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3,796,570

ELECTROPHOTOGRAPHIC, CONTACT-PRINTING PROCESS EMPLOYING A DIELECTRIC LIQUID LAYER

Robert L. Comeau, South Hadley, Mass., assignor to

Scott Paper Company

No Drawing. Filed Feb. 11, 1972, Ser. No. 225,607

Int. Cl. G03g 13/00

U.S. Cl. 96—1 R

3 Claims

ABSTRACT OF THE DISCLOSURE

A method for contact printing an electrophotographic recording element is disclosed which comprises interposing a layer of a dielectric liquid between the charged photoconductive layer of an electrophotographic material and the partially opaque original to be duplicated during the imagewise exposure of the material to a suitable light source.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates generally to an improved method for contact printing an electrophotographic material. More particularly, the invention relates to a method comprising

- (a) applying an overall charge to an electrophotographic material comprising a base support having a photoconductive layer coated thereon,
- (b) applying a layer of a dielectric liquid to the charged surface of the photoconductive layer,
- (c) placing a partially opaque original to be duplicated in contact with the layer of dielectric liquid,
- (d) imagewise exposing the charged element to light which has passed through the non-image areas of the original,
- (e) separating the original from the exposed material, and
- (f) developing an image in the electrophotographic material.

Description of the prior art

Electrophotographic recording elements are well known in the art and generally comprise a substrate having coated thereon a photoconductive layer. The substrate may be either paper or film which is rendered electrically conductive either by including therein during manufacture a conductive material or by coating thereon a layer of a conductive material. The most commonly employed conductivizing materials include, for example, carbon black and conductive resins. A photoconductive layer, generally comprising a photoconductive material in combination with a binder resin, is coated on the substrate.

Images are formed on the photoconductive layer by a three-step process comprising charging, exposing, and toning. During the charging step, an overall charge is applied to the photoconductive layer by any of the methods which are now well known in the art including, for example, by rubbing or friction or by the action of ion or electron emission, e.g., by means of a corona discharge. The polarity of the charge on the photoconductive layer can be varied depending upon whether positive or negative prints are desired. A positive print is one which is an exact duplicate of the original being copied—i.e., the imaged areas of the copy correspond to the imaged areas of the original. By comparison, a negative print is one in which the imaged areas of the copy correspond to the non-imaged, or clear, areas of the original—i.e., the copy is the reversed image of the original. The charging step

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is usually carried out in the dark under which conditions the photoconductive layer will retain the charge deposited thereon.

In the exposure step the charged electrophotographic material is selectively, or imagewise, exposed to light. The effect of the light is to cause the photoconductive layer to become conductive in the areas of the layer which are exposed to light resulting in the dissipation of the charge in those areas. The light may be either reflected from or transmitted through the non-imaged areas of the original to be duplicated. If a nontranslucent original, such as paper, is utilized the light is reflected from the non-imaged areas of the original and strikes the photoconductive layer. If a translucent original, such as microfilm, is employed the light is directed through the non-imaged areas of the original onto the photoconductive layer. Thus, the electrophotographic recording element is exposed to a light and shadow pattern whereby the illuminated areas become conductive and the charge in those areas is discharged while the conductivity of the non-illuminated areas is not changed and they retain their charge. As a result, a charge pattern, or latent electrostatic image, is formed in certain areas of the electrophotographic recording element.

In the toning step the charge pattern, or latent electrostatic image, is rendered visible by any one of several development methods all of which involve the application of a colored material, commonly referred to as a toner, to those areas of the photoconductive layer having the residual charge. The toner employed may be either liquid or dry depending upon whether the pigment used to develop the image is dispersed in a solvent or not. In either case, the pigment adheres to the charged areas of the material resulting in the formation of an image in those areas.

