United States Patent [19]

Matsumoto et al.

[11] **3,844,783**

[45] **Oct. 29, 1974**

[54] **ELECTROPHOTOGRAPHIC PROCESS INCLUDING A COLOR MASKING OPERATION**

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[22] Filed: **Dec. 28, 1971**

[21] Appl. No.: **213,136**

[30] **Foreign Application Priority Data**

Dec. 28, 1970 Japan 45-120544

[52] **U.S. Cl.** **96/1.2**
[51] **Int. Cl.** **G03g 13/00,** G03g 13/06
[58] **Field of Search** 96/1.2, 9

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[57] **ABSTRACT**

An electrophotographic process including a color masking operation comprising providing a photoconductive insulator as a main photosensitive element and a substantially transparent photoconductive insulator as a transparent photosensitive element, where the main photosensitive element is provided with a grounded conductive support and the transparent photosensitive element is provided with a transparent grounded conductive support and where the spectrum sensitivity region of the transparent photosensitive element is different from the spectrum sensitivity region of the main photosensitive element or the main photosensitive element combined with a colored filter, charging both photosensitive elements with the same polarity, facing the charged surfaces of both the photosensitive elements toward each other so that a slight gap exists therebetween (1) with the colored filter interposed and/or a substantially transparent insulator interposed, or (2) with nothing interposed, image exposing while both the photosensitive elements are held in registry from the side of the transparent photosensitive element to obtain the electrostatic latent images of reflected image relation on the main photosensitive element and the transparent photosensitive element, and developing the latent image on the main photosensitive element while maintaining the registry between both the photosensitive elements, the amount of toner deposited being influenced by the latent image on the transparent photosensitive element.

7 Claims, 3 Drawing Figures

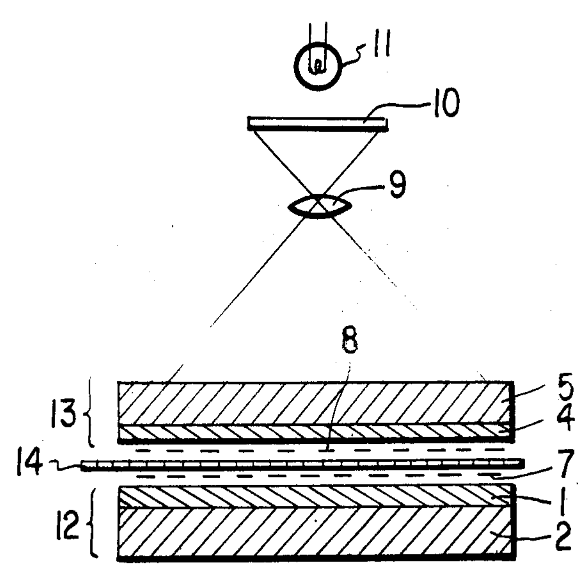

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FIG. 1

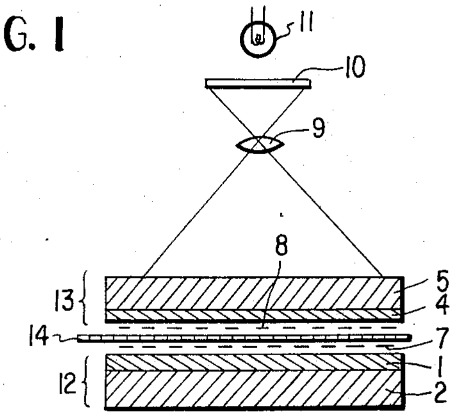


FIG. 2

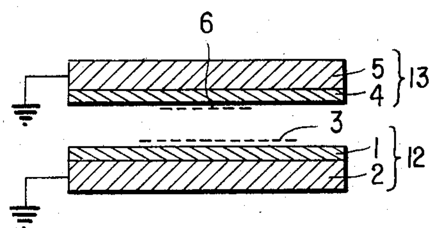
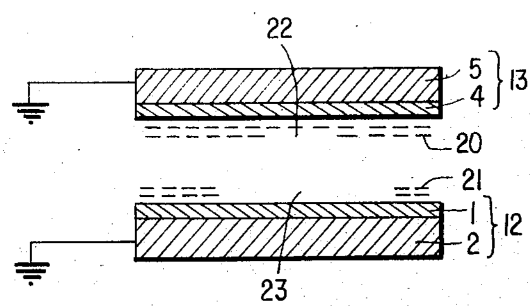


