United States Patent

Thourson et al.

[15] **3,653,891**

[45] **Apr. 4, 1972**

[54] FORMS OVERLAY TECHNIQUE USING TESI

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[73] Assignee: **Xerox Corporation**, Rochester, N.Y.

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[52] **U.S. Cl.** **96/1**, 96/1.3, 117/17.5, 355/3

[51] **Int. Cl.** **G03g 13/22**

[58] **Field of Search** 96/1, 1.4, 1.3; 117/17.5

[56] **References Cited**

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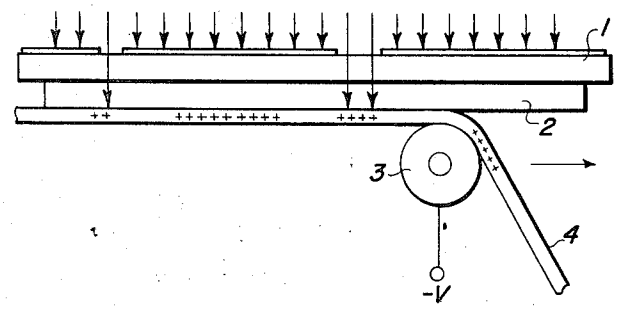
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[57] **ABSTRACT**

A method of forming composite electrostatic latent images in one mode from both positive and negative optical information is disclosed. The techniques employed to form positive electrostatic images from optically positive information and optically negative information involve the use of principles relating to breakdown of air in a gap under the influence of a field. By properly controlling the polarity of the applied field any optical input may be used to deposit a positive electrostatic latent image on a suitable receiver to provide a composite image. This method of forming a composite image from optically positive and negative information may be used in a forms overlay fashion where it is desired to have ready access to certain forms for printout with information complimentary thereto or in any other electrophotographic image application where it is desired to employ one developer to develop composite images prepared from such information.

6 Claims, 4 Drawing Figures



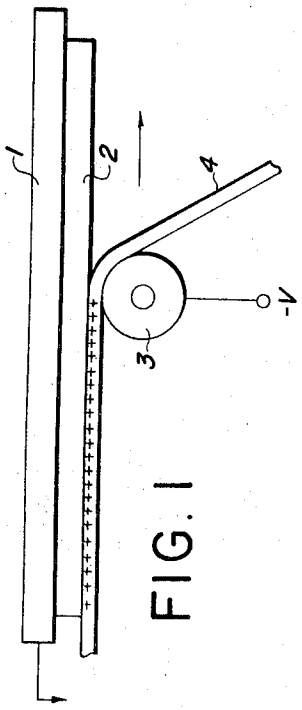


FIG. 1

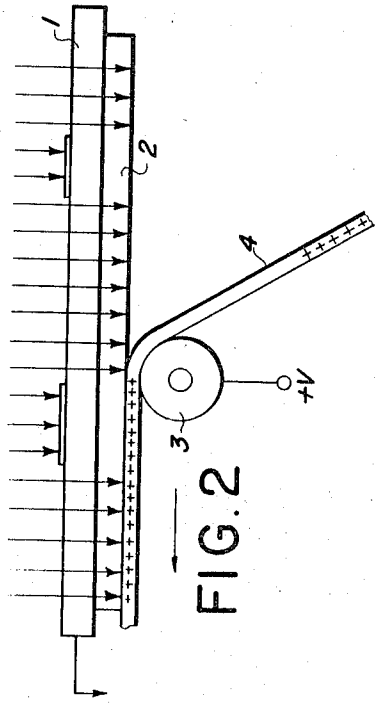


FIG. 2

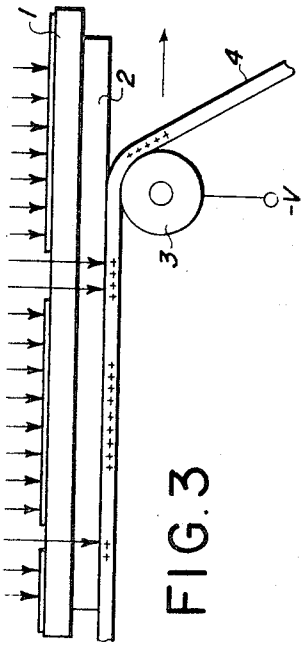


FIG. 3

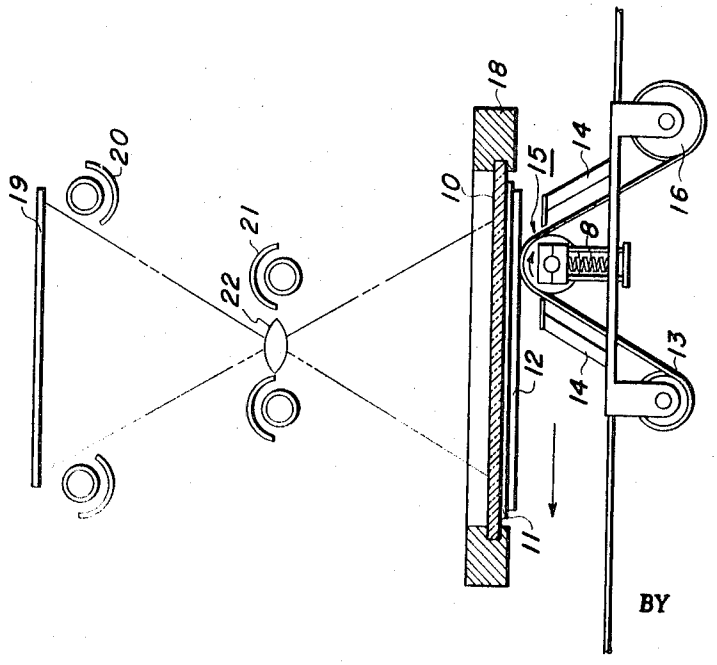


FIG. 4

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FORMS OVERLAY TECHNIQUE USING TESI

BACKGROUND OF THE INVENTION

This invention relates to the formation of electrostatic charge patterns such as xerographic electrostatic latent images and in particular to methods and apparatus for the formation of such charge images. In the basic xerographic process as disclosed in U.S. Pat. No. 2,297,691 there is provided a process and apparatus for electrophotography or xerography wherein an electrostatic charge is applied to the surface of a photoconductive insulating layer, and this charge is selectively dissipated by exposure to a pattern of light and shadow to be recorded. This selective charge dissipation results in an electrostatic latent image corresponding in its charge pattern to the pattern of light and shadow to which the photoconductive insulating layer was exposed. Conventionally, in the art now known as xerography, an electrostatic image may be formed in this manner and may be utilized as desired, for example, by development or deposition of finely divided material in conformity with the charge pattern, optionally, together with the transfer of the developed image to a print receiving surface.

The development process may be effected by employing well-known techniques in the art such as powder cloud development as disclosed in U.S. Pat. Nos. 2,725,305 and 2,918,910, magnetic brush development disclosed in U.S. Pat. Nos. 2,791,949 and 3,015,305, and cascade development as disclosed in U.S. Pat. Nos. 2,618,551 and 2,618,552. When employing one of the more widely used techniques, for example, cascade development, a developer which may consist of a carrier in a toner material is caused to flow or cascade onto a latent electrostatic image to be developed. The carrier and toners generally used possess triboelectric properties, that is the ability of the carrier and toner to assume charges opposite to one another, upon contact with one another or certain other materials, the toner assuming a charge opposite to the charge of the latent electrostatic image so as to be attracted by and affixed to the electrostatic charge pattern.

The carrier particles may comprise any suitable solid material, provided that the carrier particles as stated above acquire a charge having an opposite polarity to that of the toner particles when brought in close contact with the toner particles so that the toner particles may cling to and surround the carrier particles. When a positive reproduction of the electrostatic image is desired, the carrier particle is selected so that the toner particles acquire a charge having a polarity opposite to that of the electrostatic image. Alternatively, if a reversal reproduction of the electrostatic image is desired, the carrier is selected so that the toner particles acquire a charge having the same polarity as that of the electrostatic image. Thus, the materials for the carrier particles are selected in accordance with their triboelectric properties in respect to the electroscopic toner so that when mixed or brought into mutual contact, one component of the developer is charged positively if the other component is below the first component in the triboelectric series and negatively if the other component is above the first component in the triboelectric series. By proper selection of materials in accordance with their triboelectric effects, the polarities of their charge when mixed are such that the electroscopic toner particles adhere to and are coated on the surface of carrier particles and also adhere to that portion of the electrostatic image bearing surface having a greater attraction for the toner than the carrier particles.