When a translucent, or only partially opaque, original is employed it would be desirable to have a simple, low-cost system for contact printing an electrophotographic recording element which would produce undistorted prints having good resolution and clean background. However, it has not heretofore been possible to place the original in direct contact with the charged photoconductive layer during the exposure step due to the problems created when the partially opaque original was thereafter separated from the electrophotographic material bearing the latent electrostatic image. The separation resulted in several problems including, the partial discharge of those areas corresponding to the imaged areas of the original and/or the deposition of charge in those areas corresponding to the non-image areas of the original. The removal of charge from those areas corresponding to the imaged areas of the original results in a print having low density or distorted images after toning, whereas the deposition of charge in the non-image areas results in a print having an undesirable discoloration in the background, or non-image areas.

Dielectric liquids have previously been suggested for use in connection with electrophotographic recording elements. In U.S. Pat. 2,904,431 issued to Moncrieff-Yeates there is disclosed an electrophotographic charging means wherein a dielectric material is interposed between the electrode or charge source and the material which is to be charged. The dielectric liquid improves the electrical connection between the electrode and the electrophotographic material and conducts electric charges. After charging, the liquid is removed and the material is exposed to produce an electrostatic latent image on the surface of the photoconductive layer.

In U.S. Pat. 2,975,052 issued to Fotland et al., there are disclosed two methods for utilizing dielectric liquids in connection with electrophotographic materials. The first of these is a method for transferring a charge pattern

from a photoconductive layer to an electrically insulating material. To prevent spreading or fanning of the latent electrostatic image when the electrically insulating material, to which said image is to be transferred, is brought into contact when the photoconductive material bearing the latent electrostatic image a thin film of a liquid having a relatively high dielectric strength is applied to the photoconductive surface prior to the charge transfer. The charged pattern thus travels from the photoconductive layer, through the dielectric liquid, to the electrically insulating material. In the second method, an overall charge is applied to an electrically insulating material, a high dielectric strength liquid is applied to the charged material, and a photoconductive layer coated on a transparent electrically conductive support is then brought into contact with the liquid. Images are subsequently formed on the electrically insulating layer by exposing the photoconductive material to a light and shadow image through the transparent electrically conductive support. Where the light strikes the photoconductor it becomes conductive and the charge travels from the insulating layer, through the dielectric liquid between the layers, to these conductive areas. In this way, a latent electrostatic image is formed directly on the insulating layer. In both embodiments disclosed in the Fotland et al. patent the dielectric liquid is used as a charge transfer medium.

Dielectric liquids have also been employed as non-conductive, or insulating, carrier liquids in electrophoretic imaging systems. See, for example, U.S. Pat. 3,384,566 issued to Clark and U.S. Pat. 3,485,738 issued to Carreira.

SUMMARY OF THE INVENTION

In accordance with the present invention, contact prints are formed on an electrophotographic material by a method which comprises interposing, during the imagewise exposure step, a layer of a dielectric liquid between the charged electrophotographic recording element and the partially opaque original to be duplicated.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

According to the present invention, contact prints are formed on an electrophotographic material by a method comprising

- (a) applying an overall charge to an electrophotographic material comprising a base support having a photoconductive layer coated thereon,
- (b) applying a layer of a dielectric liquid to the charged surface of the photoconductive layer,
- (c) placing a partially opaque original to be duplicated in contact with the layer of dielectric liquid,
- (d) imagewise exposing the charged element to light which has passed through the non-image areas of the original.
- (e) separating the original from the exposed material, and
- (f) developing an image in the electrophotographic material.

The electrophotographic recording material utilized in carrying out the present invention may be prepared according to any of the methods which are now well-known in the art. A photoconductive layer comprising a photoconductive material and a binder resin is coated on a suitable base support which may be either paper or film which has been conductivized, as described above. Suitable photoconductors include both organic and inorganic materials. Inorganic photoconductors which may be employed include, for example, cadmium sulfide, cadmium sulfoselenide, zinc oxide, zinc sulfide, sulfur selenium, mercuric sulfide, lead oxide, lead sulfite, cadmium selenide, titanium dioxide, indium trioxide. Useful organic photoconductors include, for example, quinacridones, carboxamides, carboxanilides, triazines, anthraquinones, azo compounds, salts and lakes of compounds derived from 9-phenylxanthane, dioxazines, lakes of fluorescein

dyes, pyrenes, phthalocyanines, metal salts and lakes of azo dyes, polyvinyl carbazole, and substituted phenylene diamines. Suitable binder resins include, for example, polystyrene, polystyrene copolymers such as styrene-butadiene and styrene-butadiene-acrylonitrile, polyvinyl chloride, polyvinylidene chloride, polyvinyl acetate, polyvinyl acetal, polyvinylether, polyacrylates, polycarbonates, polyethylene oxide, phenoxy resins, polysulfones and polyesters.

In carrying out the present invention an overall charge is applied to the surface of the photoconductive layer by any of the methods which are well known in the art including, for example, by rubbing or friction or by action of ion or electron emission, e.g., by means of a corona discharge.

After charging, a layer of a dielectric liquid is applied to the charged surface of the electrophotographic material. Dielectric liquids useful in carrying out the present invention are those having a resistivity of at least 10^9 ohm-centimeters and include, for example, xylene, toluene, carbon tetrachloride, trichloroethylene, cyclohexane, hexane, heptane, kerosene, benzene, Solvesso 100, a narrow cut aromatic solvent having a flash point of 100° F., Solvesso 150, a narrow cut aromatic solvent having a flash point of 150° F. and a boiling range of from 370° F. to 410° F., Isopar E, a narrow cut isoparaffinic solvent having a boiling range of from 240° to 290° F., Isopar G, a narrow cut isoparaffinic solvent having a boiling range of from 320° to 350° F., Isopar H, a narrow cut isoparaffinic solvent having a boiling range of from 350° to 375° F., Freon TF which is trichlorotrifluoroethane, Freon MF which is trichlorofluoromethane, Varsol 5, a low odor mineral spirit composed of 53% paraffin hydrocarbon and 37.5% naphthenic hydrocarbons and Shellsol 71, a narrow cut paraffinic solvent having a flash point of 122° F., Varnolene and organosiloxanes. The dielectric liquid may be applied to the charged surface by any method including, for example, spraying, dipping the charged material in the liquid or cascading.

After the layer of dielectric liquid is applied to the charged electrophotographic material, a partially opaque original to be duplicated is placed in contact with said layer. It is especially preferred in carrying out the present invention to also coat the surface of the original with a layer of a dielectric liquid. After the original and the electrophotographic recording element are placed together, improved contact can be obtained by hand-rubbing or in a vacuum frame.

The electrophotographic material/dielectric liquid/original composite is then exposed to light so that the light passes through the non-image, or clear, areas of the original and strikes the photoconductive layer. Thus, the electrophotographic material is exposed to a light and shadow pattern whereby the illuminated areas become partially conductive and the charge in those areas is discharged while the conductivity of the non-illuminated areas is not changed and they retain their charge. As a result, a charge pattern, or latent electrostatic image, is formed in those areas of the electrophotographic recording element corresponding to the imaged areas of the original.

After exposure, the partially opaque original is separated from the electrophotographic material bearing the latent electrostatic image. This latent electrostatic image is then developed to form a visible image by toning. As described above, the toning may be of either the liquid or dry type and is applied by any of the methods well known in the art. The resulting print exhibits no distortion in the image areas and has a clean background, or non-image, area.

The process of the present invention is especially useful in the reproduction of images from partially opaque originals such as microfilm, overhead projectuals and engineering drawings.

In order to describe the present invention so that it may be more clearly understood, the following examples are set forth. These examples are set forth primarily for the purpose of illustration, and any specific enumeration of detail contained therein should not be interpreted as a limitation on the concept of this invention.

EXAMPLE I

A coating formulation was prepared comprising

	Grams
Toluene	90
Photox 8, a photoconductive zinc oxide available from New Jersey Zinc Co.	150
DeSoto EO41, a styrenated acrylic resin available from DeSoto Chemical Inc., Chicago, Ill.	50

The above formulation was coated by means of a Mayer rod onto a conductivized paper substrate. The resulting electrophotographic material was dried and images were formed thereon in accordance with the following procedure.

An overall charge was applied to the photoconductive layer of the recording material by subjecting it to a corona discharge and a layer of Isopar G was then applied to the charged surface of the material by means of a cotton swab. A partially opaque original was subsequently placed in contact with the layer of dielectric liquid and the composite was exposed to light. The partially opaque original was then separated from the electrophotographic material leaving a latent electrostatic image, or charge pattern, in those areas of the material corresponding to the imaged areas of the original. This latent electrostatic image was developed with a liquid toner resulting in a print having no distortions in the imaged areas and a clean background. By comparison, prints produced in the same manner but without having a layer of a dielectric liquid interposed between the charged material and the original during the exposure step exhibited severe streaking in the image areas of the resulting print.

EXAMPLE II

A coating formulation was prepared comprising

	Grams
N,N,N',N'-tetrabenzyl-p-phenylenediamine	5.0
Butvar B-76, a polyvinyl butyral resin available from Monsanto Co., St. Louis, Mo.	15.0
Chloroform	100.0
Rhodamine B	.0035

The above formulation was coated by means of a Mayor rod onto a polyester film base which had previously been coated with a conductive resin. The resulting electrophotographic material was dried and images were formed thereon in accordance with the following procedure.

An overall charge was applied to the photoconductive layer of the material by subjecting it to a corona discharge and a layer of Shellsol N was then sprayed onto the charged surface. A partially opaque original was subsequently placed in contact with the layer of dielectric liquid and the resulting composite was exposed to light. The partially opaque original was then separated from the electrophotographic material leaving a charge pattern, or latent electrostatic image, in those areas of the material corresponding to the imaged areas of the original. This latent electrostatic image was developed with a liquid toner resulting in a print having a uniform density in the imaged areas and a clean background. By comparison, prints produced in the same manner but without having a layer of a dielectric liquid interposed be-

tween the charged recording element and the original during the exposure step exhibited severe streaking in the image areas of the resulting print.

EXAMPLE III

A second sample of the electrophotographic material prepared in Example II was charged, exposed and toned as described in Example II except that instead of spraying with Shellsol N the charged material was dipped in Freon TF before the original to be duplicated was placed in contact with the charged surface. The resulting prints also had a uniform density in the imaged areas and a clean background.

EXAMPLE IV

Another sample of the electrophotographic recording material prepared in Example II was also charged, exposed and toned as described in Example II except that instead of spraying with Shellsol N, the charged material was cascaded with Solvesso 150 before the original to be duplicated was placed in contact with the charged surface. The resulting prints had a uniform density in the imaged areas and a clean background.

What is claimed is:

1. In an electrophotographic, contact-printing process comprising

- applying an overall charge to an electrophotographic material comprising an electrically conductive base support having a photoconductive layer coated thereon,
- imagewise exposing the charged material to light passing through a partially opaque original in contact with the charged photoconductive layer,
- separating the original from the exposed material, and
- developing an image in the electrophotographic material,

the improvement which comprises interposing a layer of a dielectric liquid having a resistivity of at least 10^9 ohm-centimeters between the charged photoconductive layer and the partially opaque original prior to the partially opaque original being brought into contact with the charged photoconductive layer for the imagewise exposure step.

2. A method as claimed in claim 1, in which the electrophotographic recording element comprises an electrically conductive film base having coated thereon a layer of an organic photoconductor.

3. A method as claimed in claim 2, in which the organic photoconductor is a substituted phenylene diamine.

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NORMAN G. TORCHIN, Primary Examiner
J. R. MILLER, Assistant Examiner

U.S. Cl. X.R.

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