7 and the lower surface of insulating web four is negatively charged with corona discharge electrode 8. The charged lower surface of insulating web 4 is then brought into contact with the outer surface of photoconductive layer 3. The area of the upper surface of insulating web 4 opposite to the area of insu-

lating web 4 in contact with photoconductive layer 3 is simultaneously subjected to negative polarity ions generated by corona discharge electrode 9 and irradiation in image configuration projected through corona discharge electrode 9. The light pattern projected through the transparent electrically insulating web 4 onto photoconductive layer 3 is synchronized by means of a slit scanning system to avoid relative movement between the projected pattern and the moving surface of photoconductive layer 3. The resulting electrostatic latent image formed on the upper surface of insulating web 4 is then transported to a developing unit.

The developing unit comprises a developing brush 10 and a backing roller 11. After the developing unit deposits finely divided toner particles in conformance with the electrostatic latent image on the upper surface of insulating web 4, insulating web 4 is transported to infrared fuser 12 which fixes the toner image to insulating web 4. Movement of insulating web 4 is effected by means of a web feeding device 13. Insulating web 4 with the toner image fixed thereon is then taken up by take-up roll 6.

As discussed above, the photoconductive layer may comprise a coating on a conductive support surface. If the photoconductive insulating material in the photoconductive insulating layer exhibits sufficient mechanical strength, a support member is unnecessary. Where the photoconductive layer is self supporting, the side of the photoconductive layer opposite the side facing the ion source should be in contact with an electrically conductive member which functions as an electrode or should be subjected to ions which function as an electrode. These latter ions may be generated by any suitable source such as a corona discharge electrode. If the source of the light pattern is positioned on a side of the photoconductive layer opposite to the side illustrated in the drawing, the conductive substrate, if any, is preferably transparent.

Any suitable electrically conductive substrate material may be employed. Typical electrically conductive materials include metals such as aluminum, brass, nickel, stainless steel or electrically conductive plastic. The substrate may be of any suitable shape. Typical shapes include cylindrical, plate and belt configurations. The entire substrate need not be highly electrically conductive. For example, an electrically insulating plastic material may be surface treated to render the surface electrically conductive.

Any suitable photoconductive material may be employed in the photoconductive layer. Preferably, the photoconductive material should exhibit high photoconductivity and high dark resistivity for optimum image quality. However, satisfactory results may be achieved with photoconductive insulating materials having a lower dark resistivity. Obviously, as the time required to simultaneously charge and expose to light is reduced, the resistivity requirements of the photoconductive layer can also be reduced. Thus, for example, if the time requirement of the simultaneous charging and light pattern exposure step is about 0.01 second, a photoconductive insulating layer having a resistivity at least about 10^5 ohm cms. may be employed. This is clearly indicative of the fact that photoconductors which normally cannot be employed in conventional electrophotographic imaging process may be employed in the imaging process of this invention. If the time duration required for the simultaneous charg-

ing and exposing step is less than about 0.01 seconds, many materials having a resistivity less than about 10^5 ohm cms. may be employed. Typical materials which may be employed include: elements such as Si, Ge, Sn, P, As, Sb, S, Se, and Te; the oxide, chalcogenide or halide of Cu, Ag, Sr, Ba, Zn, Ge, Cd, Si, Hg, Al, In, Ga, Tl, Sn, Mn, Fe, Ni, Pb, Ti, As, Sb, and Bi; compounds comprising these elemental metals and anionic elements such as, for example, $Cd_x \cdot Zn_{1-x}S$, $CdS_y \cdot Se_{1-y}$, $Cd_x \cdot Zn_{1-x} \cdot S_y \cdot Se_{1-y}$; the intermetallic compounds of these elemental metals such as, for example, $CuAlS_2$, $AgInS_2$, $ZnSiAs_2$, $ZnGeP_2$, $CdGeP_2$, $InSbI$; and alloys comprising the elements selected from the group of As, Sb, Pb, S, Se, Te, Tl, Br and I, the alloys being crystalline or vitreous; and the numerous well known organic photoconductors. These materials may be employed alone or admixed with each other. If the photoconductive material does not form a film, the material may be dispersed in a suitable film forming binder. Any suitable film forming binder material may be employed. Film forming binder material for photoconductive layers are well known in the art and include organic polymers, inorganic polymers and mixtures of organic and inorganic polymers. The film forming binder material may be nonphotoconductive or photoconductive. Typical examples of photoconductive layers include a glassy layer of As-Sb-Se formed on a metallic substrate by vacuum deposition or hot melt coating. Another example of a photoconductive layer is highly photoconductive hexagonal cadmium sulfide powder particles calcinated with cadmium chloride flux to form a sintered photoconductive layer on a metallic plate. The photoconductive layer may also be formed from highly sensitive dye-sensitized cadmium sulfide particles dispersed in a synthetic organic polymer binder and coated onto a metallic plate. The organic binder employed in the latter example may have photoconductive properties. Obviously, one may select photoconductive materials for the photoconductive layer having a spectral sensitivity in the range desired for the particular use intended. Generally, a panchromatic spectral sensitivity is preferred for applications in which a light source having a visible wave length spectrum is employed. As well known in the art, sensitizing agents or sensitizing dyes may be incorporated into the photoconductive layer to render the photoconductive layer more panchromatic. It is apparent that one should employ a suitably sensitized photoreceptor for the particular electromagnetic radiation source contemplated, whether it is visible light, ultraviolet radiation, x-ray radiation, infrared radiation, or the like.