When it is desired to produce a positive reproduction of the electrostatic image obtained from either an optically negative or positive source in the same apparatus and process it is required as stated above that the proper combination of carrier and toner be selected so as to triboelectrically produce a toner which will have a charge opposite to that of electrostatic image formed by exposure to an optically positive source and the same as an electrostatically formed image exposed to an optically negative source.

In such situations of necessity it has become a requirement to maintain an inventory of oppositely charged developers and exercise care in the control and application of these toners so as to use the proper combination of toner polarity with the latent electrostatic image to be developed. An example of such an application may be found where a composite electrostatic image is to be formed from both optically positive and negative sources as in an overlay process where one image is formed and then another superimposed on it. Though heretofore toners having polarities compatible with the optically positive or negative sources used to form a latent electrostatic image have been used in the same process to develop these composite images or overlays, the use of different developers in the same process has proven to cause problems where great care was not exercised in applying and removing these toners in addition to the cost and time involved in employing different developers.

It is, therefore, an object of this invention to provide novel method and means in the transfer of electrostatic images to overcome the above noted deficiencies.

Another object of this invention is to provide a method and apparatus which form a positive image from either optically positive or optically negative information.

Yet another object of this invention is to provide a novel method and apparatus which eliminate the requirement for more than one developer in developing electrostatic images from either optically positive or optically negative input.

Still another object of this invention is to provide a novel method of transfer for electrostatic images.

Yet another object of this invention is to provide a novel apparatus for the transfer of latent electrostatic images.

Again, another object of this invention is to provide method and apparatus for the transfer of one electrostatic image over which may be superimposed in an overlay fashion another electrostatic image.

Still another object of this invention is to provide a method wherein information in the configuration of a form may be made readily available in order to be printed out along with information complimentary to such form.

Still another object of this invention is to provide a versatile method and means of transferring latent electrostatic images which provide for remote development eliminating contact of the photoreceptor surface with toner and the consequential cleaning thereof.

The foregoing objects and others are accomplished in accordance with the present invention, generally speaking, by providing method and means to produce an electrostatic latent image in one desired mode utilizing either optically positive or negative information. A system is provided wherein the principles as disclosed by Walkup in U.S. Pat. No. 2,825,814 are applied in the process of the present invention whereby, for example, positive electrostatic images may be formed from either optically positive or negative input in a forms overlay mode or any other imaging application wherein it is desired to accept both optically positive and negative input for development with a common developer. In the Walkup patent means and apparatus are disclosed for the formation of an electrostatic charge pattern or xerographic electrostatic latent image. An electric field is imposed through a photoconductive layer and to a contiguous insulating receiver while the photoconductive layer is subject to the action of a pattern of light and shadow of visible light or other activating radiation. The contiguous insulating surface is positioned adjacent the surface of the photoconductive layer and is spaced therefrom by an extremely minute distance such as, for example, the small gas or air gap existent in a condition of virtual contact of one surface with another. As stated by Walkup it is believed that electric charge under the influence of an applied field through the photoconductive layer and through the insulating layer migrates through the photoconductive layer preferentially at those areas exposed to activating radiation, causing deposition of charge on the insulating layer because of electric breakdown occurring in the gas gap which may exist

between this insulating layer and the photoconductive surface, again under the influence of the applied field. The insulating receiver which may be an image receiving member, for example paper, may then be developed at a remote location.

Utilizing the system of the present invention an insulating receiver sheet is placed so as to be in virtual contact with a conductive roller and a photoconductor supported by a suitable grounded support substrate. While the photoconductor is uniformly exposed to illumination, a voltage, for example a negative voltage, of about −750 volts with respect to the photoconductor support substrate is applied to the roller as the roller passes across the receiver sheet. An electric breakdown occurs in the gap between the receiver sheet and the photoconductor surface as the receiver sheet approaches the photoconductor surface resulting in the deposition of a more or less uniform positive charge on the surface of the receiver sheet. The photoconductor surface is then exposed to information which, for example, may be optically positive while at the same time a positive voltage for example about +750 volts is applied to the roller. As the receiver sheet is separated from the photoconductor a second electric breakdown of the air in the gap again occurs between the photoconductor and receiver sheet. In those areas which are now illuminated by the information a deposition of a more or less negative charge occurs which tends to cancel out the original uniformly deposited positive charge forming a positive latent electrostatic image in the unilluminated regions of the receiver sheet. The photoconductor surface is then exposed to optically negative information while a negative potential of, for example, about −750 volts is applied to the roller. The receiver sheet is then again rolled into contact with the photoconductor surface resulting in another electric breakdown of the air in the gap which deposits a more or less positive charge on the receiver sheet in those regions which are illuminated. The image support receiver may then be removed and developed using one developer at a remote station.

Although operating conditions are to be specified under a given set of circumstances in a given application, certain relationships have been noticed from measurements made utilizing the apparatus of FIG. 4 as hereinafter referred to and described. The amount of charge transferred to the insulator has been shown to be dependent on illumination, the magnitude and sign of the applied voltage, the time during which the photoconductor and insulator surfaces are in contact, and the velocity of approach and separation of these surfaces. Specifically, for a velocity of about 5 inches per second, an illumination of about 1.28 foot candles, and an insulator dielectric thickness of about 1 micron, the voltage of the charge transferred to the paper or V_p is about +170 volts, for about a +1,000 volt bias on about a 50 micron selenium layer while V_p is about −119 volts for about a −1,000 volt bias on the same layer. If the velocity of the contact area across the photoconductor surface or V_t is changed to about 20 inches per second, then V_p is about +140 volts for about a +1,000 volt bias on about a 50 micron selenium layer. Thus a higher velocity, V_t or alternatively a shorter contact time, produces a lower transferred charge density on the paper. The transferred charge density has also been shown to be dependent on the photoconductor thickness. Varying V_p and the thickness of the selenium photoconductive layer while other parameters are held constant, it has been found that V_p is about +170 volts when about a 50 micron selenium layer plate is used and about +140 volts when about a 100 micron selenium layer is used.

In summary, it is believed that based on measurements made, the process may be somewhat optimized generally by the use of thin photoconductors, preferred polarity of applied voltages, low velocities and/or long contact times (in the order of about 50 milliseconds) when an applied voltage of about 500–1,200 volts is used and the insulator has a low dielectric thickness (in the order of about 1 micron).

The general nature of the invention having been set forth the invention will now be described illustratively in terms of the following specification and the drawings in which:

FIG. 1 illustrates charging of the dielectric receiver sheet.

FIG. 2 illustrates imaging of the dielectric receiver sheet from an optically positive source.

FIG. 3 illustrates imaging of the dielectric receiver sheet from an optically negative source.

FIG. 4 is illustrative of one embodiment of the apparatus of the present invention.

In FIG. 1 is seen the method of charging a dielectric sheet employed by the process of the present invention by passing a dielectric receiver sheet **4** between a conducting roller **3** and a photoconductive surface **2** affixed to a conductive electrode **1**. Uniform illumination is radiated through the electrode **1** while a negative charge is applied to the conductive roller **3** causing charge induced in the electrode to migrate from the electrode to the photoconductor surface resulting in an electric breakdown in the gap depositing a uniform positive charge on the surface of the dielectric receiver sheet **4** as shown.

In FIG. 2 the schematic of FIG. 1 is first repeated and then an optically positive image is exposed to the electrode surface while a positive charge is applied to the conductive roller **3**. Exposure of an optically positive image to the electrode surface **1** causes light to strike the electrode surface **1** in nonimage areas resulting in charge migrating from the electrode **1** through the photoconductor **2** causing an electric breakdown in the gap and deposition of a negative charge in nonimage areas on the surface of the dielectric receiver sheet **4** tending to cancel out the formerly deposited positive charge in the same nonimage areas. As a result as shown in FIG. 2 optically positive input is converted to a positive electrostatic image on the surface of the dielectric receiver sheet **4**.

In FIG. 3 the same schematic structure as shown in FIG. 2 is illustrated with the exception that the dielectric receiver sheet **4** having been imaged as described in FIG. 2 is now exposed to optically negative information with a charge applied to the conductive roller **3** negative with respect to the conductive electrode **1**. Light now strikes the surface of the electrode **1** and charge migrates through the photoconductor **2** resulting in an electric breakdown in the gap depositing a positive charge in image areas on the dielectric receiver sheet **4**.

In FIG. 4 is seen one embodiment of an apparatus employing the process of the present invention wherein a source of flood illumination **21** is exposed to the backside of a transparent plate **10** having a conductive coating **11** thereon over which is located a photoconductive material **12**. A dielectric web or insulating receiver usually dielectric coated paper **13** is brought into contact with the photoconductive surface **12** while the conductive coating of the glass plate is held at a positive potential of for example about +1,000 volts. The rolling motion of the conductive rubber roller **15** which is pressed against the backside of the dielectric web applies the charge to photoconductive surface **12** being pressed into contact with photoconductive surface **12** by spring assembly **17**. Delrin, guiding, fingers **14** prevent premature contact between the paper **13** and the photoconductive surface **12**. The dielectric web is wound on a roll **16**. Plate **10** is then imagewise exposed to an object **19** illuminated by light source **20** passing through a lens **22**. During the imagewise exposure the polarity of the conductive coating **11** is reversed by activating a suitable reversing mechanism to about −1,250 volts and the direction of the roller **15** is also reversed. The dielectric web is then released and advanced to the development station where the latent electrostatic image deposited on the surface may be developed. Thus imaging in the positive mode is accomplished from an optically positive image source. When optically negative information is to be recorded in a positive mode imagewise illumination is provided by light source **20** illuminating the subject **19** which is focused onto the plane of the conducting coating **11** by a lens **22**. The conducting coating of the glass plate **11** is held at a positive voltage, for example +1,000 volts, while the conductive roller **15** brings the dielectric web **13** into contact with the photoconductor surface **12**. This procedure is identical to the procedure as set out above in the positive to positive mode, however, there is no second pass in this mode so that the dielectric web is now released in order to be advanced to a development station where the electrostatic image deposited thereon may be developed.

It is to be understood that it is not intended that the structural arrangement of the apparatus described in the present invention be restricted to the design as set out herein, and it is intended to include all similar configurations which will satisfy the requirements of the present invention.

Although the uniform charging used in utilizing the system of the present invention was accomplished by employing the techniques of charge deposition as disclosed in U.S. Pat. No. 2,825,814, any suitable means of depositing a uniform charge on the dielectric receiver sheet may be employed. Typical methods of charge deposition include friction charging and induction charging as described in U.S. Pat. Nos. 2,934,649 and 2,833,930 respectively and roller charging as described in U.S. Pat. No. 2,934,650.

Any suitable method of providing illumination may be used in utilizing the system of the present invention. Typical sources and systems of illumination include tungsten filaments, quartz-iodine sources, carbon arc lamps and mercury vapor lamps.

Any suitable conductive electrode may be used in utilizing the system of the present invention. Typical conductive electrodes include NESA glass, tin oxide coated glass, aluminized Mylar (polyethyleneterephthalate), conductive polymers, metals such as chromium, aluminum, brass, stainless steel, copper, zinc, and alloys thereof. A conductive NESA glass electrode is preferred because it is not restricted in view of its transparency to the direction of exposure that may be utilized.

Any suitable photoconductive material may be used in utilizing the system of the present invention. The photoconductive composition utilized may be coated on a substrate or may be dispersed in a binder. Any suitable organic or inorganic photoconductor may be used in the system of the present invention. Typical inorganic photoconductive materials include: sulfur, selenium, zinc sulfide, zinc oxide, zinc cadmium sulfide, zinc magnesium oxide, cadmium selenide, zinc silicate, calcium strontium sulfide, cadmium sulfide, mercuric iodide, mercuric oxide, mercuric sulfide, indium trisulfide, gallium triselenide, arsenic disulfide, arsenic trisulfide, arsenic triselenide, antimony trisulfide, cadmium sulfo-selenide and mixtures thereof. Typical organic photoconductors include: triphenylamine; 2,4-bis(4,4'-diethyl-amino-phenyl)-1,3,4oxadiazol; N-isopropylcarbazole triphenylpyrrol; 4,5-diphenyl-imidazolidinone; 4,5diphenylimidazolidinelthione; 4,5-bis-(4' -amino-phenyl)-imidazolidinone; 1,5-dicyanonaphthalene; 1,4-dicyanonaphthalene, aminophthalodinitrile, nitrophthalodinitrile; 1,2,5,6-tetraazacyclooctatetraene-(2,4,6,8); 2-mercapto-benzthiazole-2-phenyl-4diphenylidene-oxazolone; 6-hydroxy-2,3-di(p-methoxy-phenyl)-benzofurane; 4-dimethylamino-benzylidene-benzhydrazide; 3-benzylidene-amino-carbazole; polyvinyl carbazole; (2-nitro-benzylidene)-p-bromo-aniline; 2,4-diphenyl-quinazoline; 1,2,4-triazine; 1,5-diphenyl-3-methyl-pyrazoline; 2-(4'-dimethyl-amino phenyl)-benzoxazole; 3-amino-carbazole; phthalocyanines and mixtures thereof.

Any suitable dielectric receiver sheet may be employed in utilizing the system of the present invention. Typical dielectric receiver sheets include non-conductive paper, polyurethane, polyvinylchloride, polyethylene, polyethyleneterephthalate, polyvinylfluoride, polypropylene, cellulose acetate, cellulose acetate butyrate and polyvinylbutyral.

Any suitable conducting roller may be used in employing the system of the present invention. Typical conducting rollers include conductive rubber, chromium, aluminum, brass, and aluminized polyesters.

Any suitable method of development may be employed in utilizing the system of the present invention. Typical methods of development include powder cloud development more fully described in U.S. Pat. Nos. 2,725,305 and 2,918,910, cascade development more fully described in U.S. Pat. Nos. 2,618,551 and 2,618,552, brush development more fully described in U.S. Pat. Nos. 2,791,949 and 3,015,305 and touchdown development.

Any suitable fixing means may be used in the course of the present invention to fix the transferred image to the surface of the dielectric receiver sheet where desired. Typical fixing methods include heat-pressure fusing, radiant fusing, combination radiant, conductive and convection fusing, cold pressure fixing and flash fusing.

To further define the specifics of the invention the following examples are intended to illustrate and not limit the particulars of the present system. Parts and percentages are by weight unless otherwise indicated.

DESCRIPTION OF PREFERRED EMBODIMENTS

Example I

A dielectric paper, PS 66–629, manufactured by Plastic Coating Corp. is passed between a conductive rubber roller charged to about −1,000 volts so as to come into intimate contact with about a 50 micron layer of selenium having a NESA glass support substrate. A 150 Watt lamp is used to illuminate the NESA glass causing positive charge induced by the negatively charged conductive rubber roller to migrate from the NESA glass electrode to the photoconductive surface causing electric breakdown in the gap. An optically positive print is then flood exposed by a 150 Watt lamp in position over the surface of the NESA glass causing the surface of the NESA to be illuminated imagewise while a positive charge of about +750 volts is applied to the conductive rubber roller. In illuminated areas negative charge induced by the positively charged conductive rubber roller is caused to migrate from the conductive NESA electrode to the photoconductive layer causing electric breakdown in the gap thereby depositing negative charge on the surface of the dielectric receiver sheet in nonimage areas resulting in the cancellation of the initially deposited positive charges in those areas. The paper is then again passed between the conductive rubber roller to which a negative charge is now applied of about −750 volts and the photoconductive surface so as to come into intimate contact with the photoconductive surface while an optically negative print is flood exposed by a 150 Watt source of illumination causing the surface of the NESA glass to be imagewise illuminated. Positive charge induced by the negatively charged conductive rubber roller is caused to migrate to image areas from the conductive NESA electrode to the photoconductive surface causing breakdown in the gap and deposition of positive charge imagewise on the paper. The receiver sheet is removed and developed by a magnetic brush. The brush is formed by dipping a magnet, contained in a testing tube, into a mixture of iron fillings and Xerox toner.

EXAMPLE II A

A dielectric coated paper, PS 66–629, is passed between a conductive roller charged to about +750 volts so as to come into intimate contact with about a 50 micron layer of selenium having a NESA glass support substrate. A 150 Watt lamp is used to illuminate the NESA glass causing electric breakdown in the gap. An optically positive print is then flood exposed by a 150 Watt lamp positioned over the surface of the NESA glass causing the surface of the NESA to be illuminated imagewise while a negative charge of about −750 volts is applied to the conductive rubber roller. In illuminated areas positive charge induced by the negatively charged rubber conductive roller is caused to migrate from the conductive NESA electrode to the photoconductive layer causing electric breakdown in the gap thereby depositing positive charge on the surface of the dielectric receiver sheet in nonimage areas resulting in the cancellation of the initially deposited negative charges in those areas. The dielectric receiver sheet is then again passed between the conductive rubber roller to which a positive charge is now applied of about +750 volts and the photoconductive surface so as to come into intimate contact with the photoconductive surface while an optically negative print is flood exposed by a 150 Watt source of illumination causing the surface of the NESA glass to be imagewise illuminated. Negative charge induced by the positively charged

conductive rubber roller is caused to migrate in image areas from the conductive NESA electrode to the photoconductive surface causing breakdown in the gap and deposition of positive charge imagewise on the paper. The receiver sheet is then removed and developed by a magnetic brush.

Although the present examples were specific in terms of conditions and materials used, any of the above listed typical materials may be substituted when suitable in the above examples with similar results. In addition to the steps used to carry out the process of the present invention, other steps or modifications may be used, if desirable. For example, optically negative information may be superimposed on optically negative information resulting in a positive electrostatic latent image or any one of a number of combinations involving more than two imaging steps may be employed as desired. Also sequential techniques more fully described in U.S. Pat. No. 2,825,814 may be employed in connection with the process of the present invention. In addition, other materials may be incorporated in the system of the present invention which will enhance, synergize or otherwise desirably effect the properties of the systems for their present use. For example, a smooth thin coating of a dielectric material, for example Tedlar (polyvinylfluoride film), may be applied to the surface of the photoconductor in order to avoid irregularities in the gap between the photoconductor and the dielectric receiver sheet.

What is claimed is:

1. A method of forming a composite electrostatic image on an insulating receiver sheet from optically positive and optically negative information comprising providing a grounded photoconductive layer, uniformly applying a positive charge to an insulating receiver sheet, placing the charged surface of said receiver sheet into virtual contact with said photoconductive layer, placing a positively charged conductive member adapted to move the receiver sheet into and out of virtual contact with said photoconductive layer adjacent the free surface of said receiver sheet, exposing said receiver sheet to a first pattern of radiation through said photoconductive layer while moving said conductive member to move the receiver out of contact with said photoconductive layer causing negative charges to deposit on said receiver by electrical breakdown of the air in the immediate vicinity of said receiver in conformance with said information, reversing the polarity of said conductive member, and exposing said receiver to a second pattern of radiation opposite in optical sense from said first pattern through said photoconductive layer while moving said conductive member to move the receiver back into virtual contact with said photoconductive layer causing positive electrical charges to deposit on said receiver by electrical breakdown in conformity with said second pattern.

2. The process as defined in claim 1 wherein said uniform charging of the insulating receiver comprises:

a. placing said insulating receiver between said conductive member and said photoconductive layer,

b. illuminating said photoconductive member uniformly, and

c. applying a negative charge to said conductive member with respect to said photoconductive layer.

3. A method as defined in claim 1 wherein a uniform negative charge is originally applied to said receiver and wherein the voltages applied to the conductive member in the subsequent imaging steps are reversed so as to create a negative composite electrostatic image.

4. The process as defined in claim 3 wherein said uniform charging of the insulating receiver comprises:

a. placing said insulating receiver between said conductive member and said photoconductive layer,

b. illuminating said photoconductive member uniformly, and

c. applying a negative charge to said conductive member with respect to said photoconductive layer.

5. The method as defined in claim 1 wherein the electrostatic composite image is developed with a developer.

6. A method as defined in claim 3 wherein the electrostatic composite image is developed with a developer.

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