

[54] ELECTROPHOTOGRAPHIC OR
XEROGRAPHIC METHOD FOR TREATING
A PICTURE IMAGE

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[51] Int. Cl. G03g 13/22
[58] Field of Search..... 96/1 R, 1.4, 44, 45.2;
117/17.5

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Primary Examiner—Norman G. Torchin
Assistant Examiner—John L. Goodrow
Attorney, Agent, or Firm—Wolder & Gross

[57] ABSTRACT

An electrophotographic method for treating a picture includes the steps of charging a substrate at a first polarity, projecting an image of an original on the charged substrate to produce an electrostatic latent image, imparting a uniform charge of opposite polarity to the image bearing substrate to reverse the polarity of the electrostatic latent primary image and projecting a secondary image of an original on the reversed polarity image bearing substrate to produce a resultant image which is then developed. The primary and secondary images may be of different originals to produce resultant images of additive or reductive portions permitting the simple examination of the differences between the originals, the images may be offset images of the same original to provide relief pictures, or they may be focussed and defocussed images of the same original to emphasize fine details. The charge reversal is obtained by exposing the primary image bearing substrate to a constant current corona or to a uniformly charged superimposed dielectric member.

11 Claims, 19 Drawing Figures

Fig. 1.

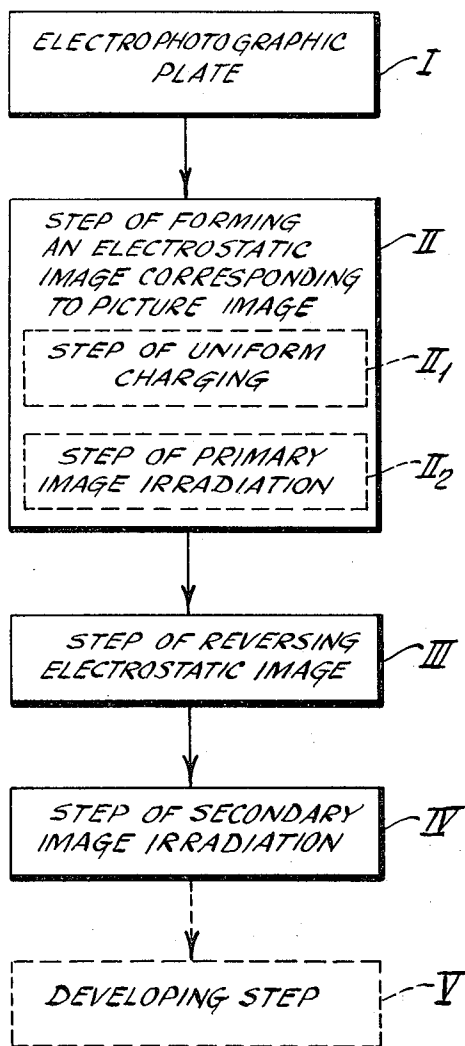


Fig. 2(a)

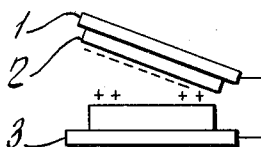


Fig. 2(b)

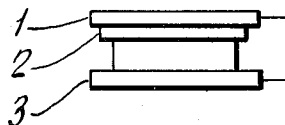


Fig. 2(c)

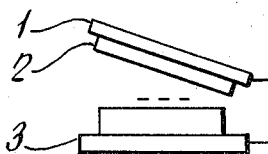
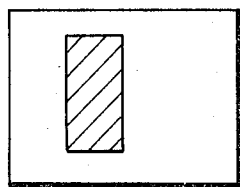


Fig. 3(a)



ORIGINAL A

Fig. 3(b)

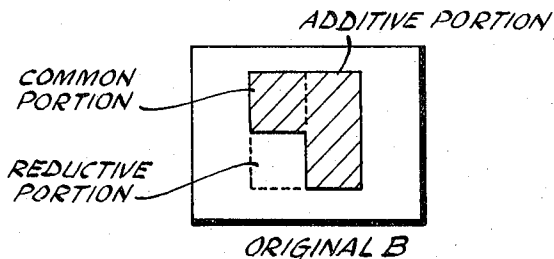


FIG. 4(a).

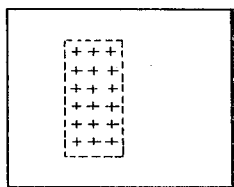


FIG. 4(b)

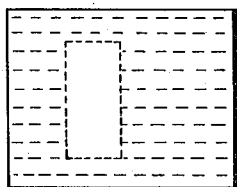


FIG. 4(c)

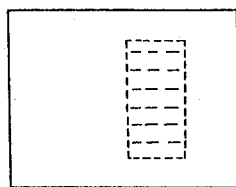


FIG. 5(a)

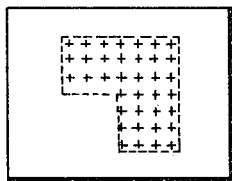


FIG. 5(b)

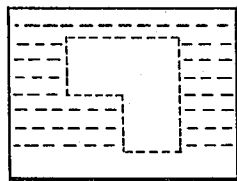


FIG. 5(c)

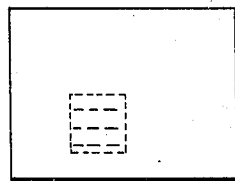


FIG. 6(a)

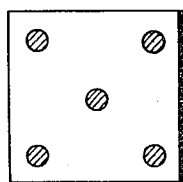


FIG. 6(b)

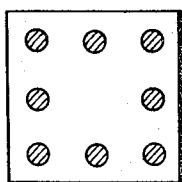


FIG. 6(c)

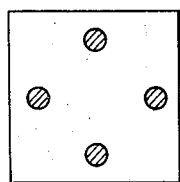


FIG. 6(d)

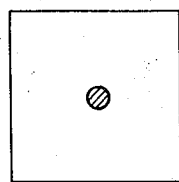


FIG. 7.

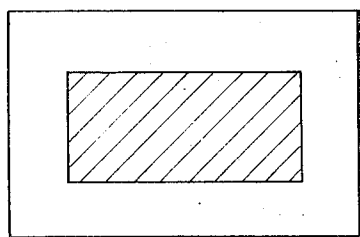


FIG. 8.

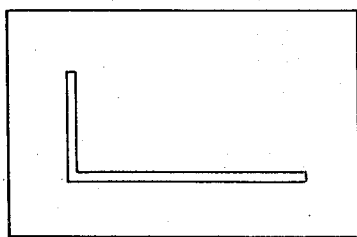
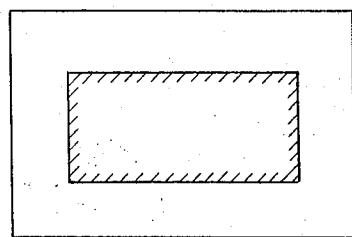


FIG. 9.



ELECTROPHOTOGRAPHIC OR XEROGRAPHIC METHOD FOR TREATING A PICTURE IMAGE

The present invention relates generally to a method for treating a picture image by electrophotography, and it relates more particularly to an improved electrophotographic or xerographic method for treating a picture image which is capable of modifying the picture image depending upon the specific end purpose.

There are various occasions when modification or change of a picture image is desirable. Among such occasions are for example, the emergence of a variant portion such as an adding portion or a reducing portion, between two picture images; formation of reliefs, the emergence of detailed or fine portions of a picture image, or the like. The method for treating a picture image provides, modification or change of a picture image depending upon the specific purposes and serves as an improvement in a picture image and facilitates judgement or observation of represented objects and relationships.

The conventional methods for treating a picture image in which a desired picture image is either added or reduced are:

1. an electrical image treatment method wherein a picture image is subjected to scanning to be converted to electric signals, and the electric signals are electrically treated by electric circuits or an electronic computer for presenting a modified image on a picture tube;
2. an optical image treatment method in which a modified picture image is produced through an optical procedure by means of an optical system using interference light and known as a coherent optical system; and,
3. a silver-salt photographic image treatment method wherein a silver-salt photograph is used, and a negative image subjected to a given treatment is overlapped upon a positive image, thereby obtaining a modified picture image. The known methods, however, possess many drawbacks. The first above indicated method fails to produce a picture image of high resolving-power, because of the scanning interval and the characteristics of the picture tube, and in addition the apparatus used in this method is costly; in the second or optical treatment method, because of the nature of the light wave, an accuracy of the respective components of the optical system is required at least commensurate with the order of the wave length in every unit of wave length, and this results in great difficulty in obtaining a suitable picture image; and in the last or silver-salt photographic image treatment method, it is very difficult to provide the required gradation and density, and in addition, the procedures are troublesome because it is necessary to form a negative image and to adjust the position of the picture image for overlapping two images one upon another.

It is accordingly a principle object of the present invention to provide an improved method for producing a composite image or picture.

Another object of the present invention is to provide an improved method for producing a composite image by electrophotography or xerography.

Still another object of the present invention is to provide an improved method for producing a composite image which is a function of a plurality of unit images.

A further object of the present invention is to provide an improved electrophotographic method for producing a resultant image which is the variance or difference between a pair of images or originals.

Still a further object of the present invention is to provide an improved electrophotographic method for forming relief images.

Another object of the present invention is to provide an improved method of the above nature characterized by its simplicity, low cost, inexpensive equipment, great versatility and which is capable of producing images having fine detail and varied characteristics.

The above and other objects of the present invention will become apparent from a reading of the following description taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a block diagram representing the basic process of the present invention;

FIGS. 2(a) to 2(c) are front elevational views illustrating the reverse changing of a latent electrostatic image;

FIGS. 3(a) and 3(b) are plan views of a pair of originals which are to be treated by the present method;

FIGS. 4(a) to 4(c) are plan views illustrating the successive steps in the production of a first composite image from the originals shown in FIGS. 3(a) and 3(b);

FIGS. 5(a) to 5(c) are views similar to FIGS. 4(a) to 4(b) showing the production of another composite image;

FIGS. 6(a) to 6(d) are plan views illustrating a pair of originals and a pair of composite images produced from the originals in opposite sequences;

FIG. 7 is a plan view of another original;

FIG. 8 is a plan view of a relief image thereof produced by the present method; and

FIG. 9 is a plan view of an image emphasizing fine detail produced by the present method.

Referring now to FIG. 1 of the drawings which shows the basic process of the present invention, a photosensitive member or substrate 1, for example, a photosensitive paper, or a photosensitive plate is employed in the present method and is of the type which may be charged to a positive or negative polarity and in which the charge is dissipated where exposed to incident light.

More specifically, the photosensitive members employable in the present method are an organic photoconductor, a zinc-oxide resin bonded material of a nature for use with positive and negative polarities, and a polyvinyl carbazol-selenium laminate. An electrostatic latent image of a positive or negative polarity, which corresponds to a given picture image depending upon the desired modification purpose is formed by a known method on the surface of photosensitive member 1 chargeable to a positive or negative polarity. This is the process step II of FIG. 1, and more particularly, the photosensitive member is uniformly charged to a positive or negative polarity by, for example, a corona discharge device, after which a given picture image for the desired purpose is irradiated onto the charged photosensitive member. Through the process, electrostatic charge on a portion corresponding to a light portion of the picture image is attenuated or dissipated according to the brightness thereof, whereby an electrostatic latent image corresponding to the original picture image is formed on the photosensitive member.

The electrostatic latent image thus formed by the preceding process step is reversed in the succeeding

process step in such a way that the portion corresponding to the light portion of picture image on the photosensitive member is charged with an opposite polarity to that of the preceding process step and the charges on the portion corresponding to a dark portion of picture image becomes neutralized, the process step III of FIG. 1.

This is effected by imparting a uniform charging of an opposite polarity to the surface of the photosensitive member by means of an opposite polar cross electrification system or an opposite polarity electrostatic charge transfer system. For producing a picture image of high resolving-power, it is necessary, in the present process, to prevent the collapse of the electrostatic latent image and the lowering of the electrostatic contrast.

An opposite polarity corona electrification system is described in U.S. Pat. No. 2,817,765 but in the present method invention there is employed a corona discharge device having such a characteristic that the corona discharge current is constant in a dark space, irrespective of the difference in the surface potential of the photosensitive member, that is to say, a uniform charge of an opposite polarity to that in process step II is effected by so-called a constant current corona discharge device, thereby reversing the electrostatic latent image formed in the preceding process steps.

The opposite polarity electrostatic charge transfer system in which the electrostatic charge of an opposite polarity is effected by a corona discharge indirectly through a dielectric member will be described by way of an example, with reference to FIG. 2. A surface of a dielectric member 2 such as a Mylar (polyester) film adhered to a surface of a metallic electrode plate 1 is charged to an opposite polarity to that of the electrostatic latent image on the photosensitive member 3, as shown in FIG. 2 (2), then the dielectric member is brought in access to a space gap of 10 μ , for closely adhering the surface thereof to the surface of the photosensitive member, as shown in FIG. 2, (b), and followed by separation of the dielectric member from the photosensitive member, as shown in FIG. 2 (c) whereby the electrostatic latent image on the photosensitive member is reversed. The capacitance of the dielectric member should be considerably smaller than that of the photosensitive member. The system using the dielectric member is advantageous in that the reversed electrostatic latent image is excellent, compared with that by the opposite polarity corona electrification system, and there is no need of using a constant current corona discharge device.

Considering the picture image irradiation process step IV of FIG. 1, the reversed electrostatic latent image is again subjected to irradiation. This is effected by irradiating a given or secondary picture image according to the desired purpose onto the initial picture image on the photosensitive member, whereby the electrostatic charge existing on that portion corresponding to the light areas of the picture image decays in accordance with the brightness of the secondary picture image, hence the electrostatic charge existing on a portion corresponding to a dark area of the secondary picture image remains on the photosensitive member. In short, the initial or primary picture image of electrostatic latent primary image.

Thus, an electrostatic latent image modified or changed depending upon the desired purpose is pro-

duced. The electrostatic latent image thus formed is developed into a visible image in any suitable manner, thereby permitting the observation of the resultant or composite visible image.

The foregoing description outlines the basic process of the present invention. The various modification of a picture image is possible by varying sequence or selection of the primary or initial and secondary picture images in the present multiple picture image irradiation process.

The following examples of the modification of a picture image according to the method of the present invention are hereinafter described merely by way of illustration.

APPLICATION I

This is an example of a method of producing a composite image which is the variant portion between two picture images, such as an additive portion or a reductive portion.

As shown in FIG. 3, there are employed a picture image bearing original image A, and a picture image bearing original image B having a common portion, an additive portion and a reductive portion in relation to the original image A, in order to produce a variant portion or picture image between both original picture images.

The case of producing a composite image corresponding to the additive portion is shown in FIG. 4. In the process step II₂ of the second process step II, in which the picture image irradiation is effected, the original picture image A, is projected on the photosensitive member which has been charged with, for example, a positive polarity in the process step II₁, for forming a primary electrostatic latent image of the original picture image A, as shown in FIG. 4 (a). Then, the electrostatic latent image is reversed in the process step III as shown in FIG. 4 (b), after which the original or secondary picture image B is projected on the primary image by irradiation process step IV, whereby a composite or resultant image containing only the electrostatic latent image of the additive portion of the image is produced. Thereafter, the resultant or composite electrostatic latent image is subjected to development into a visible image and the desired visible image is thus obtained.

Formation of the reductive portion will be explained referring to FIG. 5. An electrostatic latent primary image of the original picture image B is firstly formed as shown in FIG. 5 (a), then reversed by process step III as shown in 5 (b), and followed by projection of the secondary defining original picture image A by process step IV, thereby obtaining a composite electrostatic latent image of only the reductive portion between both original picture images, as shown in 5 (c).

As is apparent from the foregoing description, where the present method is applied to the production of a variant portion between two images, a change between two phenomena or matters which occurs in an interval of time can be effectively determined by observing the additive portion or the reductive portion between the two original picture images. For example, the above method is highly efficacious when applied to observing the change in the condition of a disease by the X-ray photograph, since the variant portion is easily produced by irradiating or projecting image from two sheets of X-ray photograph in the process steps II and

IV. Furthermore, this method is useful to exactly detect an injured portion of an extremely complicated pattern, such as in case of detecting damage to a part of an electronic circuit.

APPLICATION II

Reliefs may be produced by the present method in the following manner.

The picture image irradiation is effected by shifting the position of a picture image, using a single original image to sequentially apply the primary and secondary image irradiation. In the first picture image irradiation process step II₂, the picture image of an original is projected, and in the second picture image irradiation process IV, the position of the picture image is shifted for the projection of the said picture image, thereby obtaining a relief picture image. The shift of the position of the picture image may be effected at the stage of the first picture image irradiation. In the present application, only the single sheet of original is used, hence there is no need for aligning the picture images.

APPLICATION III

This application is for the production of the minute and fine portions of a picture image. In accordance therewith, a single sheet (an identical one) of original is used, and the picture image is subject to irradiation or projection in an unfocussed condition. In the first picture image irradiation process step II₂, the picture image of the original is projected in slightly unfocussed condition, and in the subsequent picture image irradiation process step IV, the image irradiation is effected in a sharply focussed condition, thereby providing a formation of a minute and fine portion of the original picture image. In this application, there is no need for aligning the picture image.

The applications I through III illustrate examples of picture image modification according to the method of the present invention. In practice, the gradation and density of an image to be produced are adjustable by adjusting an amount of electrostatic charge on both an electrostatic latent image formed in process step II and a reversed electrostatic latent image in process step III and the amount of exposure in the picture image irradiation process. This mechanism will be referred to hereafter.

An amount of electrostatic charge q charged on the photosensitive member or substrate and a density D thereof are, given by determination of sectional area S of a developing toner and an amount of charged static electricity ne , and are in the proportional relation as represented by the formula $D = Sq/2.3ne$, wherein n is the amount of electrified electrostatic charge per unit toner, and e is the prime amount of electrostatic charge. The relation of the amount of electrified electrostatic charge with an amount of exposure is adjustable depending upon the kind of photosensitive material of the photosensitive member used, the wave length and charge polarity, and the like. Accordingly, if a suitable selection of the factors and parameters described is made for adjusting the amount of electrified electrostatic charge of the electrostatic latent image formed in process step II and the reversed electrostatic latent image formed in process step III and the amount of exposure in the picture image irradiation process, the gradation and density of the picture image to be produced are adjusted, and thus various modes of picture image

treatment other than the examples of the applications explained above are performed. This affords a wide range of application of the present method, including its use in the improvement in a picture image and for the observation or examination of things and events.

The following are specific examples of the present method.

EXAMPLE I

This example is an illustration of the opposite polarity charging by a corona discharge. To begin with, two film slides bearing positive images were prepared as original photographs as shown in FIG. 6 (a) and (b). The photosensitive member or substrate employed was a Fax paper (ZrO sensitive paper) manufactured by Crown Zenovac Company which can be charged to a negative or positive polarity.

The photosensitive substrate maintained stationary on a metallic plate, was subjected to two charging scans at an applied voltage of about +6.5KV and a charging speed of 6cm/second to be uniformly charged to a surface potential of about +650V. Subsequently, the slide film bearing the positive image as shown in FIG. 6 (a) was projected on the charged substrate by a projector using a tungsten lamp of 150W at about 210 lux.sec. for dissipating the charge at the illuminated areas to about 50V. At the same time, the charge of the dark areas is decayed by about 50V. The electrostatic latent image thus formed was again subjected to scanning for charging by a corotron charger at an applied voltage of about -4.8KV and at a charging speed of 9cm/second, with the result that the surface potential was decreased to OV or thereabout at the dark areas and to -200V at the light areas, whereby the electrostatic latent image is inverted.

Following the reversal of the electrostatic latent image, the slide film bearing the positive image as shown in FIG. 6 (b) was projected onto the primary image carrying substrate by the projector having a tungsten lamp of 150W. At this stage, the films were set so as to align the common portions of the positive picture images in FIGS. 6 (a) and 6 (b) with each other. Thereafter, the photosensitive substrate was subjected to a wet development by a positive toner, thereby obtaining the image of pattern as shown in FIG. 6 (c). In this example, only the additive portion of FIG. 6 (b) in relation to FIG. 6 (a) is produced in the composite or resultant picture.

EXAMPLE II

This example demonstrates the reversal of the primary image polarity making use of a charge transfer procedure. In accordance therewith, the identical image and identical photosensitive paper to those of Example I were used. Following the uniform charging of a positive polarity, like in Example I, the slide film bearing the positive image as shown in FIG. 6 (b) was subjected to irradiation in the same condition as in Example I, for forming an electrostatic primary latent image corresponding to FIG. 6 (b).

Subsequently, a Mylar film of 75 μ in thickness located on the metallic plate was uniformly charged to a surface potential of about 1,000V by a corotron charger, after which the metallic base plate carrying the Mylar film and the metallic base plate with the photosensitive paper were brought into registry and were maintained in a short-circuited state to adhere the

Mylar film to the photosensitive paper. Then, the Mylar film was carefully separated from the photosensitive paper. Thus, the reversed electrostatic latent image having the light areas at about 200V and the dark areas at about O_1 was obtained.

Then, the slide film bearing the positive image as shown in FIG. 6 (a) replaced the slide film 6 (b), and the slide film 6 (a) was subjected to irradiation under the same condition as in Example I, and followed by the wet development by a positive toner, thus producing the image as shown in FIG. 6 (d). This procedure produces the reducing portion with respect to the image 6 (b).

The image obtained in the example was found excellent in resolving-power, compared with that produced in Example I

EXAMPLE III

This example demonstrates the formation of a relief image. A single original of image bearing slide film was prepared as an original image, as shown in FIG. 7, and the same photosensitive paper as in Example I was used. A uniform charging of a positive polarity was effected in the manner of Example I, after which the image bearing original film was projected under the same condition as in Example I, thereby forming an electrostatic latent image corresponding to the image of FIG. 7.

Through the process completely identical to that in Example II, a reversed electrostatic latent image having a light areas charge of about 200V and a dark areas charge of O_1 was obtained. Subsequently, the original film was set in a slightly shifted position and subjected to irradiation under the same condition as in Example I, then followed by the wet development by a positive toner, thereby obtaining the relief image as shown in FIG. 8. In this case, instead of shifting the position of the film, the photosensitive paper may be shifted.

EXAMPLE IV

This example demonstrates a method for producing the minute and fine portions of a picture image. The same original pattern and the same photosensitive paper as those of Example III were used. After a uniform charge application of positive polarity, in the similar manner to Example I, the image bearing original film (projecting portion) was shifted slightly upwardly into a defocussed position. The original film thus set in the defocussed condition was subjected to irradiation of about 210 lux.second for dissipating the illuminated areas to a potential of about 50V. The potential in the dark areas decayed by about 50V. The electrostatic latent image thus formed was reversed through the same procedures with those of Example III into an electrostatic latent image having the light portion of about 70V and the dark portion of O_1 or thereabout.

Thereafter, the picture image bearing original film was shifted to the focussed position, then subjected to irradiation under the same condition as in Example I, and followed by the wet development by the positive toner. Thus, the minute portion of the original picture image was produced, as shown in FIG. 9.

According to the present invention, the improvement in a picture image as well as in judgement examination and comparison of things and events can be achieved by treating a picture image by a simple process, including the steps of the formation of an electrostatic latent

image, a treatment for inverting the electrostatic latent image and the steps of subjecting the inverted electrostatic latent image to irradiation, all of which are performed of electrophotographic techniques. Accordingly, the technical drawbacks of earlier methods are mostly overcome and in addition, charge application is effected with great ease. Another advantage is in that in practice, there is no need for preparing an original bearing a negative image, and in the process for producing relief images or minute portions of an original picture image, neither process for overlapping two picture images nor a process for setting two picture images in alignment is needed.

In addition, the gradation and density of a picture image to be produced are adjustable readily by adjusting the amount of electrostatic charge and the amount of exposure.

While there have been described and illustrated preferred embodiments of the present invention, it is apparent that numerous alterations, omissions and additions may be made without departing from the spirit thereof.

We claim:

1. The method of producing a composite picture comprising the steps of producing a reversed electrostatic latent primary image on a substrate by forming said primary image at a predetermined polarity on said substrate and thereafter reversing the polarity of said first latent image, directing on said latent image carrying substrate a secondary image to produce a resultant latent electrostatic image which is a function of said primary and secondary images and developing said resultant latent electrostatic image.

2. The method of claim 1 wherein the polarity of said first latent image is reversed by imparting a uniformly distributed charge of opposite polarity to said image carrying substrate.

3. The method of claim 2 wherein primary and secondary images are different and in overlapping condition.

4. The method of claim 2 wherein said primary and secondary images are similar and are offset relative to each other.

5. The method of claim 2 wherein one of said primary and secondary images comprises the defocussed image of an original and the other of said images comprises the focussed image of said original.

6. The method of claim 1 wherein said primary image polarity is reversed by exposing said primary image carrying substrate to a constant current corona discharge uniformly over the area of said substrate at a polarity opposite to said predetermined polarity.

7. The method of claim 1 wherein said primary image polarity is reversed by superimposing on said primary image carrying substrate a dielectric member carrying a uniformly distributed charge of a polarity opposite to said predetermined polarity.

8. A method for treating a picture image by electrophotography comprising the steps of;

forming an electrostatic latent image of a specific polarity corresponding to a given image on an electrophotographic sensitive member chargeable to a positive or negative polarity;

reversing said electrostatic latent image by imparting thereto a uniform charging at an opposite polarity to said latent image;

irradiating an image variant or displaced from the given image with respect to the reversed electro-

static latent image, for reducing the initial picture image therefrom; and,

subjecting said electrostatic latent image to development, thereby producing a modified electrostatic latent image.

9. A method for treating a picture image by electrophotography comprising the steps of;

forming an electrostatic latent primary image of a specific polarity corresponding to a picture image of one original image on an electrophotographic sensitive member chargeable to a positive or negative polarity, using two originals each bearing a picture image and having a variant portion between the two images thereon;

reversing the electrostatic latent image by imparting thereto a uniform charging of an opposite polarity to said latent image; and,

irradiating the reversed primary image with a common portion between two picture images overlapping each other to thereby reduce the primary picture image, whereby an electrostatic latent image corresponding to an additive portion of the other original picture image in relation to original picture primary image is formed.

10. A method for treating a picture image by electrophotography comprising the steps of;

forming an electrostatic latent primary image of a specific polarity corresponding to an original picture image on an electrophotographic sensitive

member chargeable to a positive or negative polarity, using a single original;

reversing said electrostatic latent image by imparting thereto a uniform charging of an opposite polarity; and,

subjecting the original picture image to irradiation as said image is in the shifted position, whereby reducing said initial picture image, whereby an electrostatic latent image corresponding to a relief image of the original picture image is formed.

11. A method for treating a picture image by an electrophotography comprising the steps of;

forming an electrostatic latent image of a specific polarity corresponding to a slightly unfocussed original picture image on an electrophotographic sensitive member chargeable to a positive or negative polarity, using a single original;

reversing said electrostatic latent image by subjecting it to a uniform charging of an opposite polarity; and,

irradiating the original picture image at an identical position and in focussed relation, thereby reducing the initial unfocussed image of the original picture image, thereby there is formed an electrostatic latent image having a portion specially accentuated, corresponding to a detailed or delicate portion of the original picture image.

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