Any suitable electrically insulating web may be utilized in the imaging system of this invention. The expression "web" as employed herein is intended to include sheets as well as belts and webs of any desired length. The web is preferably insulating in the dark because an electrostatic latent image is formed on the web in the dark. If desired, the web may be selected from a material which is insulating in the light also. If the electrostatic latent image on the web is to be developed very rapidly after the latent image is formed, the web need not be highly insulating. Electrostatic latent images formed on the web may be transferred to another insulating web if desired. If the electrostatic latent image on the web is developed with toner particles, the resulting toner image may be fixed to the web or transferred to a receiving surface and subsequently

fixed thereon. If the toner image is fixed directly on the web, the web normally is employed as the final vehicle for the image. Where the web forms a part of the final copy, selection of the physical appearance of the ultimate copy will be determined by the intended use. Thus, for most applications, the web is preferably white, glossy and opaque. As discussed above, the web should be electrically insulating. Since the web is a significant factor in the latent image formation process, it is preferable that the thickness of the web be substantially uniform. For optimum image quality, the thickness of the web is preferably selected to provide substantially the same capacitance as that of the photosensitive layer. Satisfactory results are achieved with web thicknesses of between about 10 microns and about 100 microns. Generally, sufficient contrast potential to develop the electrostatic latent image is difficult to achieve when the web thickness is less than about 10 microns. Resolution of the ultimate image approaches an impractical level when the thickness of the web is greater than about 100 microns. Obviously, when the light pattern is to be projected through the web onto the photosensitive layer, the web should be transparent to at least the wavelength of the electromagnetic radiation employed. As discussed above, opaque insulating webs may be utilized where the light pattern is projected through the conductive substrate to the photoconductive layer. Typical examples of suitable webs include well dried paper, coated paper, plastic films, and synthetic paper.

As described above, the electrically insulating web is charged on both surfaces with charges of opposite polarities. The charging may be effected, for example, by the well known double corona discharge technique. The charging polarity may be determined by the value of $\mu \cdot \tau$ of the free charge carrier in the photoconductor employed, the symbol μ representing drift mobility and the symbol τ representing the mean life time. If the value of $\mu \cdot \tau$ for the free electron is greater than that of the free hole, the surface of the web not in contact with the photoconductive layer is charged with a positive charge and if the value of $\mu \cdot \tau$ for the free electron is greater than that of the free hole, the surface of the insulating web not in contact with the photoconductive layer is charged with a negative charge. This criteria for determining charging polarity applies only when the light pattern is projected through the insulating web to the photoconductive layer. Where the light pattern is projected through a conductive substrate to the photoconductive layer, the converse of the procedure described above for determining charging polarity is employed. In other words, if the value of $\mu \cdot \tau$ the free electron is greater than that of the free hole, the surface of the insulating web not in contact with the photoconductive layer is charged negatively. If the value of $\mu \cdot \tau$ of the insulating web not in contact with the electrically conductive substrate is charged with a positive polarity. The foregoing technique for determining polarity of charge should be considered a general guide and may not be applicable in every situation. Similarly, the charge density provided on the surface of the insulating web not in contact with the conductive substrate is preferably substantially the same as the charge density on the other surfaces of the insulating web, but this requirement is not absolute.

After the insulating web is double corona charged, it is brought into contact with the photoconductive layer

and simultaneously exposed to the image pattern to be reproduced and subjected to a fluid mass of ions. The exposure to the image pattern or the treatment with ions may precede the other. Also, either the image pattern exposure step or the ion treatment step may extend for longer periods than the other.

The mass of fluidizing charges is applied to one surface of the insulating web while the other surface of the insulating web is in contact with the photosensitive layer. As described above the photoconductive layer is in intimate contact with a grounded electrically conductive support member. Obviously, where the photoconductive layer is self supporting, the electrically conductive support member may be replaced by an electrical equivalent such as a corona device for applying ions of the appropriate polarity to the insulating web. Thus, in either of the two foregoing alternative techniques, the equivalent of an electric circuit, from the surface of the insulating web not in contact with the photoconductive layer around to the side of the photoconductive layer not in contact with the insulating web is achieved. Examples of systems for applying a mass of fluidizing charges include electron current, an ion stream or cloud in a gas, a stream or cloud of charged particles in a gas, an ion stream or cloud in a liquid, a stream or cloud of charged particles in a liquid and the like. The ion stream or cloud of gas may be provided, for example, by AC or DC corona discharge.

A light pattern of the image to be reproduced is projected onto the photoconductive layer by conventional electrophotographic imaging techniques. For example, as illustrated in the drawing, a light image is projected through projector lens 14 from a light source 15 reflected from an original 16. The beam of light pattern reflected from original 16 is restricted by slit 17. As shown in the drawing, an ion cloud is simultaneously generated by corona discharge applied to the area of the photoconductive layer 3 upon which the light image is projected. The original 16 in the embodiment illustrated in the drawing remains stationary while projection lens 14, slit 17 and light source 15 move in synchronism with the movement of the photoconductive layer.

The insulating web 4 is thereafter stripped from the photoconductive layer 3 and developed. If desired, the photoconductive layer 3 may be uniformly illuminated prior to removal of insulating web 4.

The following examples further define, describe and compare preferred methods and materials of the present invention. Parts and percentages are by weight unless otherwise indicated.

EXAMPLE I

A photoconductive member is prepared by vacuum depositing a vitreous layer of arsenic triselenide having a thickness of about 70 millimicrons on the clean surface of an aluminum cylinder. The resulting vitreous layer of arsenic triselenide is photoconductive and exhibits a photosensitivity to the visible light range when employed in a conventional xerographic process.

EXAMPLE II

A photoconductive member is prepared by polishing and cleaning the surface of the aluminum tube and thereafter depositing thereon a glassy layer of an alloy comprising about 15 per cent tellurium and about 85

per cent selenium having a thickness of about 80 microns. The resulting selenium-tellurium layer is photosensitive to visible light, but exhibits a dark resistivity which is too low to retain a satisfactory electrostatic charge in the dark when employed in a conventional electrophotographic process. The layer does, however, have a panchromatic response. The value for the free hole in this layer is slightly greater than that for the free electron.

EXAMPLE III

A photosensitive member is prepared by cleaning the surface of an electrically conductive NESA glass plate with a vitreous layer of an alloy of about 25 parts by weight arsenic, about 10 parts by weight of antimony and about 49 parts by weight of selenium. The thickness of the photosensitive layer is about 40 microns. The vitreous layer is photosensitive to visible light, but exhibits a dark resistivity which is too low to retain sufficient charge for use in conventional electrophotographic processes. The value for the free hole is slightly greater than that for the free electron.

EXAMPLE IV

A light sensitive member is prepared by dispersing specially treated photoconductive particles into an electrically insulating resinous binder material and thereafter coating the mixture onto a glass cylinder. The photoconductive particles are prepared by adding about 18 parts by weight of finely divided particles comprising about 1.5 parts by weight of cadmium carbonate core material encapsulated in about one part by weight of cadmium sulfide shell material, calcining the resulting mixture for about 20 hours at about 200° C to about 250° C. and then drying the calcined mixture with about 0.1 part by weight of malachite green, a sensitizing dye. The insulating resin binder employed comprises about 50 parts by weight of a thermosetting acrylic resin lacquer and an organic solvent. The glass cylinder is coated with a thin conductive tin oxide layer. The dispersion of the photoconductive particles in the acrylic resin lacquer is applied to the glass cylinder, dried and heated at about 150° C for about 30 minutes to form a photoconductive layer having a thickness of about 50 microns. The photosensitive layer is photoconductive when exposed to visible light. The value $\mu \cdot \tau$ for the free electron is slightly greater than that for the free hole. The photosensitive layer may be exposed by a light pattern projected through the glass substrate.

EXAMPLE V

A photosensitive member is prepared by dispersing about 100 parts by weight of the photoconductive particles, prepared as described in Example IV, into about 30 parts by weight of a thermoplastic acrylic resin lacquer containing an organic solvent which permits drying of the photoconductive mixture at room temperature. The resulting mixture is coated onto a conductive substrate and dried. The thickness of the photoconductive layer is about 40 microns. The substrate employed comprises a polyethylene terephthalate sheet having a surface treated with copper iodide to render the surface conductive. The resulting light sensitive member may be illuminated by a light pattern projected through the substrate because the substrate is transparent. The photosensitive layer is photoconductive when

exposed to visible light and the value for the free hole is slightly less than for the free electron. The photosensitive member is flexible and may be employed as a belt or a flexible sheet.

EXAMPLE VI

An imaging process is conducted with a machine having a configuration similar to that illustrated in the drawing. However, the machine is modified by adding a drying unit for paper sheets positioned so that the paper sheets are transported through the drying unit prior to encountering the corona discharge electrodes 7 and 8. The electrically insulating web employed is a transparent cellulose triacetate film having a thickness of about 45 microns. A DC voltage of about minus 5 kilovolts is applied to the corona discharge electrode positioned above the insulating web and a DC voltage of plus 6 kilovolts is applied to the corona discharge electrode positioned below the insulating web thereby depositing a negative charge on the upper surface of the insulating web and a positive charge on the lower surface of the insulating web. The potential of the upper surface of the insulating web, when the lower surface is contacted with a conductive body and grounded, is about minus 1,000 volts and the potential of the lower surface of the insulating web, when the upper surface is contacted with the conductive body and grounded, is about plus 500 volts. A photoconductive member comprising a photoconductive layer of vitreous selenium-tellurium on an aluminum cylinder is employed. The thickness of the photoconductive layer is about 80 microns. Upon contacting the insulating web with the surface of the photoconductive member, positive charges are applied to the negatively charged upper surface of the insulating web by applying a DC voltage of about plus 8 kilovolts to a corotron positioned above the insulating web. Simultaneously, a light pattern of the image to be reproduced is projected through the corotron. The corotron applying the positive voltage to the upper surface to the insulating web is constructed so that light may be transmitted therethrough. A slit scanning projection system is utilized to project the light pattern through the insulating web. The speed of the insulating web and the photoconductive layer are both about 25 centimeters per second. The width of the opening in the corona discharge electrode through which the light pattern is projected is about 15 millimeters. The width of the slit in the slit scanning system is also about 15 millimeters. About 1 second after the simultaneous charging and light pattern exposure step are completed, the insulating web is peeled from the photoconductive layer. The surface potential of the resulting electrostatic latent image on the insulating web is about plus 850 volts in the area exposed to light and about minus 20 volts in the unexposed image areas. These potentials on the surface of the insulating web are measured by contacting the lower surface of the insulating web to a grounded conductive member. The electrostatic latent image is then developed with electroscopic toner particles applied with a conventional magnetic brush applicator. Development is effected while the lower surface of the insulating web is in contact with a grounded roll. The resulting toner image is then fixed to form a permanent image on the transparent insulating web. After the insulating web is peeled from the photoconductive layer, the photoconductive layer is employed

again to form images without the necessity of any preparatory treatment such as cleaning.

EXAMPLE VII

An imaging procedure similar to that described in Example VI is employed to form images on an electrically insulating synthetic paper web. The synthetic paper web is white and comprises opaque high density polyethylene and titanium oxide particles. The upper surface of the web is charged to a potential of about minus 1,100 volts and the lower surface of the web is charged with a potential of plus 1,500 volts as measured by the technique described in the immediately preceding example. The charged insulating web is then brought into contact with a photoconductive layer. The photoconductive layer is prepared by forming a vitreous layer of an alloy containing arsenic, antimony and selenium on a NESA glass plate. A light pattern is projected onto the photosensitive layer through the NESA glass plate. Simultaneously with the exposure step, the upper surface of the insulating web is subjected to positive corona ions applied by a moving corona discharge electrode. The potential applied to the upper surface of the web by the moving corona discharge electrode is about 8.5 kilovolts. The light intensity at the photoconductive layer is about 5 lux. The velocity of the corona discharge electrode is about 20 centimeters per second. About 1 second after the charging and exposure steps are terminated, the insulating web is peeled from the photoconductive layer. Since the web is insulating, the insulating web may be peeled off the photoconductive layer while exposed to light. The resulting electrostatic latent image formed on the insulating web is developed and fixed. After the insulating web is peeled from the photoconductive layer, the photoconductive layer is employed again to form images without the necessity of any preparatory treatment such as cleaning. In modification of this process, an electrostatic latent image formed on the insulating web is transferred to a receiving sheet. In still another modification of this process, the toner particles to be deposited in image configuration on the insulating web is transferred to an ordinary paper sheet.

