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

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Description

This invention relates to two color electrophotography and to the formation of two-color images therein. 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 to electrophotographic 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, US—A—4,189,224 and US—A—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 for 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 downstream 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 (US—A—4 264 185 patented to Ricoh Co Ltd).

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 electrophotographic process for two-color electrophotography of this invention which overcomes the above-discussed disadvantages and other numerous drawbacks and deficiencies of the prior art, comprises:

(1) forming an electrostatic latent image with positive and negative polarities on an electrostatic latent image forming medium,

(2) 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 polarity different from the polarity of the first color toner, and a magnetic carrier,

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

(4) transferring the first color toner from the first developing roller to the electrostatic latent image with a polarity different from the charging polarity of the first color toner,

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

(6) transferring the second color toner on the second developing roller to the electrostatic latent image with the other polarity.

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

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

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

(1) a medium on which an electrostatic latent image can be formed,

(2) means for forming an electrostatic latent image with positive and negative polarities on said medium,

(3) a non-magnetic sleeve,

(4) 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 polarity different from the polarity of the first color toner, and a magnetic carrier,

(5) a feeding meuns feeding for the developer to the non-magnetic sleeve,

(6) magnetic means for holding said developer on the sleeve,

(7) a first and a second developing roller, each of which is disposed between said sleeve and said medium and

(8) means to transfer the first color toner from the sleeve to the first developing roller and the second color toner to the second developing roller.

The apparatus preferably comprises means for applying a bias potential having a polarity different 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 polarity different 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 process for two-color electrophotography wherein a two-color 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 process for two-color electrophotography wherein developing is simple to carry out; (3) providing an electrophotographic apparatus for the formation of distinct images having two colors, using a single developing container; and (4) providing an electrophotographic apparatus whose developing equipment has 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 the components of an electrophotographic apparatus which together embody this invention.

The drawing shows an electrophotographic 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 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 color 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 uopn 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 transferred 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 conveyance 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. An electrophotographic process for two-color electrophotography comprising:

(1) forming an electrostatic latent image with positive and negative polarities on an electrostatic latent image forming medium,

(2) 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 polarity different from the polarity of the first color toner, and a magnetic carrier,

(3) transferring the first color toner from the

sleeve to a first developing roller,

(4) transferring the first color toner from the first developing roller to the electrostatic latent image with a polarity different from the charging polarity of the first color toner,

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

(6) transferring the second color toner on the second developing roller to the electrostatic latent image with the other polarity.

2. An electrophotographic process for two-color electrophotography according to claim 1, wherein the electrostatic latent image is formed on a photoreceptor.

3. An electrophotographic process for two-color electrophotography according to claim 1 or 2, wherein said developer is held on the sleeve by means of a fixed magnet disposed within said sleeve.

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

5. An electrophotographic process for two-color electrophotography according to any preceding claim, wherein a bias potential having a polarity different from the polarity of said second color toner is applied to the second developing roller.

6. An electrophotographic apparatus comprising:

(1) a medium (1) on which an electrostatic latent image can be formed,

(2) means for forming an electrostatic latent image with positive and negative polarities on said medium (1),

(3) a non-magnetic sleeve (430),

(4) a developer vessel (42) containing a first insulative and non-magnetic color toner (411) charged with an electrical polarity, a second insulative and non-magnetic color toner (412) charged with a polarity different from the polarity of the first color toner, and a magnetic carrier (413),

(5) a feeding means for feeding the developer to the non-magnetic sleeve (430),

(6) magnetic means (431) for holding said developer on the sleeve,

(7) a first (44) and a second (45) developing roller, each of which is disposed between said sleeve (430) and said medium (1) and

(8) means (440, 450) to transfer the first color toner from the sleeve (430) to the first developing roller (44) and the second color toner to the second developing roller (45).

7. An electrophotographic apparatus according to claim 6, wherein said medium (1) is a photoreceptor.

8. An electrophotographic apparatus according to claim 6 or 7, additionally comprising a fixed magnet (431) disposed within said sleeve for holding said developer on the sleeve.

9. An electrophotographic apparatus according to claim 6, 7 or 8, comprising means (440) for applying to the first developing roller (44) a bias potential having a polarity different from the polarity of said first color toner.

10. An electrophotographic apparatus according to any one of claims 6 to 9, comprising means (450) for applying to the second developing roller (45) a bias potential having a polarity different from the polarity of said second color toner.

Patentansprüche

1. Ein elektrophotographisches Verfahren für zweifarbige Elektrophotographie mit folgenden Verfahrensschritten:

(1) Erzeugen eines elektrostatischen, unsichtbaren Bildes mit einer positiven und negativen Polarität auf einem Medium zum Erzeugen eines elektrostatischen, unsichtbaren Bildes,

(2) Zuführen eines Entwicklers zu einer nichtmagnetischen Trommel, wobei der Entwickler einen ersten, isolierenden und nicht-magnetischen Farbtoner, der mit einer elektrischen Polarität geladen ist, einen zweiten, isolierenden und nicht-magnetischen Farbtoner, der mit einer von der Polarität des ersten Farbtoners unterschiedlichen Polarität geladen ist und einen Magnetträger enthält.

(3) Übertragen des ersten Farbtoners von der Trommel auf eine erste Entwicklungsrolle,

(4) Übertragen des ersten Farbtoners von der ersten Entwicklungsrolle zu dem elektrostatischen, unsichtbaren Bild mit einer von der Ladepolarität des ersten Farbtoners unterschiedlichen Polarität,

(5) Übertragen des zweiten Farbtoners von der Trommel auf eine zweite Entwicklerrolle, und

(6) Übertragen des zweiten Farbtoners auf der zweiten Entwicklerrolle zu dem elektrostatischen, unsichtbaren Bild mit der anderen Polarität.

2. Ein elektrophotographisches Verfahren für Zweifabrelektrophotographie nach Anspruch 1, bei dem das elektrostatische, unsichtbare Bild durch einen Photoaufnahmer gebildet wird.

3. Ein elektrophotographisches Verfahren für zweifarbelektrophotographie nach Anspruch 1 oder 2, bei dem der Entwickler auf der Trommel mittels eines festen Magneten gehalten wird, der innerhalb der Trommel angeordnet ist.

4. Ein elektrophotographisches Verfahren für zweifarbelektrophotographie nach Anspruch 1, 2 oder 3, bei dem ein Vorspannungspotential mit einer Polarität, die von der Polarität des ersten Farbtoners abweicht, an die erste Entwicklerrolle angelegt wird.

5. Ein elektrophotographisches Verfahren für Zweifarbelektrophotographie nach einem der vorhergehenden Ansprüche, bei dem ein Vorspannungspotential mit einer Polarität, die von der Polarität des zweiten Farbtoners abweicht, an die zweite Entwicklerrolle angelegt wird.

6. Ein elektrophotographisches Gerät mit folgenden Merkmalen:

(1) einem Medium (1), auf dem ein elektrostatisches, unsichtbares Bild erzeugbar ist,

(2) einer Einrichtung zum Erzeugen eines elektrostatischen unsichtbaren Bildes mit positiven und negative Polaritäten auf dem Medium (1),

(3) einer nicht-magnetischen Trommel (430),

(4) einem Entwicklergefäß (42), das einen ersten, isolierenden und nicht-magnetischen Farbtoner (411) enthält, der mit einer elektrischen Polarität geladen ist, einen zweiten isolierenden und nicht-magnetischen Farbtoner (412) enthält, der mit einer von der Polarität des ersten Farbtoners unterschiedlichen Polarität geladen ist und einen magnetischen Träger (413) enthält,

(5) einer Zuführvorrichtung zum Zuführen des Entwicklers zu der nicht-magnetischen Trommel (430),

(6) einer magnetischen Vorrichtung (431) zum Halten des Entwicklers auf der Trommel,

(7) einer ersten (44) und einer zweiten (45) Entwicklerrolle, die jeweils zwischen der Trommel (430) und dem Medium (1) angeordnet sind, und

(8) einer Einrichtung (440, 450) zum Übertragen des ersten Farbtoners von der Trommel (430) zu der ersten Entwicklerrolle (44) und des zweiten Farbtoners zu der zweiten Entwicklerrolle (45).

7. Ein elektrophotographisches Gerät nach Anspruch 6, bei dem das Medium (1) ein Photoaufnehmer ist.

8. Ein elektrophotographisches Gerät nach Anspruch 6 oder 7, das zusätzlich einen festen Magneten (431) enthält, der innerhalb der Trommel zum Halten des Entwicklers auf der Trommel angeordnet ist.

9. Ein elektrophotographisches Gerät nach Anspruch 6, 7 oder 8, mit einer Einrichtung (440) zum Anlegen eines Vorspannungspotentials mit einer von der Polarität des ersten Farbtoners abweichenden Polarität an die erste Entwicklerrolle (44).

10. Ein elektrophotographisches Gerät nach einem der Ansprüche 6 bis 9, mit einer Einrichtung (450) zum Anlegen eines Vorspannungspotentials mit einer von der Polarität des zweiten Farbtoners abweichenden Polaraität an die zweite Entwicklerrolle (45).

Revendications

1. Procédé électrophotographique pour électrophotographie en deux couleurs, consistant:

(1) à former une image latente électrostatique à polarités positive et négative sur un milieu de formation d'images latentes électrostatiques,

(2) à amener un agent de développement à un manchon non magnétique, cet agent de développement comprenant un premier toner couleur isolant et non magnétique chargé avec une polarité électrique donnée, un second toner couleur isolant et non magnétique chargé avec une polarité différente de le polarité du premier toner couleur et un support magnétique,

(3) à transférer le premier toner couleur du manchon à un premier rouleau de développement,

(4) à transférer le premier toner couleur de ce premier rouleau de développement à l'image latente électrostatique ayant une polarité différente de la polarité de la charge appliquée au premier toner couleur,

(5) à transférer le second toner couleur du manchon à un second rouleau de développement et

(6) à transférer le second toner couleur situé sur ce second rouleau de développement à l'image latente électrostatique ayant l'autre polarité.

2. Procédé électrophotographique pour électrophotographie en deux couleurs suivant la revendication 1, dans lequel l'image latente électrostatique est formée sur un photorécepteur.

3. Procédé électrophotographique pour électrophotographie en deux couleurs suivant la revendication 1 ou 2, selon lequel l'agent de développement est maintenu sur le manchon à l'aide d'un aimant fixe disposé à l'intèrieur de ce manchon.

4. Procédé électrophotographique pour électrophotographie en deux couleurs suivant la revendication 1, 2 ou 3, selon lequel un potentiel de polarisation présentant une polarité différente de la polarité du premier toner couleur est appliquée sur le premier rouleau de développement.

5. Procédé électrophotographique pour électrophotographie en deux couleurs suivant l'une quelconque des revendications précédentes, selon lequel un potentiel de polarisation offrant une polarité différente de la polarité du second toner couleur est appliqué au second rouleau de développement.

6. Appareil électrophotographique, comprenant:

(1) un milieu (1) sur lequel peut être formée une image latente électrostatique,

(2) des moyens permettant de former une image latente électrostatique à polarités positive et négative sur ce milieu (1),

(3) un manchon non magnétique (430),

(4) un réservoir d'agent de développement (42) contenant un premier toner couleur isolant et non magnétique (411) chargé suivant une polarité électrique donnée, un second toner couleur isolant et non magnétique (412) chargé avec une polarité différente de la polarité du premier toner couleur et un support magnétique (413),

(5) des moyens d'amenée permettant d'amener l'agent de développement au manchon non magnétique (430),

(6) des moyens magnétique (431) permettant de maintenir l'agent de développement sur ce manchon,

(7) un premier (44) et un second (45) rouleaux de développement, dont chacun est disposé entre le manchon (430) et le milieu (1) et (8) des moyens (440, 450) destinés à transférer le premier toner couleur du manchon (430) au premier rouleau de développement (44) et le second toner couleur au second rouleau de développement (45).

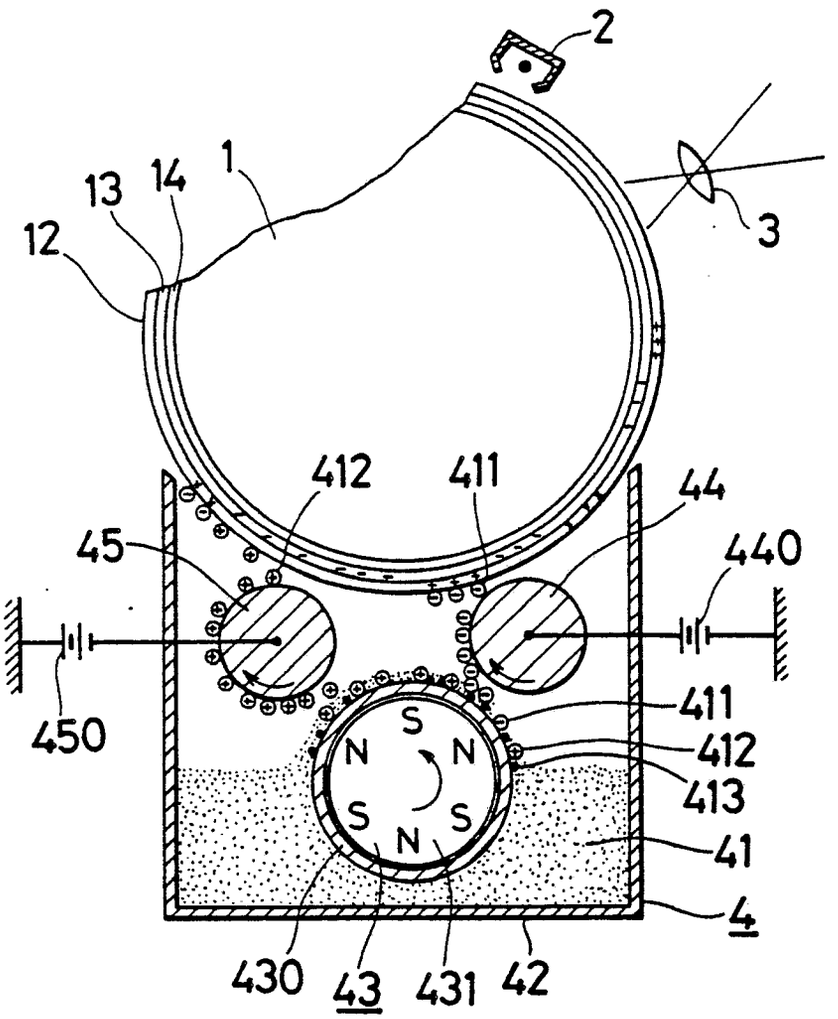
7. Appareil électrophotographique suivant la

revendication 6, dans lequel ledit milieu (1) est un photorécepteur.

8. Appareil électrophotographique suivant la revendication 6 ou 7, comprenant en outre un aimant fixe (431) disposé à l'intérieur du manchon et permettant de maintenir l'agent de développement sur ce manchon.

9. Appareil électrophotographique suivant la revendication 6, 7 ou 8, comprenant des moyens (440) permettant d'appliquer au premier rouleau de développement (44) un potentiel de polarisation offrant une polarité différente de la polarité du premier toner couleur.

10. Appareil électrophotographique suivant l'une quelconque des revendications 6 à 9, comprenant des moyens (450) permettant d'appliquer au second rouleau de développement (45) un potentiel de polarisation offrant une polarité différente de la polarité du second toner couleur.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