FIG. 3



ELECTROPHOTOGRAPHIC PROCESS INCLUDING A COLOR MASKING OPERATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a masking process which compensates deficiencies in the spectral absorption properties of coloring agents used for forming electrophotography multicolor images.

2. Description of the Prior Art

The so-called "subtractive color process" is utilized for multi-color electrophotographic printing to obtain a colored image by distributing the quantities of three kinds of coloring agents, which respectively absorb blue, green and red components of visible rays. In the subtractive color process, there are used three kinds of coloring agents: yellow to absorb blue; magenta to absorb green; and cyan to absorb red. Coloring agents of magenta and cyan, such as printing inks, pigments, dyestuffs, etc. absorb only green or red, respectively, and they do inaccurately absorb other wave length areas. For example, cyan coloring agents absorb a fair amount of green and a minor amount of blue while magenta absorbs a fair amount of blue and a minor amount of red. The yellow coloring agent is nearly ideal in absorption.

Accordingly to correct the inaccurate absorption of cyan coloring agents in the image, the quantity of magenta coloring agent to absorb green decreased by the amount of said inaccurate absorption of the cyan coloring agent. The overlapping portions of cyan and magenta color agents will then absorb a proper amount of green. Also, the cyan coloring agent absorbs blue and, if necessary, a decrease of yellow coloring agent corresponding to the quantity of cyan coloring agent in the image will overcome this fault. Correction for the inaccurate absorption of magenta coloring agents is quite the same.

SUMMARY OF THE INVENTION

In the present invention, a transparent electrophotographic sensitive element and an ordinary electrophotographic sensitive element are provided. The photosensitive layers are sensitive to different regions of the spectrum. The two photosensitive elements are uniformly charged and are placed as photosensitive layers facing each other to obtain simultaneously two color separated electrostatic latent images by exposure from the side of the transparent photosensitive element.

For multi-color electrophotography, the operations the two color separated latent images face each a small and definite distance apart and developing with a coloring agent corresponding to the color separated latent image to be developed. This process is repeated to obtain a multi-color electrophotography print corrected for inaccurate absorption of the coloring agents.

Thus, a primary object of the present invention is to provide a process of correcting the inaccurate absorption of coloring agents and provide clear color images.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an illustration of the exposure process of the present invention.

FIGS. 2 and 3 are illustrations of the whole process of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The principle of the present invention will now be described in greater detail with reference to the accompanying drawings.

FIG. 1 is an illustration the exposure process by the present invention. In FIG. **1, 12** is the main photosensitive element and comprises a main photosensitive layer **1** which is a photoconductive insulating layer, and conductive support **2.**

13 is the transparent photosensitive element which acts as a developing electrode during development, and comprises transparent photosensitive layer **4** which is, a photoconductive insulating layer, and transparent support **5.**

7 represents the charge uniformly given the main photosensitive layer **1,** and **8** represents the charge uniformly given the transparent photosensitive layer **4.** The uniform charge may be either positive or negative, but the charges on the main and transparent photosensitive layers should be the same polarity. A negative charge is shown in FIG. **1.**

10 is an original picture such as a "color slide" for exposure. **11** is a source of illumination, and **9** is a projection lens. **14** is a red, green or blue filter inserted between the transparent photosensitive layer **4** and the main photosensitive layer **1.** The main photosensitive layer and the trannsparent photosensitive layer are made to face each other, and filter **14** is placed between them whereafter exposure is made from the transparent photosensitive layer side as shown.

By exposure, electrostatic latent images are formed on both photosensitive layers. Since the transparent photosensitive layer's spectral sensitivity distribution differs from that of the main photosensitive layer due to the combination of the filter **14** and the main photosensitive layer, the electrostatic latent images formed are different and correspond to the colors of the original picture.

The total (or resulting) spectral sensitivity distribution of the main photosensitive layer is a function not only of the spectral sensitivity of the main photosensitive layer per se but also the spectral transmittance of the filter **14.** It is important that the total (or resulting) spectral sensitivity distribution of the main photosensitive layer (that is, the spectral transmittance of filter **14** plus the spectral sensitivity of the main photosensitive layer) is substantially different from the spectral sensitivity of the transparent photosensitive layer. Thus, it is possible that the spectral sensitivity of the two photosensitive layers be different or the spectral sensitivity may be the same with a filter such as filter **14** inserted.

For example, an electrostatic latent image corresponding to the magenta image portion on the main photosensitive layer may be made as follows (where the main photosensitive layer is panchromatically sensitized): As the transparent photosensitive layer **4,** a red sensitive layer (non-sensitive to blue and green) is used. In order to cut ultraviolet radiation, it is advisable to insert an ultra-violet filter in an appropriate position between the light source **11** and the transparent photosensitive element **13.** The main photosensitive layer **1** is exposed to light through the transparent photosensitive element **13** and the filter **14** (which is a green filter and only transmits green light). Thus, on the main photosensitive layer **1** an electrostatic latent image corresponding to green light, that is, the magenta portion of the image is formed. While on the transparent photosensitive layer 4 which is red-sensitive, an electrostatic latent image corresponding to red light, that is, the cyan portion of the image is formed.

The thus obtained electrostatic latent images are then developed.

FIG. 2 is a representation of the relative positions of the elements during development. The main photosensitive element and the transparent photosensitive element are secured with a small space therebetween (to insure no movement) in a facing relationship as during exposure. 3 represents the electrostatic latent image on the main photosensitive layer and 6 represents the electrostatic latent image on the transparent photosensitive layer. In such a state, the electrostatic latent image 3 (for example, having a negative polarity) on the main photosensitive layer is developed with a positively charged magenta toner. The coloring agent adheres well to the edge portion of electrostatic latent image 3 on the main photosensitive layer 1 which does not face the electrostatic latent image 6 on the transparent photosensitive layer as can be seen in FIG. 2. Only a portion of coloring agent, determined by the difference of electric field strength between electrostatic latent image 3 and electrostatic latent image 6 adheres to that portion of electrostatic latent image 3 which faces electrostatic latent image 6 on transparent photosensitive layer 4. Thus, it is possible to decrease the quantity of toner which adheres to electrostatic latent image 3 by using a "masking" effect, that is by controlling the electric field of electrostatic latent image 3 with electrostatic latent image 6.

As stated above, the latent image 6 corresponds to the cyan portion of the original and on the highly charged portion of the main photosensitive element a large amount of magenta toner is deposited. On the main photosensitive layer the magenta toner is deposited corresponding to the charge, that is, the latent image. However, the amount of toner deposited is influenced by the charge on the transparent photosensitive layer (that is, latent image 6). Therefore, the amount of toner deposited on the portion which faces the highly charged portion of the latent image 6 is decreased. The magenta image density thus decreased is compensated by the magenta absorption portion of the cyan toner image which normally is an unwanted absorption.

For reproduction of a three colored image such as a "color slide," the above process is carried out in cyan, magenta and yellow colors. To obtain a three colored image by the use of the same main photosensitive layer, the main photosensitive layer must be panchromatically sensitized.

The following shows the combinations of the main photosensitive layer and filters and the spectral sensitivity of the transparent photosensitive layer to obtain various colors:

Toner Color For Developing	Filter Color	Spectral Sensitivity of Transparent Photosensitive Layer
Cyan	Red	Green
Magenta	Green	Red
Yellow	Blue	Red and Green

Thus, the toner image on the main photosensitive layer is obtained by correcting the inaccurate absorption of individual toner image for other colors.