EXAMPLE VIII

An imaging process is carried out with the apparatus described in Example VI. Ordinary paper is utilized as the insulating web. The drying unit described in Example VI dries the paper web to render the web more electrically insulating prior to charging. The surface potentials of both the upper and lower surfaces of the web are about 500 volts as measured by the technique described above. The upper surface of the web is positively charged and the lower surface of the web is negatively charged. The photoconductive member employed comprises a NESA glass cylinder coated with dye sensitized CdS-CdCO_3 photoconductive particles dispersed in a resinous binder material. The light exposure step is carried out by projecting a light pattern through the NESA glass substrate. The negatively charged corona discharge ions are then applied to the upper surface of the paper web. Upon completion of the simultaneous charging and light exposure steps, the photoconductive layer is uniformly illuminated and the paper web is thereafter peeled from the photoconductive member. The resulting electrostatic latent image is then developed to form a toner image. In a modifica-

tion of this process, the electrostatic latent image is developed while the paper web is in contact with the photoconductive layer.

The processes of this invention, as described above, is capable of forming high contrast electrostatic latent images on electrically insulating webs. Photoconductive materials which in the past, could not be employed in conventional electrophotographic processes can be utilized in the process of this invention. The photosensitive layer may be employed repeatedly to form images without any preparatory treatment prior to formation of the next image.

Although specific materials and conditions are set forth in the foregoing examples, these are merely intended as illustrations of the present invention. Various other suitable electrophotographic layers, insulating webs, ion sources, and electromagnetic radiation such as those listed above may be substituted for those in the Examples with similar results. Other materials may also be added to the photoreceptor, insulating web, and the developer to sensitize, synergize or otherwise improve the imaging properties or other desirable properties of this system.

Other modifications of the present invention will occur to those skilled in the art upon a reading of the present disclosure. These are intended to be included within the scope of this invention.

What is claimed is:

1. An electrostatographic imaging apparatus comprising:
 - a. an recyclable photoconductive imaging layer in operative association with a conductive substrate;
 - b. means for grounding said substrate;
 - c. an electrically insulating web having an imaging surface and a nonimaging surface, said nonimaging surface being in at least partial contact with the photoconductive imaging layer;
 - d. a plurality of processing stations, including (i) a charging station having means for imparting a charge of one polarity to the imaging surface of said web and means for imparting a charge of an opposite polarity to the nonimaging surface of said web and (ii) an exposure station having means for projecting a light pattern on the imaging surface of

said web at a point of contiguity of said web and said photoconductive imaging layer, and means for simultaneously imparting a charge to the exposed area of the imaging surface, the polarity of said charge being opposite to that originally imparted to said imaging surface; and

e. means for effecting relative movement of the electrically insulating web with regard to the photoconductive insulating layer and the processing stations.

2. An electrostatographic imaging apparatus of claim 1, wherein the electrically insulating web comprises a plastic film.

3. The electrostatographic imaging apparatus of claim 1, wherein the electrically insulating web comprises untreated paper.

4. The electrostatographic imaging apparatus of claim 1, wherein the electrically insulated web comprises coated paper.

5. The electrostatographic imaging apparatus of claim 1, wherein the photoconductive imaging layer is cylindrical.

6. The electrostatographic imaging apparatus of claim 1, wherein the photoconductive imaging layer is in the form of a plate.

7. The electrostatographic imaging apparatus of claim 1, wherein the photoconductive imaging layer comprises vitreous selenium-tellurium alloy.

8. The electrostatographic imaging apparatus of claim 1, wherein the photoconductive imaging layer comprises vitreous arsenic triselenide.

9. The electrostatographic imaging apparatus of claim 1, wherein the photoconductive imaging layer comprises cadmium sulfide.

10. The electrostatographic imaging apparatus of claim 1, wherein the photoconductive imaging layer comprises a selenium-arsenic-antimony alloy.

11. The electrostatographic imaging apparatus of claim 1, wherein the plurality of processing stations includes (iii) a means for selectively depositing electroscopic toner particles on the imaging surface of the web subsequent to formation of a latent electrostatic image thereon.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3794418

Dated February 26, 1974

Inventor(s) Katsuo Makino, Akira Yoshikawa, Toshio Nagashima

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

1. Column 5, line 9--"Se₁₋₆" should be --Se_{1-y}--.
2. Column 11, line 15--The word "presnet" should be --present--.

Signed and sealed this 3rd day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3794418

Dated February 26, 1974

Inventor(s) Katsuo Makino, Akira Yoshikawa, Toshio Nagashima

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

1. Column 5, line 9--"Se₁₋₆" should be --Se_{1-y}--.
2. Column 11, line 15--The word "presnet" should be --present--.

Signed and sealed this 3rd day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents