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Takahashi

[11] **3,904,406**

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[54] **ELECTROPHOTOGRAPHIC PROCESS OF TRANSFERING COLORED ELECTROSTATIC IMAGES**

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Related U.S. Application Data

[63] Continuation of Ser. No. 830,947, June 6, 1969, abandoned.

[52] **U.S. Cl.** **96/1.4;** 96/1.2

[51] **Int. Cl.**[2] **G03G 13/14;** G03G 5/12; G03G 13/01

[58] **Field of Search** 96/1, 1.2, 1.3, 2, 1.4; 355/11, 10

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Attorney, Agent, or Firm—Watson, Leavenworth, Kelton & Taggart

[57] **ABSTRACT**

A photosensitive member comprises a substrate, a photoconductive layer and an insulating layer. An electrostatic image corresponding to a first color content of a multicolor original image is formed on the photosensitive member and is developed by a color developing agent of such first color. The developed image is applied for temporary storage to an expanse of a transfer member placed in contact with the photosensitive member. This practice is repeated for at least a second color content of said original image using a developing agent of the second color, the developed image being applied to the same expanse of the transfer member. Discretely colored images so formed and accumulated on the transfer member are transferred at one time to an image recording member by pressing the recording member against the transfer member.

13 Claims, 12 Drawing Figures

FIG. 1

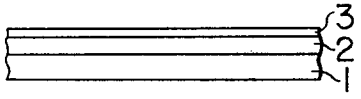


FIG. 2

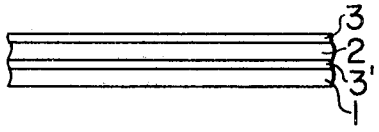


FIG. 3

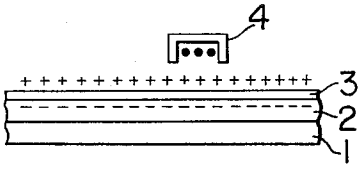


FIG. 4

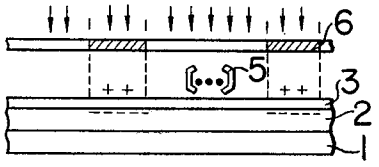


FIG. 5

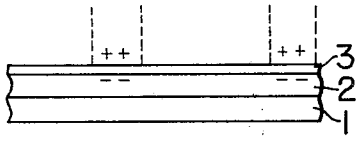


FIG. 6

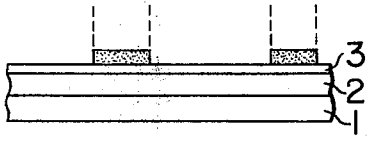


FIG. 7

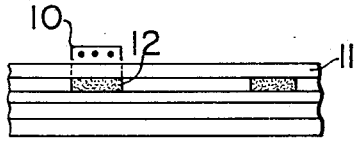


FIG. 8

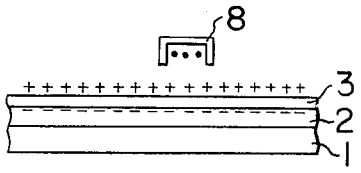


FIG. 9

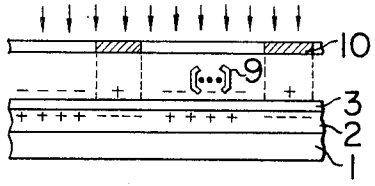


FIG. 10

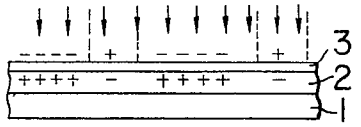


FIG. 11

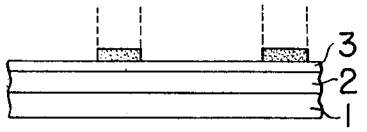
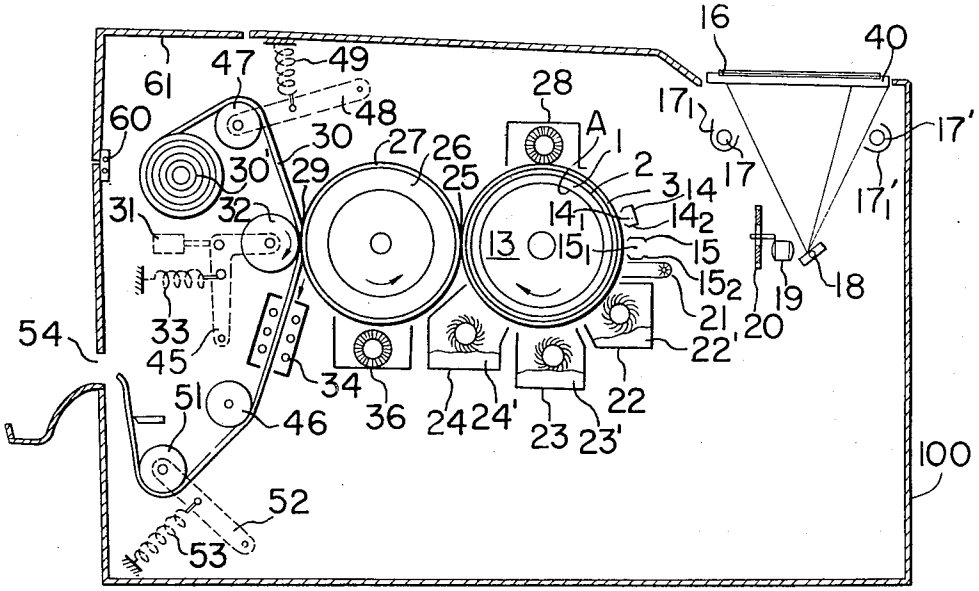


FIG. 12



ELECTROPHOTOGRAPHIC PROCESS OF TRANSFERING COLORED ELECTROSTATIC IMAGES

This is a continuation of application Ser. No. **830,947**, filed June **6, 1969**, now abandoned.

The present invention relates to an electrophotographic process and device and more particularly to an improved color electrophotographic process and device.

In conventional color electrophotographic methods, electrostatic charge is first uniformly imparted to the surface of a photosensitive member, a light image of an original is next projected thereon through a color filter to form an electrostatic latent image, this latent image is then developed with a developing agent having a color corresponding to that of the color filter, and the developed image is then transferred to an image recording member. The cycle consisting of the above described steps is repeated for each different color to forming the desired image upon the image recording member.

There has been proposed a color electrophotographic method in which electrostatic charge is imparted to a photosensitive member consisting of an electrically conductive substrate and a photoconductive layer laminated thereon, an electrostatic latent image is next formed by exposure through a color filter, the latent image is then developed with a developing agent having a color corresponding to that of the filter, and the developed visible image is transferred to an image recording member which is driven in synchronism with the photosensitive member. However, such method has a shortcoming in that color shears occur when multicolor printing is made upon a flexible member, such as fabric cloth, paper sheets, etc., which tends to expand or contract. There has been also proposed a method for transferring the pattern onto fabrics by use of the first-mentioned color electrophotographic methods. In this method, after formation the developed toner image on the photosensitive member is transferred by providing gentle contact between an image recording member and the toner image so as to transfer this image by use of the electric field therebetween. Therefore, the toner particles are only lightly attached on the nap of the cloth so that when the toner is fused the toner cannot penetrate into the fibers. That is, the toner is bonded to the portions of the cloth which are subjected to the strongest washing action so that the toner tends to be washed from the cloth. In multicolor printing, one color is printed or transferred to the cloth and another color is further printed or transferred to such colored cloth so that the adhesive or bonding force of the toner particles will not be improved even though the layer of the toner particles is increased. Therefore, color resistance to washing is very weak. In textile printing the printing conditions are more severe as compared with paper sheet printing. The present invention contemplates the elimination of the shortcomings described above by the provision of an electrophotographic process in which each color image is transferred to an intermediate blanket drum so that a complete color image may be formed thereupon and thereafter this image is transferred at one time to the image recording members, such as fabrics, thereby preventing color shears. The process according to the present invention may be advantageously used in printing textile fabrics. The primary object of the present invention is

therefore to provide an improved electrophotographic process and device.

Another object of the present invention is to provide an improved color electrophotographic process and device.

Another object of the present invention is to provide an improved electrophotographic process and device which completely eliminates color shears. A further object of the present invention is to provide an improved color electrophotographic process and device which can form high quality color images on fabrics. A still further object of the present invention is to provide an improved color electrophotographic process and device which can form high contrast color images.

In the embodiment of the present invention, the electrophotographic sensitive member disclosed in the applications, Ser. Nos. **563,899** and **571,538** is advantageously used. The present invention is characterized in that a photosensitive member whose fundamental construction consists of a substrate, a photoconductive layer and an insulating layer is precharged so that the electrostatic charge may be uniformly imparted thereto, a light image of an original is next projected through a color filter upon the photosensitive member while simultaneously applying a second electrostatic charge thereto, thereby forming an electrostatic latent image, the latent image is then developed with a developing agent of color corresponding to that of the color filter, the developed toner image is then transferred to a blanket roller, the above described steps being repeated so that toner images of different color are transferred to the blanket roller, thereby forming a complete color image, this complete color image is transferred to an image recording member at one time, thereby reproducing a color image of the original.

According to the process of the present invention, the electrostatic latent image formed upon the electrophotographic photosensitive member can be retained for a long time, and has remarkably high sensitivity and the photoconductive layer can withstand a large number of repetitive uses.

The above and other objects, features and advantages of the present invention will become more apparent from the following description taken in conjunction with the accompanying drawings, in which

FIG. **1** is a transverse elevational view of one embodiment of an electrophotographic sensitive member used in the present invention;

FIG. **2** is a transverse elevational view of another embodiment of an electrophotographic sensitive member used in the present invention;

FIGS. **3** to **5** are representative of the steps for forming an electrostatic latent image according to a fundamental electrophotographic process of the present invention;

FIG. **6** shows the visible image obtained by developing the electrostatic latent image formed in the steps of FIGS. **3** to **5**;

FIG. **7** shows the transfer of the visible iimage of FIG. **6** to an image recording member;

FIGS. **8** to **10** are representative of the steps for forming an electrostatic latent image according to another fundamental electrophotographic process of the present invention;

FIG. **11** shows the visible image obtained by developing the electrostatic latent image formed in the steps of FIGS. **8** to **10**; and

FIG. 12 is a schematic view of one embodiment of a color electrophotographic device suitable for carrying out the process of the present invention.

FIG. 1 is a transverse elevational view of one preferred embodiment of an electrophotographic photosensitive member advantageously used in the present invention. Reference numeral 1 designates a substrate, 2, a photoconductive layer, and 3, an insulating layer. FIG. 2 is a transverse sectional view of another preferred embodiment of an electrophotographic photosensitive member in which the reference numeral 1 designates an electrically conductive layer, 2, a photoconductive layer, and 3 and 3', insulating layers. In the case of FIG. 1, the substrate 1 may be either a conductive or an insulating layer. When the substrate 1 is made of conductive material, various conductive materials may be used. For example, they are of metal, such as copper, tin, aluminum and others. The substrate consisting of hygroscopic paper sheet having a thin aluminum foil bonded thereupon may be also used. Various insulating materials may be used as the insulating substrate. For example, they may be organic high molecular compounds such as fluororesins, polyethylene resins, polyethylens, etc. or inorganic compounds such as Al_2O_3, SiO_2, silica glass, TiO_2, BN, etc. The material for the photoconductive layer 2 may be selected from any material exhibiting photoconductivity upon illumination by radiation. For example, they may be CdS, CdSe, crystalline Se, ZnO, TiO_2, SeTe, PbO and other inorganic photoconductive materials and mixtures thereof. According to the present invention, crystalline Se which has not been used heretofore because of its low resistance, in sufficient for trapping or binding electrostatic charge, may be used with better results. Naturally, the photoconductive layer 2 may be made of an organic photoconductor. There may be used various organic photoconductors, for example: heterocyclic compounds such as oxadiazole, 5-aminothiazole and the like; compounds having a fused ring such as benzothiazole; compounds having a double bond such as acyl hydrazone; compounds having an amino group such as aminocarbazole triphenylamine, derivatives of triphenylamines and aminated biphenyl; compounds having a nitrile group such as aromatic nitrile, for example, dicyano naphthalene and dicyano nitrophenol; condensed products such as a condensation product of an aldehyde with an aromatic amine; polyvinylcarbazole such as poly-N-vinylcarbazole vinyl polymer such as α-alkylacrylamide polymer; and condensed polymer such as condensed products of a halide of carboxylic acid with triphenylamine.

Any material having a high resistance sufficient to trap or bind electrostatic charge may be used in the insulating layer 3. It is preferable to use a material having relatively high anti-abrasive strength for repetitive uses. For example, organic high molecular compounds such as fluororesins, polycarbonate resins, polyester resins, and the like and inorganic compounds such as Al_2O_3, SiO_2, silica glass, TiO_2, BN, and the like may be used. As the insulating layer 3', any material for the insulating layer 3 may be used. In order to form an electrostatic latent image of an original upon the electrophotographic photosensitive member shown in FIGS. 1 and 2, the photosensitive member is precharged, that is imparted with electrostatic charge by corona discharge, electrode charging, friction charging, etc. and then electrostatic with polarity opposite to that of said precharging, or AC voltage, is applied to the photosensitive member while simultaneously projecting a light image of the original thereon. Thereafter, if required, radiation to which the photoconductive layer is sensitive is applied to the whole surface of the photosensitive member, thereby forming upon the photosensitive member an electrostatic latent image having high contrast corresponding to the image of the original.

FIGS. 3 to 5 illustrate the fundamental electrophotographic process of the present invention for forming an electrostatic latent image upon a photosensitive member. This process will be described with respect to the photosensitive member consisting of three laminated layers, that is, an electrically conductive substrate, a photoconductive layer and an insulating layer. First, the photosensitive member is precharged with electrostatic charge of predetermined polarity by means 4, corona such as a corona discharger, friction discharger or electrode discharger. Electrostatic charge of positive polarity is imparted to the surface of the photosensitive member, but the present invention is of course not limited to positive polarity. In general, it is preferable to impart positive electrostatic charge to the photoconductive layer 2 when it is of n-type photoconductivity, and negative electrostatic charge thereto when it is of p-type photoconductivity, in the first or precharging step. By positive precharging, negative electrostatic charge is considered to be injected from the substrate side 1 and bound or trapped in the interface between the photoconductive layer 2 and the insulating layer 3 or in the portion of the photoconductive layer 2 adjacent to the insulating layer 3.

Next, by means of an AC corona discharger 5, AC corona discharge is applied to the precharged surface of the insulating layer 3, thereby dissipating the electrostatic surface charge, while simultaneously radiating the image of an original 6 upon the surface of the photoconductive layer which is sensitive to that radiation. Thus, an electrostatic latent image, due to the surface potential difference corresponding to the light and dark pattern of the original is formed upon the insulating layer 3 as shown in FIG. 4. In this embodiment, the insulating layer 3 is transmissive to radiation rays to which the photoconductive layer 2 is sensitive. If required, radiation is applied to the whole surface of the photoconductive layer to form a better quality electrostatic latent image corresponding to the light and dark pattern of the original 6. This is shown in FIG. 5. By such exposure, the electrostatic charge, which is trapped or bound in the portion of the photosensitive member corresponding to the dark portion (image portion) of the original and which is not bound by the electrostatic charge upon the insulating layer, is dissipated so that the original field due to the electrostatic charge having precharge polarity may be increased, thereby forming upon the surface of the insulating layer an electrostatic latent image having higher contrast than that of the electrostatic latent image shown in FIG. 4. The electrostatic latent image so formed will not be dissipated in ambient light and is stabilized sufficiently for a relatively longer time. Thus, it is suitable for repetitive use.

FIGS. 8 to 10 illustrate the steps of another fundamental electrophotographic process of the present invention for forming an electrostatic image upon the surface of an electrophotographic photosensitive member. The photoconductive member is first precharged

with electrostatic charge of predetermined polarity by means **8**, such as a corona discharger, friction discharger or electrode discharger. The polarity may be determined in the same manner as described in the first process above. In this case, the electrostatic charge layer is formed in the interface between the insulating layer **3** and the photoconductive layer **2**, the polarity of said charge layer being opposite to that of the electrostatic charge on the surface of the insulating layer. This is shown in FIG. **8**.

Next, voltage of polarity opposite to that used in precharging is applied to the surface of the insulating layer by a corona discharger **9** while simultaneously a radiant energy image of an original **10** is projected upon the surface of the photosensitive member, photoconductive layer **2** being sensitive to such radiation.

Therefore, the electrostatic charge condition or state of the insulating layer **3** is varied depending upon the dark and light pattern of the original, thereby forming an electrostatic latent image due to surface potential difference as shown in FIG. **9**. In the dark portion of the image, a high potential results on the photosensitive member.

Next, the radiation is applied to the whole surface of the photoconductive layer **2**, thereby dissipating the electrostatic charge in a portion of the interface between the photoconductive layer and the insulating layer corresponding to the dark portion of the original and not bound by the electrostatic charge on the surface of the insulating layer, whereby the polarity of the electrostatic charge on the surface is reversed and simultaneously the surface potential difference is increased. Therefore, as shown in FIG. **10**, on the insulating layer surface is formed a high contrast electrostatic latent image having a high potential at a portion thereof corresponding to the light portion of the original. In this process the electrostatic latent image so formed will not dissipate in ambient light and is sufficiently stable for long term use as in the case of the first process described with reference to FIGS. **3** to **5**.

After formation of the electrostatic latent image, it may be developed by means of electrophotographic developing agents. The developing step is shown in FIG. **11**. When the photoconductive layer is made of n-type photoconductive material, the surface potential of the image portion after over-all-surface exposure is positive with respect to that of the non-image portion while when the photoconductive layer is made of p-type photoconductive material, the surface potential of the image portion after over-all-surface exposure is negative with respect to that of the non-image portion. The polarity of the electrostatic charge at the image portion as described above, directs selection of the polarity of the electrostatic charge imparted to electrophotographic developing agents. However, for some purposes, the polarity of electrostatic charge imparted to the developing agents can be otherwise selected. The next step is to transfer the developed visible image to a conductive or insulating image recording member such as paper sheet, cloth, wood, metal foil, etc. by pressing the recording member upon the toner image. It is preferable to apply corona discharge or the like to the image recording member when the image is transferred thereto. This is shown in FIG. **7** wherein, the toner image is designated by reference numeral **12**, the image recording member, by **11**, and a corona discharger by **10**. The discharger applies corona dischage to the image recording member thereby transferring the toner image **9** to the recording member.

According to the color electrophotographic process and device in accordance with the present invention, in the step of simultaneous exposure and secondary voltage application, the exposure is made through one of a predetermined number of color filters, and the latent image formed by the exposure is developed by use of a developing agent corresponding to one specific color filter. The developed color image is transferred to an intermediate blanket drum. Such cycle is repeated for each color filter used. Then a single color printing is made by transferring the complete color image to an image recording member from the intermediate blanket, as described in more detail hereinafter.

FIG. **12** shows one embodiment of a color electrophotographic device adapted to carry out the electrophotographic process according to the present invention. The device comprises a housing generally designated by reference numeral **100** in which various components and elements for carrying out the color printing are arranged. A photosensitive member A consists of a substrate **1**, a photoconductive layer **2** and an insulating layer **3** laminated one upon another in the order named, and has the configuration of a roll adapted to be fitted over a rotary drum **13** which is rotated in the direction indicated by the arrow by drive means (not shown). A corona discharger **14** for precharging is disposed in spaced relation with the insulating layer **3** and has an electrode 14_1 and a shield 14_2 encircling said electrode. The electrode 14_1 is connected to a high voltage source (not shown), so that the surface of the insulating layer **3** may be charged with uniform electrostatic charge upon energization of the corona discharger **14**. Positive or negative polarity charge is imparted to the insulating layer **3** preferably in accordance with the n- or p-conductivity of the photoconductive layer **2**. An exposure unit **50** has optical system comprising light sources **17** and **17'** their reflecting plates or hoods 17_1 and $17_1'$, a rotatable mirror **18**, lens **19** and color filter **20**. An original **16** placed upon an original holder **40** is projected upon the insulating layer **3** through the color filter **20** selected from a predetermined number of color filters which may be changed from one to another just prior to exposure. Another corona discharger **15** which serves to apply the second voltage to the photosensitive member is provided with a high voltage of polarity opposite to that of the precharging voltage, or high AC voltage, so as to apply corona discharge upon the surface of the insulating layer **3** from the electrode 15_1 while the light image of the original **16** is simultaneously projected or radiated thereupon. In order to carry out the simultaneous light image projection of the original, the upper portion of a shield 15_2 of the corona discharger **15** is preferably opened or made of a transparent electrode which can transmit said light image therethrough. Radiation means **21** is adapted to radiate the whole surface of the photoconductive layer **2** and is, for example, an incandescent lamp or fluorescent lamp so that the electrostatic latent image formed in the preceding step may have increased contrast. Developing agent containers **22**, **23** and **24** contain therein developing agents corresponding to the electrostatic latent images formed through the color filters. For example, the container **22** contains yellow toner **22'** for developing the latent image formed through the blue filter. The magenta

toner 23' for developing the image formed through the green filter is provided in the container 23: and the cyan toner 24' for developing the latent image formed by the red filter is provided in the container 24. Wet or dry type developing agents may be used. For example, as dry type developing agents, there may be used: a cyan toner containing Picolastic D-125 (Trademark, Esso Standard) which is a polystyrole resin and Orasol Brilliant Blue GN (Trademark, Ciba Ltd.) which is an oil soluble metal complex dye; magenta toner containing Picolastic D-125 and Orasol red G; and a yellow toner contaning Picolastic D-125 and Orasol yellow GRL, etc. They are best suited for transferring the toner images to the paper sheets. In case of printing onto silk or the like, it is preferably to use in development the cyan toner containing Picolastic D-125 and Kayacyl Blue AGG (Trademark, Nippon Kayaku K.K.), which is an acid dyestuff, magenta toner containing Picolastic D-125 and Kayanol Milling Red GRN, and yellow toner containing Picolastic D-125 and Kayacyl Yellow GG. However, it will be understood that the present invention is not limited to the above developing agents, there. As wet type developing agents may be used the yellow developing solution in which the yellow toner containing boiled linseed oil and lead chromate is dispersed in a highly insulating liquid, such as n-pentene carbon tetrachloride, Isoper H, etc; magenta developing solution in which the toner containing boiled linseed oil and cadmium selenate is dispersed in n-pentene; and the cyan developing solution in which the cyan toner containing boiled linseed oil and phthalocyanine blue is dispersed in n-pentane. The foregoing are examples only and all of the conventional toners may be used in the present invention. In the embodiment, three-color printing is used, but it is to be understood that the present invention is of course not limited to three-color printing. Any number, n, of colors may be used in the printing process of the present invention, n, being a whole integer. Furthermore, when for example the developing container 22 is actuated, the other two, 23 and 24, remain unoperated.

An intermediate blanket drum 26 is interposed between the photosensitive member drum 13 and an image recording member so as to rotate in the direction indicated by the arrow. A color toner image so developed is temporarily transferred onto the intermediate blanket drum or roller 26 at a position such as 25. Thus, a number of color toner images corresponding to the number of images formed through the color filters may be transferred onto the intermediate blanket drum 26 and then finally transferred to the flexible image recording member to be printed. If required, a conductive film, semi-conductor film or insulating film 27 may be coated over the intermediate blanket drum 26. Cleaner means 28 is provided for removing all of the remaining developing agent upon the photosensitive member A after transferring the toner image formed thereupon to the blanket drum or roller 26. For example, the cleaner means 28 contain a fur brush for rubbing the surface of the photosensitive member so as to remove the toner. However, the present invention is not limited to such fur brush cleaner means. For example, cleaning solution may be used to clean the surface of the photosensitive member and the cleaning solution containing therein the developing agent may be directed into a cleaning chamber so that the toner may be separated and purified by attracting the same to electrode plates disposed within the chamber. Purified cleaning solution may then be recirculated for further cleaning operation. A cleaner 36 is adapted to clean the surface of the intermediate blanket drum 26 after transfer of the images. A desired number of color toner images of one original formed and transferred to the intermediate blanket drum or roller 26 may be transferred to the flexible image recording member 30 at a position as 29. The image recording member 30 remains spaced from the blanket drum 26 until all of the color toner images are transferred to the intermediate blanket drum 26 from the photosensitive member A. Thereafter, the image recording member 30 is brought in contact with the blanket drum 26 so that all of the color toner images transferred thereupon may be transferred further at one time to the image recording member 30. To an arm 45 are connected a plunger 31 and a pressure roller 32 adapted to press the image recording member against the blanket drum 26. A spring 33 is connected to the arm 45 to bias the arm to a protracted position. The plunger 31 is adapted to move the pressure roller 32 toward and away from the blanket drum 26. In this case, it is preferable that the pressure applied to the image recording member 30 be higher than 1 kg. The pressure roller 32 may serve as a transfer roller when a voltage is applied across the intermediate blanket drum 26 and the pressure roller 32 in transferring the images to the flexible image recording member 30. A fixing device 34 may be, for example, composed of an infrared heater so that the toner of the visible image transferred to the flexible image recording member 30 may be melted and fixed to the image recording member 30 when passing through the fixing device 34. Feed rollers 46, 47 and 51 are provided for advancing the image recording member 30 in the direction indicated by the arrow in FIG. 12 and springs 49 and 53 are attached to the feed rollers 47 and 51 respectively through their arms 48 and 52 so that the suitable tension may be imparted to the advancing image recording member 30. The image recording member 30 passed through the feed roller 51 may be discharged directly out of the printing device or may be cut into a predetermined length by a suitable cutting means (not shown) prior to the discharge through an outlet 54.

A rolled image recording member 30' may be supplied and set in position through a cover 61 attached to the housing 100 by a hinge 60. It is to be understood that the present invention is not limited to the use of a rolled image recording member. The image recording member in the form of sheet may be fed into the printing device one by one from a stack thereof.

The mode of separation of the color electrophotographic device having the construction as described will now be described. First, the photosensitive member A on the drum 13 is precharged by the discharger 14 so that electrostatic charge may be uniformly imparted to the surface thereof. Next by means of the optical system comprising the light sources 17 and 17', the rotatable mirror 18, the lens 19 and the filter 20, image of the original is projected upon the photosensitive member A while simultaneously imparting electrostatic charge with polarity opposite to that of the precharging voltage or applying AC corona discharge, so that the electrostatic latent image due to the surface potential difference corresponding to the light and dark pattern of the original is formed upon the surface of the insulating layer. In this case, for example, a blue filter

is used. Next by the radiation means **21**, the whole surface of the photosensitive member A is exposed so that an electrostatic latent image having highly increased contrast is formed upon the surface of the photosensitive member A. Thereafter, the electrostatic latent image is developed by yellow toner corresponding to the blue filter. The developed image is electrostatically transferred at position **25** to the intermediate blanket drum which is rotating in synchronism with the photosensitive member A. The latter is cleaned by the cleaner means **28.** Next a green filter is used and the above described steps are repeated in similar manner with the exception of the use of the magenta toner of color corresponding to the green filter. The developed image is transferred to the blanket drum having the yellow toner image thereupon formed by the preceding steps. The drum A is cleaned by the cleaner means **28.** Thereafter, a red filter is used. The image forming steps described above are repeated so that a cyan toner visible image is formed and transferred to the blanket drum **26** then bearing a two-colored toner image, whereby a three-color toner image is formed upon the blanket drum **26.** Then, the flexible image recording member **30** such as fabric cloth which had been spaced from the blanket drum **26** during the above three-color image formation is pressed against the blanket drum **26** by the pressure roller **32** which is protracted under force of the spring **33** since the plunger **31** is released. Thus, three color toners may be forced into the image recording member **30** by the pressure roller **32** so that the toner particles may be more deeply and securely held in the recording member **30** as compared with the case where the image is transferred by the conventional photosensitive plate and the transfer roller. In the fixing device **24,** the toner held in the recording member **30** is fused and fixed thereto securely the recording member is then discharged from machine. The cleaner **26** is actuated only after the image has been completely transferred to the image recording member **30** from the blanket drum **26** so as to clean the same. It is preferable that all of the exposure portion and the transfer portions **25** and **29** may be arranged in the same plane, so that the vibrations caused by the impact of the roller **32** upon the drum **26** by the sudden release of the plunger **31** may be prevented from adversely affecting the formation of the electrostatic latent image during the exposure. Also in case the photosensitive member A is subjected to radiation once in a half cycle of the drum **13,** the actuation of the plunger **31** does not cause color shears in printing.

According to the color electrophotographic process and device of the present invention, each color image may be transferred once to the blanket drum which rotates in precise synchronism with the photosensitive member drum so that accurate registration may be effected. Thereafter, the complete color image is transferred in one step to the image recording member from the blanket drum so that no color shear may occur. Therefore, the process and the device of the present invention are well suited for multicolor printing. Furthermore, since the visible image is forced into the image recording member by the pressure roller when the cloth fabric is printed, sufficient color fastness to washing is provided. Furthermore, the photoconductive layer **2** on the photosensitive member drum may be prevented from being damaged by contact with the rigid blanket drum **26** because the photosensitive drum generally incorporates an insulating layer surface made of a strong resin, such as a polyester resin.

What is claimed is:

1. An electrophotographic process for copying an original comprised of *n* different color contents, *n* being a whole integer, comprising the steps of:

a. forming separate electrostatic images on a photosensitive member, each said electrostatic image corresponding to a different one of said *n* different color contents of said original;

b. developing each said electrostatic image with a developing agent corresponding to the color content of said original involved in said forming of said electrostatic image;

c. applying each such developed image to the same expanse of a non-elastic image transfer member to form a multicolor image thereon; and

d. transferring said multicolor image to a recording member.

2. An electrophotographic process for copying a multicolor original, comprising the steps of:

a. forming separate electrostatic images on a photosensitive member, each said electrostatic image corresponding to one selected color content of said original;

b. developing each said electrostatic image with a developing agent corresponding to the color content of said original involved in said forming of said electrostatic image;

c. applying each such developed image to the same expanse of non-elastic image transfer member to form a composite color image thereon; and

d. transferring said composite color image to a recording member.

