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(71) Applicant: **MITA INDUSTRIAL CO. LTD., 2-28, 1-chome, Tamatsukuri Higashi-ku, Osaka 540 (JP)**

(72) Inventor: **Kubo, Masahiko, 332, Chisahara-cho, Tenri-shi Nara (JP)**

(74) Representative: **Silverman, Warren et al, HASELTINE LAKE & CO. Hazlitt House 28 Southampton Buildings Chancery Lane, London WC2A 1AT (GB)**

(54) A developing process for two-coloured electrophotography and a developing apparatus for the same.

(57) A developing process for two-colored electrophotography comprises: (1) feeding a developer to a non-magnetic sleeve, said developer comprising a first insulative and non-magnetic color toner charged with an electrical polarity, a second insulative and non-magnetic color toner charged with a different polarity from the charging polarity in the first color toner, and a magnetic carrier, (2) holding said developer on the sleeve, (3) transferring the first color toner from the sleeve to a first developing roller to hold on the first developing roller, (4) transferring the first color toner on the first developing roller to an electrostatic latent image on the surface of a photoreceptor with a different polarity from the charging polarity in the first color toner to form a visible image, (5) transferring the second color toner from the sleeve to a second developing roller to hold on the second developing roller, and (6) transferring the second color toner on the second developing roller to the other electrostatic latent image on the surface of the photoreceptor with the other polarity to form a visible image.

A DEVELOPING PROCESS FOR TWO-COLOURED ELECTROPHOTOGRAPHY AND A DEVELOPING APPARATUS FOR THE SAME

This invention relates to an electrophotographic method for the formation of two-colored images. More particularly, it relates to a developing process for the formation of distinct images having two colors, using two kinds of insulative and non-magnetic color toner and a simple developing unit, and toadeveloping apparatus for the same.

In order to emphasize particular portions in documents, conference materials or the like printed in a color ink such as black, corrections, comments and underlines are made on the original document material or the like by the use of colored pencils (e.g., red pencils) which are distinguishable from the basic color (i.e., black) of the original. However, once the original documents or materials are copied by a copying machine to distribute to subscribers, conference members, etc., such corrections, comments and underlines are reproduced in black only, so that the corrections, comments and underlines no longer appear to be emphasized. The colors to be used for such corrections, comments or underlines do not usually have to correspond to the colors in the original, but they are required to be distinguishable from the basic color of the original.

For this purpose, various methods for the formation of two-colored images have been proposed in, for example, U.S.P. 4,189,224 and U.S.P. 4,413,899 both of which are patented to Ricoh Co. Ltd., Japan.

According to these proposed methods, two kinds of electrostatic latent image having different polarities from each other which correspond to the two colors in the original are simultaneously formed, first, on a photoreceptor comprising a conductive substance and a photoconductive layer formed on the conductive substance. Two kinds of colour developer charged with different polarities are adhered to the electrostatic latent images, resulting in two-colored images, which are then subjected to a charging treatment to have the same polarity and transferred to a transfer paper followed by a fixing treatment. Two kinds of photoreceptor have been used, the photoreceptor mentioned above, one of which has a single photosensitive layer and an insulating layer on the photosensitive layer and the other of which has a photosensitive composite composed of two photosensitive layers of different spectral sensitivities. In the case where the photoreceptor is composed of a photosensitive composite, the electrostatic latent images having different polarities are formed by two charging treatments with different polarities and an exposing treatment, followed by a developing using a positively charged developer from a first developing means and a negatively charged developer from a second developing means, resulting in toner images having two colors.

Since the positively charged developer and the negatively charged developer, respectively, are fed to the electrostatic latent images from two separate developer containers, the developer positioned down stream tends to be contaminated by the developer preceding it. Moreover, having two developing means

results in an enlarged development area and increase in the amount of machinery required, resulting in a complicated mechanism which is difficult to maintain. On the other hand, there has been an approach in which these developers are contained in a single container, but it is so difficult to control the polarities of the developers that the formation of a toner image having a compound color cannot be avoided.

In addition, when the developer is a dual component developer, it is difficult to maintain the concentration ratio of the toner to the carrier at the tip of the brush to adhere the toner to the electrostatic latent image on the photoreceptor. Since the tip of the brush containing a rigid carrier composed of iron particles or glass beads is in contact with the surface of the photoreceptor, the surface of the photoreceptor is easily damaged. If the carrier is electroconductive, electric charges leak at the time when the carrier contacts the latent image on the photoreceptor resulting in a brush mark in the obtained visible image.

When the developer is a mono-component toner which is made using a rigid magnetite, etc., it tends to damage the surface of the photoreceptor during cleaning by means of a blade.

The developing process for two-colored electrophotography of this invention which overcomes the above-discussed disadvantages and other numerous drawbacks and deficiencies of the prior art, comprises: (1) feeding a developer to a non-magnetic sleeve, said developer comprising a first insulative and non-magnetic color toner charged with an electrical polarity, a second insulative and non-magnetic color toner charged with a different polarity from the charging polarity in the first color toner, and a magnetic carrier, (2) holding said developer on the sleeve, (3) transferring the first color toner from the sleeve to a first developing roller to hold on the first developing roller, (4) transferring the first color toner on the first developing roller to an electrostatic latent image on the surface of a photoreceptor with a different polarity from the charging polarity in the first color toner to form a visible image, (5) transferring the second color toner from the sleeve to a second developing roller to hold on the second developing roller, and (6) transferring the second color toner on the second developing roller to the other electrostatic latent image on the surface of the photoreceptor with the other polarity to form a visible image. The developer is, in a preferred embodiment, held on the sleeve by means of a fixed magnet disposed behind said sleeve.

A bias potential having a different polarity from the polarity of said first color toner is, in a preferred embodiment, applied to the first developing roller. A bias potential having a different polarity

from the polarity of said second color toner is, in a preferred embodiment, applied to the second developing roller.

A developing apparatus of this invention which overcomes the above-discussed disadvantages and other numerous drawbacks and deficiencies of the prior art, comprises:

(1) a non-magnetic sleeve,

(2) a developer vessel containing a first insulative and non-magnetic color toner charged with an electrical polarity, a second insulative and non-magnetic color toner charged with a different polarity from the charging polarity in the first color toner, and a magnetic carrier, and located in the vicinity of the photoreceptor drum,

(3) a feeding means for the developer to the non-magnetic sleeve when the latter is located in the vicinity of a photoreceptor drum,

(4) a holding means for holding said developer on the sleeve, and

(5) a first and a second developing roller, each of which is disposed between said holding means and said photoreceptor drum.

The apparatus preferably comprises means for applying a bias potential having a different polarity from the polarity of said first color toner to the first developing roller. Moreover, the apparatus preferably comprises means for applying a bias potential having a different polarity from the polarity of said second color toner to the second developing roller.

Thus, the invention described herein makes possible the objects of (1) providing a developing process for two-colored electrophotography wherein two-colored toner image is formed uniformly and reliably on

a photoreceptor using a single developing container, resulting in distinct images having two colors (but not a compound color); (2) providing a simple developing process for two-colored electrophotography; (3) providing a developing apparatus for the formation of distinct images having two colors, using a single developing container; and (4) providing a developing apparatus having a simple structure which makes easy the maintenance thereof.

For a better understanding of the invention and to show how the same can be carried into effect, reference will now be made by way of illustration only, to the accompanying drawing which is a partly sectional side view of a developing apparatus according to this invention.

The drawing shows a developing apparatus of this invention, which comprises a photoreceptor drum 1, a charging means 2 in the vicinity of the drum 1, an exposing means 3 beyond the charging means 2, and a developing means 4 beyond the exposing means 3.

As the photoreceptor drum **1**, any of photoreceptors on which electrostatic latent images are formed and maintained with positive and negative polarities by a known exposure treatment can be used with this invention, an example of which is a photosensitive composite comprising a first photosensitive layer **12** and a second photosensitive layer **13** formed on a conductive substrate **14**. The photosensitive layers **12** and **13** have different spectral sensitivities and are made of, for example, inorganic photosensitive substances such as amorphous selenium, zinc oxide, etc., or organic photosensitive substances such as polyvinylcarbazole, etc., but are not limited thereto. The photosensitive layer made of, for example, amorphous selenium is positively charged due to the p-electroconductivity, while the photosensitive layer made of zinc oxide is negatively charged due to the n-electroconductivity. The conductive substrate **14** supporting the photosensitive layers is made of, for example, a conductive metal such as aluminium, or by disposing an electroconductive substance on a plastic film base by vacuum evaporation deposition, or the like, but is not limited thereto.

A dielectric drum instead of the photoreceptor drum **1** can be used for the medium on which electrostatic latent images are formed with positive and negative polarities provided by means of pin electrodes.

The charging means **2** and the exposing means **3**, respectively, are selected from any means known to be useful for colored electrophotography in this invention. An example of the charging means **2** is an AC corona charger or two kinds of corona charger for

charging positively and negatively. An example of the exposing means **3** is made up of a light source and an optical system.

The developing means **4** comprises a container **42** for containing a developer **41** therein. The container **42** has a holding means **43** for holding the developer **41** on a sleeve **430**. The holding means **43** comprises the sleeve **430** and a fixed magnet **431** disposed behind the sleeve **430**. The magnet **431** is preferably fixed in order to uniformly adhere the developer **41** to the surface of the sleeve **430**. A first developing roller **44** and a second developing roller **45** are rotatably disposed between the holding means **43** and the photoreceptor drum **1**, and have bias potential application means **440** and **450**, respectively. At least the surface of each of the rollers **44** and **45** is made of a conductive and non-magnetic material such as aluminium .

The developer **41** in the container **42**, which consists of a first insulative and non-magnetic color toner **411**, a second insulative and non-magnetic color toner **412**, and a magnetic carrier **413**, is mixed by the sleeve **430** or an agitation roller (not shown) such that friction induces an electrostatic charge on the toners and the carrier, the polarities of each of which depend upon the order of charging tendency therebetween or the dielectric constant of the carrier. The first color toner **411** is, for example, charged with a negative polarity and the second color toner **412** is charged with a positive polarity. The fixed magnet **431** in the holding means **43** serves to adhere the charged developer **41** to the surface of the sleeve **430** and hold

it thereon. The sleeve **430** is made of, for example, a conductive and non-magnetic material such as aluminium and is rotatable around the magnet **431**. The carrier **413** is made of a magnetic material such as iron particles or the like. A bias potential is applied to each of the first and the second developing rollers **44** and **45** in such a manner that the first and the second developing rollers **44** and **45** are charged with, for example, a positive polarity and a negative polarity, respectively.

The developing process of this invention using the above-mentioned apparatus is as follows :

The developer **41**, which consists of two kinds of color toner **411** and **412** and a magnetic carrier **413** charged with a positive or a negative polarity due to friction therebetween, is adhered to the sleeve **430** and held thereon by means of the magnet **431** in such a manner that it forms a brush thereon in the direction of magnetic lines of force of the magnet **430**. The direction and the density of the magnetic lines of force to the developer **41** on the sleeve **430** vary as the sleeve **430** turns.

Then, the magnetic brush rises toward the developing rollers **44** and **45** due to an electrostatic force among the bias potential applied to each of the developing rollers **44** and **45** and the color toners **411** and **412**. Due to the bias potential, the first color toner **411** transfers from the sleeve **430** to the first developing roller **44** and is held thereon. The second color toner **412** transfers from the sleeve **430** to the second developing roller **45** and is held thereon, as

well. Since the magnetic carrier **413** bearing the second color toner **412** has the same charging polarity as the first color toner **411**, the magnetic carrier **413** tends to be attracted toward the first developing roller **44** due to the electrostatic force of the bias potential applied to the roller **44**. However, the magnetic carrier **413** is maintained on the sleeve **430** without transferring to the first developing roller **44** because the attraction of magnetic force of the magnet **431** is greater than that of the electrostatic force of the first developing roller **44**.

The color toners **411** and **412**, respectively, are carried toward the photoreceptor drum **1** as the developing rollers **44** and **45** turn. On the surface of the photoreceptor drum **1**, electrostatic latent images having polarities, which correspond to the two colors in the original, are formed, in advance, by the charging means **2** and the exposing means **3**. The first and the second color toner **411** and **412** are transfered from the first and the second developing rollers **44** and **45**, respectively, to the electrostatic latent images by a non-contact development such as a "jumping" development, a touch-down development, etc., resulting in a toner image. To control the thickness of the toner layer on each of the developing rollers, a thickness-regulation board such as a blade is disposed near the surface of the roller.

As the photoreceptor drum **1** turns, the toner image is successively formed on the electrostatic latent images thereon. The resulting toner images are then charged with the same polarity by means of a charger down stream of the developing means **4**, and

electrostatically transferred to a transfer paper in the transfer area, resulting in a distinct image having two colors.

It is understood that the colors of the toners **411** and **412** are not specific because they do not usually have to correspond to the colors in the original, but they are required to be distinguishable from the basic color of the original.

According to this invention, it is important that the color toners which constitute a developer together with a magnetic carrier, are insulative and non-magnetic. These toners are charged with a different polarity from each other due to friction between the toners and the carrier, resulting in an improved fluidity of the developer and an improved convayance of the toners. The toners do not damage the surface of the photoreceptor in the cleaning step because they contain no magnetite. The color toner consists of particles having a diameter of from **1** to **50**μm which are prepared by dispersing pigments into a resin binder such as styrene resins, acrylic resins, olefine resins, vinyle resins, saturated polyester resins, polyamide resins, alkyd resins, epoxy resins, xylene resins, etc., together with, as desired, a charge control agent, a toner-blocking agent, etc. These resins are selected depending upon the order of the charging tendency thereof. The pigments are made of, for example, carbon black when they are black, red iron oxide, cadmium red, fast red, etc., when they are red. As the charge control agent, an oil-soluble dye such as nigrosine base (C.I.5045), oil black (C.I.26150), spirane blue, etc.; metal naphthenates; metallic

fattiates soaps; resinate soaps; azo dyes containing metals; etc., can be used. As the toner-blocking agent, silica, alumina, talc, etc., can be used.

As the carrier, any of magnetic carriers known to be useful for two-colored electrophotography may be used, which is made of particles such as ferrite, nickel, cobalt, iron or the like the surface of which is coated with a polymer resin to improve the control of the friction-charging characteristic and the humidity depending characteristic.

Claims:

1. A developing process for two-colored electrophotography comprising:

(1) feeding a developer to a non-magnetic sleeve, said developer comprising a first insulative and non-magnetic color toner charged with an electrical polarity, a second insulative and non-magnetic color toner charged with a different polarity from the charging polarity in the first color toner, and a magnetic carrier,

(2) holding said developer on the sleeve,

(3) transferring the first color toner from the sleeve to a first developing roller to hold on the first developing roller,

(4) transferring the first color toner on the first developing roller to an electrostatic latent image on the surface of a photoreceptor with a different polarity from the charging polarity in the first color toner to form a visible image,

(5) transferring the second color toner from the sleeve to a second developing roller to hold on the second developing roller, and

(6) transferring the second color toner on the second developing roller to the other electrostatic latent image on the surface of the photoreceptor with the other polarity to form a visible image.

2. A developing process for two-colored electrophotography according to claim 1, wherein said developer is held on the sleeve by means of a fixed magnet disposed

within said sleeve.

3. A developing process for two-colored electrophotography according to claim 1 or 2, wherein a bias potential having a different polarity from the polarity of said first color toner is applied to the first developing roller.

4. A developing process for two-colored electrophotography according to claim 1, 2 or 3, wherein a bias potential having a different polarity from the polarity of said second color toner is applied to the second developing roller.

5. A developing apparatus comprising:

(1) a non-magnetic sleeve,

(2) a developer vessel containing a first insulative and non-magnetic color toner charged with an electrical polarity, a second insulative and non-magnetic color toner charged with a different polarity from the charging polarity in the first color toner, and a magnetic carrier, and located in the vicinity of the photoreceptor drum,

(3) a feeding means for the developer to the non-magnetic sleeve when the latter is located in the vicinity of a photoreceptor drum,

(4) a holding means for holding said developer on the sleeve, and

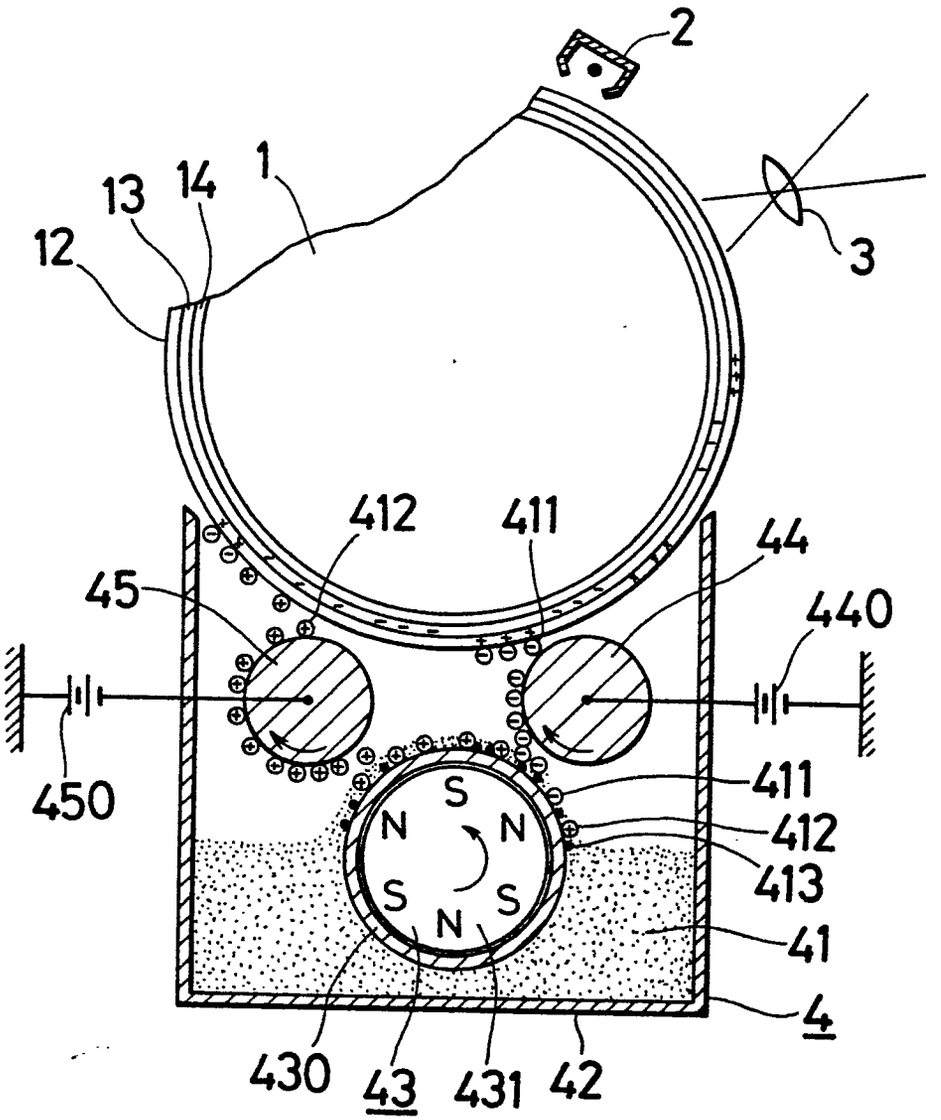
(5) a first and a second developing roller, each of which is disposed between said holding means and said photoreceptor drum.

6. A developing apparatus according to claim 5, additionally comprising a fixed magnet disposed within said sleeve for holding said developer on the sleeve.

7. A developing apparatus according to claim 5 or 6, additionally comprising means for applying to the first developing roller a bias potential having a different polarity from the polarity of said first color

toner.

8. A developing apparatus according to claim 5, 6 or 7, additionally comprising means for applying to the second developing roller a bias potential having a different polarity from the polarity of said second color toner.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EUROPEAN SEARCH REPORT

Application number

EP 85303870.1

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl 4)
D,A	US - A - 4 189 224 (SAKAI) * Abstract; fig. 1-3 * --	1,3,5,7	G 03 G 13/01 G 03 G 13/08 G 03 G 15/01 G 03 G 15/08
D,A	US - A - 4 413 899 (KARASAWA et al.) * Abstract * --	1,5	
A	US - A - 4 264 185 (OHTA) * Abstract; fig. 3,4 * --	1,5	
A	US - A - 4 351 604 (KARASAWA et al.) * Abstract; fig. 3 * ----	1,5	

TECHNICAL FIELDS SEARCHED (Int. Cl 4)

G 03 G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	05-09-1985	SCHÄFER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure

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