The electrostatic latent image of the transparent photosensitive layer and the main photosensitive layer should be developed with no movement in their positions while they are facced but since exposure is carried out with one above another, registration is very easy.

For example, the photosensitive elements may be fixed relative to each other at one end, or may have a stick inserted into holes at one corner, etc.

The two electrostatic latent images are easily formed by a one time exposure.

The electrostatic latent images on the transparent photosensitive element and the main photosensitive element are in a mutual image relationship because the former is exposed from the support mirror side and the latter from the photosensitive layer side.

Accordingly, if the two images are faced as they are exposed, they match completely and are in a convenient form for development.

The present invention thus finds excellent application to obtaining electrostatic latent images in a mirror image relation by a one time exposure.

In representative photosensitive elements employed in the present invention, the following may be used.

For the conductive support, the following are generally used:

1. Paper having applied thereto polyvinyl alcohol, etc. so as to be electrically conductive;
2. Plastic films having a conductive surface layer, such as vacuum vaporized metal;
3. Metallic foils;
4. Metallic plates;
5. Plastic films having applied thereto organic materials, e.g., potassium polybenzene sulphonate so as, to be conductive.

As the main photosensitive layer, any photoconductive material may be used, for example, the following materials can be used:

1. Photoconductive zinc oxide which is spectrally sensitized by a coloring material, applied on the support in a polymeric binder, e.g., a styrenated alkyd resin, to provide a 5–30 micron dry thickness.
2. Photoconductive CdS powder which is spectrally sensitized by a coloring material absorptive in the red, green and blue regions, applied as in 1 above with a binder.
3. Selenium or selenium/tellurium evaporated on the support to a 10–200 micron thickness.
4. An organic photoconductive body such as polyvinyl carbazole which is spectrally sensitized by a coloring material, applied on the support with a plasticizer.

For the transparent photosensitive element, the following may be used:

For the support:

1. NESA coated glass.
2. CuI is on a plastic film.
3. A thin metal evaporated on the plastic film which is transparent and electrically conductive.

The transparent photosensitive part need not necessarily be completely transparent, and may be translucent with little absorption or diffusion of light because the main photosensitive part is exposed through the transparent photosensitive element.

For the photosensitive layer:

1. Photoconductive zinc oxide powder which is dye-sensitized, mixed with a binder and then applied to a thickness of 1–10 micron to be easily light penetrated.

2. An organic photoconductive body such as polyvinyl carbazole which is dye-sensitized.

When the main photosensitive layer is striking in color, for example, an evaporated selenium or selenium and tellurium layer, the toner image is preferably transferred onto an appropriate material such as paper, so that the colored image is obtained by repetitively transferring the different color images on the same material in position registration.

Where the colored image deposited is transferred, main photosensitive layers which are respectively sensitive to only blue, green and red can be used in each transfer process. In this case of the filter **14** is not necessary, since the spectral sensitivity of the main photoconductive layer is only blue, green or red.

In this case two photoconductive layers can directly each other, but in order to prevent undesirable discharging it is preferable to insert a transparent insulative material, that is, a plastic film between these two photoconductive layers.

For the present invention, any of the following well-known electrophotographic developments can be used.

1. Cascade developing;
2. Powder cloud developing;
3. Liquid developing;
4. Magnetic brush developing.

When the colored toner image is obtained by applying toner images on the same photosensitive material, the first toner image should not influence the electrophotography process occurring during the formation of the second color toner image. Thus, the liquid developing process using fine toner dispersed in an insulating liquid as the developer is especially suitable in this situation.

The present invention is also available for obtaining a separated positive separation or negative separation with color masking for printing instead of a colored image by applying toner image in an electrophotography process. In the instance, there is no need to change the color of the toner to each color with multiple applications. The exposure and development of the present invention are made one time with each color, and the color masked separated positives or negatives are obtained which can be used in photoengraving.