3. An electrophotographic process comprising the steps of:

a. forming a first electrostatic image corresponding to a first color content of a multicolor original image on a photosensitive member comprising a substrate, a photoconductive layer overlying said substrate and an insulative layer overlying said photoconductive layer;

b. developing said first electrostatic image with a developing agent of said first color;

c. applying said developed first image to an expanse of a non-elastic image transfer member;

d. forming on said photosensitive member a second electrostatic image corresponding to a second color content of said original image;

e. developing said second electrostatic image with a developing agent of said second color;

f. applying said developed second image transfer member expanse; and

g. disposing on image recording member in pressure contacting relation with said image transfer member expanse, thereby providing a multicolored image of said original shape in said image recording member.

4. The process claimed in claim **3** wherein said steps of forming said electrostatic images on said photosensitive member are performed by:

a. applying a charge of one polarity to the surface of said insulative layer; and

b. while exposing said photoconductive layer to a pattern of image radiation corresponding to one color content of said original image, applying to

said insulative layer surface an electrostatic charge of polarity opposite to said one polarity.

5. The process claimed in claim **3** wherein said steps of forming said electrostatic images on said photosensitive member are performed by:

a. applying a charge of one polarity to the surface of said insulative layer;

b. while exposing said photoconductive layer to a pattern of image radiation corresponding to one color content of said original image applying to said insulative layer surface an electrostatic charge of polarity opposite to said one polarity; and

exposing said photoconductive layer to unpatterned radiation.

6. The process claimed in claim **3** wherein said steps of forming said electrostatic image on said photosensitive member are performed by:

a. applying a charge of one polarity to the surface of said insulative layer; and

b. while exposing said photoconductive layer to a pattern of image radiation corresponding to one color content of said original image, applying to said insulative layer surface an alternating current corona discharge.

7. The process claimed in claim **3** wherein said steps of forming said electrostatic image on said photosensitive member are performed by:

a. applying a charge of one polarity to the surface of said insulative layer;

b. while exposing said photoconductive layer to a pattern of image radiation corresponding to one color content of said original image, applying to said insulative layer surface an alternating current corona discharge; and

c. exposing said photoconductive layer to unpatterned radiation.

8. The process claimed in claim **3** wherein said color developing agents are dry color developing agents.

9. The process claimed in claim **3** wherein said color developing agents are wet color developing agents.

10. The process claimed in claim **3** further including the terminal step of fixing said multicolored image on said image recording member.

11. The process claimed in claim **3** wherein said image transfer member includes a surface film of insulative material.

12. The process claimed in claim **3** wherein said image transfer member includes a surface film of semiconductor material.

13. An electrophotographic process comprising the steps of:

a. supporting for rotation a first drum bearing a surface photosensitive member comprising a substrate, a photoconductive layer overlying said substrate and an insulative layer overlying said photoconductive layer;

b. disposing a second drum supported for rotation and bearing on its surface a non-elastic image transfer member in contacting relation with said first drum for rotation synchronously therewith;

c. forming on said photosensitive member a first electrostatic image corresponding to a first color content of a multicolor original image;

d. developing said first electrostatic image on said photosensitive member with a developer of said first color;

e. rotating said first drum sufficiently to transfer said first colored image onto said image transfer member;

f. repeating said image forming, image developing and first drum rotating steps in respect of a second color content of said original image, thereby transferring a second colored image onto said image transfer member in registration with said first colored image thereon; and

g. further rotating said first drum while pressing a translatable image recording member into substantially line contacting relation with said second drum, thereby providing a multicolored image of said original image in said image recording member.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,904,406

DATED : September 9, 1975

INVENTOR(S) : Toru Takahashi

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 59 "iimage" should read --image--.
Column 3, line 23, "polyethylene" should read --polycarbonate--.
Column 3, line 24, "polyethylens" should read --polyethylenes--.

Column 3, line 68, after "electrostatic" insert --charge--.
Column 4, line 43, delete "rays".

Column 4, line 56, delete "having" and insert --of the--.
Column 4, line 62, after "time" insert --period--.
Column 5, line 24, delete "the" (first instance).
Column 5, line 54, delete "the" (first instance).
Column 5, line 54, after "to" insert --the--.
Column 6, line 57 "opened" should read --open--.
Column 7, line 15, "preferably" should read --preferable--.

Column 7, lines 27 and 30, "pentene" should read --pentane--.
Column 7, line 59, "contain" should read --contains--.
Column 8, line 53, "separation" should read --operation--.
Column 8, line 61, before "image" insert --an--.

Column 9, line 68, after "photosensitive" insert --member--.
Column 11, line 10, after "image" insert --,--.
Column 11, line 13, before "exposing" insert --(c)--.

Signed and Sealed this

Third Day of August 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks