PROCESS FOR TRANSFERRING ELECTROSTATIC CHARGE IMAGES

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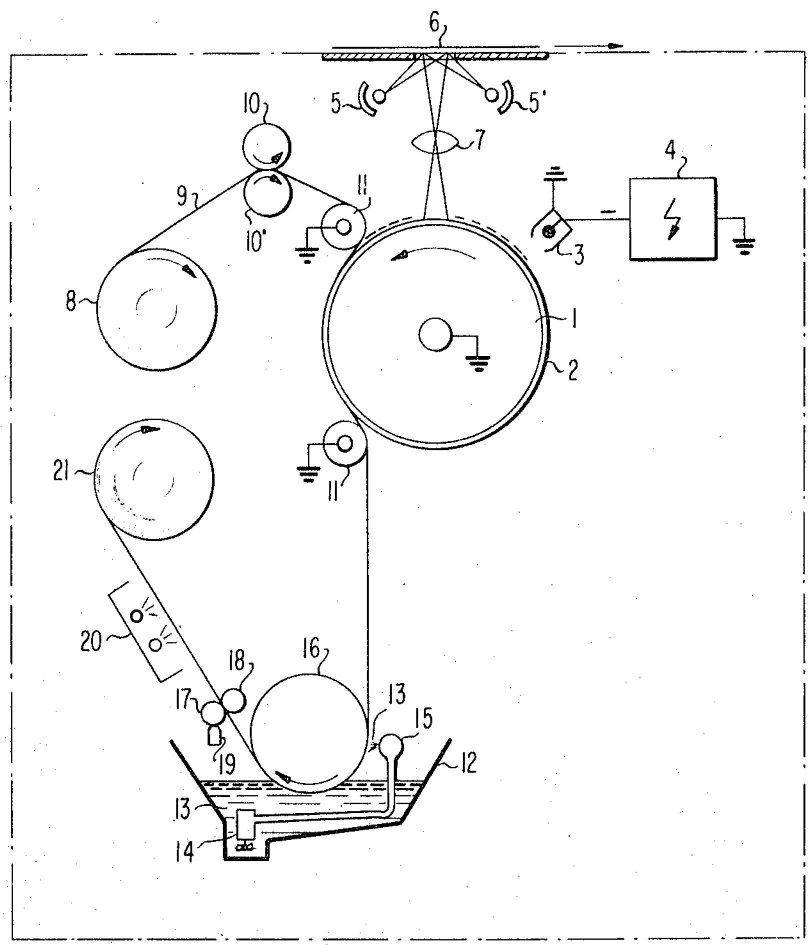

INVENTORS
REINHOLD ARNETH
HANS TRITTLER
JÜRGEN EMIG

BY James E. Bryan
ATTORNEY

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Reinhold Arneth, Budenheim, Hans Trittler, Wiesbaden-Schierstein, and Jurgen Emig, Mainz-Gonsenheim, Germany, assignors to Kalle Aktiengesellschaft, Wiesbaden-Biebrich, Germany

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ABSTRACT OF THE DISCLOSURE

This invention relates to a process for the electrophotographic production of copies by transferring an electrostatic charge image from a photoconductor layer on a conductive support onto a dielectric layer on a conductive support, the dielectric layer being in virtual contact with the photoconductor layer, separating the layers from each other, developing the transferred latent charge image by electrophotographic dry or liquid development, and then fixing the same if desired, the photoconductor layer comprising organic charge transfer complexes and being capable, in a thickness of 8 to 15μ, of being charged to 800 to 1,600 volts and the exposed layer having a voltage of at least about 500 volts in the image areas and not more than about 300 volts in the non-image areas.

This invention relates to a process for the electrophotographic production of copies by transferring electrostatic charge images from a photoconductor layer carried on a conductive support onto a dielectric layer provided with a conductive support, which latter layer is in virtual contact with the photoconductor layer, separating the layers from one another, and developing the transferred latent charge image by electrophotographic dry or liquid development and, if desired, subsequently fixing the same.

The numerous hitherto known processes of this kind have in common that, for the layers in contact, an external electric field is applied to transfer the charge. The external electric field may be produced by direct or alternating voltage or by a corona discharge on the reverse side of one or both dielectric layers. Depending on the type of process employed, there is an exactly adjusted air gap of 50 to 200μ between both layers, or they are in so-called virtual contact, or an intimate contact is produced by applying high mechanical pressure.

Virtual contact means the superposition of two surfaces without the application of an additional external pressure perpendicularly to the surfaces. Between two surfaces in virtual contact, there is always a thin air film the thickness of which depends upon the smoothness of both surfaces and, in the present case, is about 1μ. This small air gap can be eliminated only by mechanical pressure or evacuation of the surrounding space, whereby the state of the above-mentioned so-called intimate contact is obtained.

These known processes have the disadvantage that, under the action of the external field, charges are transferred to the receiving material not only in the image areas but also in the non-image areas. Due to the overlapping of the external field with the field produced by the latent charge image, insufficient differentiation between image and non-image areas is possible so that copies with an intensely colored background are obtained upon development.

Performing such processes while maintaining a constant air gap, of about 50 to 200μ involves the further

disadvantage that a poorly defined image is obtained which is particularly disadvantageous for the reproduction of small character text originals.

Sufficient tests have been carried out to eliminate the disturbing blackening of the background but a fully satisfactory solution has not been found. It has been suggested, for example, prior to the image transfer, to uniformly charge the dielectric layer of the receiving material, by means of a corona discharge, oppositely to that of the charge image. The charge image obtained thereby has a charge opposite to that in the non-image areas. After development, the layers have an excess charge of the same polarity as the toner (same polarity as the non-image areas) and they firmly adhere to one another upon superimposition. Furthermore, the copies obtained are not free from scumming since the toner, due to friction at the layer, readily tends to recharge with a charge of the same polarity, and a certain fraction of every toner has a charge opposite to the charge to be expected.

Also, in another modification in which the receiving material is charged at the same polarity as in the latent charge image and a voltage of the same polarity is applied to the reverse side of the receiving material, copies are obtained the background of which is more intensely black than in the case of receiving material which has not been charged.

Also according to the known processes operating with an intimate contact of both layers, i.e. with the application of mechanical pressure, distinct blackening of the background cannot be avoided, apart from the fact that the photoconductor layer is very soon mechanically damaged, which is a substantial disadvantage particularly in the case of a desired continuous high speed working method.

In the process of the present invention, which is performed in a simple manner and also yields high-quality copies of good contrast, the photoconductor layer comprising organic charge transfer complexes and capable of being charged, in a thickness of 8 to 15μ, to 800 to 1,600 volts is exposed to light so that the image areas have a voltage of at least about 500 volts and the non-image areas of at most about 300 volts. According to a preferred embodiment, the voltage difference on the photoconductor layer between the image areas and the non-image areas is between about 500 and 900 volts.

As surprisingly has been found, the use of such photoconductor layers requires neither the application of an external field nor the application of pressure for obtaining flawless copies.

Photoconductor layers based upon charge transfer complexes are known, particularly from German Pat. No. 1,127,218. They are combinations of compounds which contain a photoconductive substance with an electron donor function as well as an activator with an electron acceptor function. The first-named compounds particularly include those which have at least one aromatic or heterocyclic ring, which also may be substituted. Such photoconductors are aromatic hydrocarbons, such as naphthalenes, anthracenes, phenanthrenes, benzanthrenes, chrysenes, carbazoles, oxidazoles, triazoles, imidazoles, imidazolethiones, oxazoles, thiazole derivatives and many others, polymers of one or more vinyl heterocyclic compounds, such as N-vinylcarbazoles, C-vinylcarbazoles, vinyl dibenzofurans, fluorene, and the like, being particularly suitable.

Suitable activators are, particularly, compounds having strongly polar groups, such as, for example, halogens, a cyan, nitro, keto, ester, acid anhydride, or carboxyl group or a quinone grouping. Further details are to be found in the German patent, supra. Particularly suitable for the purposes of the invention are compounds such as fluorenones, particularly 2,4,7-trinitro-9-fluorenone; 2,4,5,7-tetranitro-9-tetranitro-9-fluorenone, compounds such as chloranil, and the like.

The quantity of the activator with respect to the photoconductive substance may vary within wide quantitative ratios, small quantities often being sufficient. In some cases, it is advantageous to use molar ratios of 1:1 of both components, or the quantity of the activator may be about 0.7 to 1.3 moles, based on 1 mole of the photoconductor.

The photoconductor material is produced in known manner, charged and image-wise exposed to light.

The dielectric material employed must be such that, in the charged state during the image production, it does not exhibit a significant charge loss, i.e. one which significantly decreases the image quality. This requires a specific volume resistivity greater than about 10^{14} ohm·cm. Very suitable is a support of conductive paper having a top coating of an insulator, e.g. polystyrene, cellulose acetate, and the like.

According to another feature of the invention, the support materials for the photoconductor layer and the dielectric layer are grounded during virtual contact. Images with a particularly good contrast are obtained thereby, but image production is also possible without grounded rollers. Virtual contact of both layers can be produced in the simplest way by conveying the image-receiving material, without any outer mechanical pressure, over two rollers against a drum carrying the photoconductor layer.

For producing the contact, the paper tension necessary for transport is sufficient. The rollers conveying the image-receiving material as well as the drum carrying the photoconductor material are grounded.

Rendering the transferred latent charge image visible is performed according to the known methods of dry or liquid development. A further advantage of the invention is that, even with the application of the liquid dispersion development advantageous for many purposes, images with very good contrast and which are surprisingly free from scumming are obtained.

As an exemplary embodiment of the invention, the accompanying drawing diagrammatically illustrates an apparatus for the continuous production of copies. A metal drum **1**, grounded via its axis, carries the organic photoconductor layer **2** which is negatively charged above ground to about 1,000 volts by means of a corona **3** fed from a direct voltage source **4**. A master **6** conveyed synchronously and in a direction opposite to that of the drum **1** is exposed to the lamps **5** and **5'** through a gap and reproduced by means of the objective **7** onto the photoconductor layer. The image-receiving material is drawn from the roll **8** by means of the transport rollers **10** and **10'** and conveyed over the grounded metal rollers **11** and **11'** in virtual contact with the photoconductor layer.

The resulting latent charge image is developed with the liquid dispersion developer **13** in the trough **12**, which is sprayed through the nozzle **15**. The material running over the roller **16** is then immersed in the developer and then freed from the major part of the adhering developer liquid by means of the squeeze rollers **17** (metal) and **18** (rubber). Final drying of the copy is performed by the heat radiators **20**. Furthermore, for circulating the developer liquid, there is a pump **14** and, for cleaning the squeeze roller **17**, a scraper **19**. The finished copies are wound up on the roller **21**.

The performance of the invention may be modified in known manner, differing from the above-described embodiment in adaption to practical requirements. Instead of the described dispersion development, dry development according to the cascade or other process may be provided. The organic photoconductor layer may also be applied, for example, to a metal foil or a metallized synthetic plastic film which is then secured on the drum. When using such a high-resistance layer as the image-receiving material having a hydrophilizable surface, the production of printing plates is possible in known manner. The production of the charge image on the electrophotographic layer may be performed by any known method, e.g. by image-wise deposition of metal pins having a sufficiently high electric impulse voltage or by other processes.

Although, according to the process of the invention, photoconductor layers comprising or consisting of organic charge transfer complexes generally can be used, the following layers have proved particularly suitable:

(1) A layer consisting of 1 mole of 2,4,7-trinitro-9-fluorenone and poly-N-vinylcarbazole, in a molar ratio of 1:1, based on the monomer unit of the polyvinyl carbazole;

(2) A layer consisting of 17.8 parts by weight of phenanthrene, 0.245 part by weight of chloranil, and 26 parts by weight of polyvinyl acetate (Mowilith 50, registered trademark);

(3) A layer consisting of 16.6 parts by weight of fluorene, 0.36 part by weight of 2,4,5,7-tetranitro-9-fluorenone, and 26 parts by weight of polyvinyl acetate (Mowilith 50, registered trademark).

The present invention will be further illustrated by reference to the following examples:

EXAMPLE 1

The photoconductor described under (1) above was applied to an aluminized 75μ thick polyethylene terephthalate film in a layer thickness of 12μ. The layer was capable of retaining a maximum charge of −1,400 volts, measured by means of a Monroe Isoprobe Electrostatic Voltmeter. The film was secured on a metal drum and charged to −1,300 volts by means of a corona discharge, the aluminum layer being grounded at one end. By means of a photographic objective, a master was reproduced from a synchronously and oppositely rotating drum via a slit stop onto the photoconductor layer. Exposure of the master was performed with two green fluorescent lamps type TLD/15W of Philips.

The charge acceptance was 900 volts in the image areas and 300 volts in the non-image areas. After the transfer of the charge image to the high-resistance layer, the voltage was 290 volts in the image areas and less than 10 volts in the non-image areas.

After making the transferred latent charge image visible by means of a liquid developer, a copy of good contrast and free from scumming was obtained.

EXAMPLE 2

A photoconductor layer containing 2,4,7-trinitro-9-fluorenone and poly-N-vinylcarbazole in a molar ratio of 0.8:1, based on the monomer unit of the polyvinyl carbazole, was applied to an aluminum foil. The layer had a thickness of 10μ and could be charged to −1,150 volts maximum. The coated aluminum foil was secured as described in Example 1 and charged to −1,100 volts by means of a corona discharge. Exposure to light was carried out as described in Example 1. The charge acceptance determined was 700 volts in the image areas and 220 volts in the non-image areas. After transfer of the charge image in virtual contact with the high-resistance layer, the voltage in the image areas of the high-resistance layer was 200 volts. The measured voltage in the non-image areas was in the range from 0 to 3 volts. After making the transferred charge image visible by means of a dry toner/iron mixture (4 percent by weight of toner) and a magnetic brush, thoroughly blackened copies free from scumming were obtained.

It will be obvious to those skilled in the art that many modifications may be made within the scope of the present invention without departing from the spirit thereof, and the invention includes all such modifications.

What is claimed is:

1. An electrophotographic process for the production of copies which comprises electrically charging a photoconductor layer on a conductive support, exposing the photoconductor layer to light under a master and transferring, without the application of an external electric field or pressure, the electrostatic charge image from said photoconductor layer on a conductive support onto a non-precharged dielectric layer on a conductive support, while the dielectric layer is in virtual contact with the photoconductor layer and wherein the supports for the dielectric layer and the photoconductor layer are grounded during virtual contact, separating the layers, and developing the transferred latent charge image with an electroscopic material, the photoconductor layer comprising organic charge transfer complexes and being capable, in a thickness of 8 to 15μ, of being charged to 800 to 1,600 volts and the photoconductor layer having a voltage of at least about 500 volts in the image areas and not more than about 300 volts in the non-image areas before charge transfer.

2. A process according to claim **1** in which the voltage difference between the image areas and the non-image areas on the photoconductor layer is between about 500 and 900 volts.

3. A process according to claim **1** in which the photoconductor layer comprises 2,4,7-trinitro-9-fluorenone and

a photoconductive polymer of at least one vinyl heterocyclic compound in a ratio of about 0.7 to 1.3 moles of the fluorenone per mole of the monomeric vinyl compound.

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CHARLES E. VAN HORN, Primary Examiner

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96—1.5; 117—17.5, 37 LE