In the present invention, the foregoing description applies only to ordinary color separation color reproduction. In addition, the color of filter **14** shown in FIG. **1,** or the spectral sensitivity of the main photosensitive layer combined with the filter **14,** or the spectral sensitivity of the main photosensitive layer without the use of filter **14,** can be used to obtain special effects to extend over two colors or to select the middle color, without being limited to red, green and blue. The spectral sensitivity of the transparent photosensitive layer may also be varied in the same manner.

It goes without saying that the present invention is available for obtaining images by a positive — positive or negative — negative process as well as by a negative — positive process.

For instance, for negative — positive reproduction, the developing electrode is given a bias voltage of the same polarity as that of the charge of the electrostatic latent image and developing is made with a charged toner of the same polarity.

The present invention, as shown in FIG. **3,** can employ a transparent photosensitive element wherein the charge thereon acts as a biasing voltage instead of a developing electrode to which is applied a biasing voltage.

In FIG. **3**, for example, for obtaining a toner image of magenta, much magenta toner sticks to the low charge portion **23** as compared to charged area **21** of the electrostatic latent image on the main photosensitive element **12** because the toner, being charged negative, is repelled by the charge **20** of the transparent photosensitive layer to the main photosensitive part.

This is the case of reversal development. In contrast with the above cases, toners deposit on the portion where less charge is present on the main photoconductive element. On portion **22** where the charge is less corresponding to the cyan image of the original, magenta toner is deposited but reduced.

Thus, a masked image of magenta, which is in negative — positive relation to the original, is obtained on the main photosensitive part.

Numerous modifications of the invention will become apparent to one of ordinary skill in the art upon reading the foregoing disclosure. During such a reading it will be evident that this invention provides a unique electrophotographic process for accomplishing the objects and advantages herein stated.

What is claimed is:

1. An electrophotographic process including a color masking operation comprising providing a photoconductive insulator as a main photosensitive element and a substantially transparent photoconductive insulator as a transparent photosensitive element, where said main photosensitive element is provided with a grounded conductive support and said transparent photosensitive element is provided with a transparent grounded conductive support and where the spectrum sensitivity region of said transparent photosensitive element is different from the spectrum sensitivity region of said main photosensitive element or said main photosensitive element combined with a colored filter, charging both photosensitive elements with the same polarity, facing the charged surfaces of both said photosensitive elements toward each other so that a slight gap exists therebetween (1) with said colored filter interposed and/or a substantially transparent insulator interposed, or (2) with nothing interposed, image exposing while both said photosensitive elements are held in registry from the side of said transparent photosensitive element to obtain the electrostatic latent images of reflected image relation on said main photosensitive element and said transparent photosensitive element, and developing the latent image on said main photosensitive element while maintaining said registry between both said photosensitive elements, the amount of toner deposited being influenced by the latent image on said transparent photosensitive element.

2. An electrophotographic process as in claim **1** where said main photosensitive element is panchromatic and blue, green, and red filters are used respectively to effect a subtractive color process.

3. An electrophotographic process as in claim **1** where said main photoconductive material is panchromatic and a red filter is used, said transparent photoconductive material is green sensitive, and the color of the toner is cyan.

4. An electrophotographic process as in claim **1** where said main photoconductive material is panchromatic and a green filter is used, said transparent photoconductive material is red sensitive, and the color of the toner is magenta.

5. An electrophotographic process as in claim **1** where said main photoconductive material is panchromatic and a blue filter is used, said transparent photoconductive material is red and green sensitive, and the color of the toner is yellow.

6. An electrophotographic process as in claim **1** where said toner is of the same polarity as that of said latent images whereby reversal development is effected.

7. An electrophotographic process as in claim **1** where the polarity of said toner is opposite to that of said latent images to effect positive development.

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