

[54] **ELECTROPHOTOGRAPHY USING CRT
EXPOSURE AND LIQUID DEVELOPER**

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G03g 13/04

[58] **Field of Search** **96/1 R, 1 LY; 355/3 R,**
355/10; 346/74 EP; 117/37 LE

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[57]

ABSTRACT

A method for forming an electrostatic image on a photo-
sensitive member having a photoconductive layer
bonded to a conductive layer by applying a charge of
one polarity to the photoconductive layer, and then
exposing the photoconductive layer to a pattern of
image radiation to form an electrostatic latent image.
The photoconductive layer is then exposed to blanket
radiation and the electrostatic latent image is then de-
veloped by using a liquid developer having the same
polarity as the charge applied to the photoconductive
layer to form a visual image in a relatively shortened
exposure time.

4 Claims, 3 Drawing Figures

FIG. 1

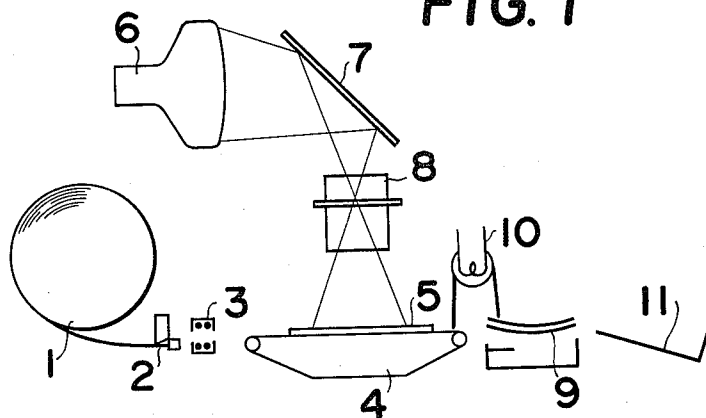


FIG. 2

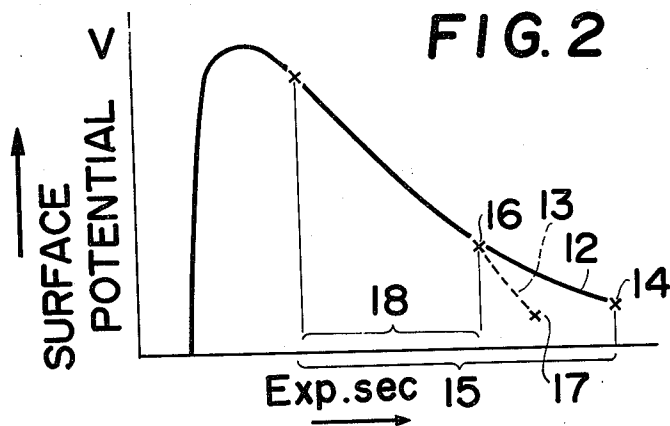
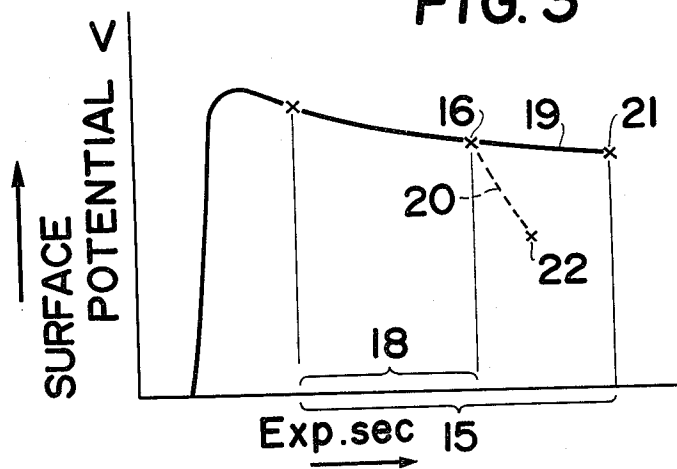


FIG. 3



ELECTROPHOTOGRAPHY USING CRT EXPOSURE AND LIQUID DEVELOPER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to electrophotography in general, and more particularly, to a method for rendering visible, in the reverse sense, latent images formed by negative electrostatic charges on photosensitive paper.

2. Description of the Prior Art

In a conventional method for forming an electrostatic image on a photosensitive paper which consisted of a photoconductive insulating film such as zinc oxide bonded to a conductive substrate layer, the photosensitive paper was uniformly charged by a corona discharge, and thereafter was irradiated with an original image. During exposure to the image, the electrical conductivity within the film was reduced in the area where light impinged upon the film. This caused dissipation of the surface charge in those areas due to conduction through the film to the substrate layer. As a result an electrostatic image was formed on the photosensitive paper according to the light-and-dark pattern of the original. The electrostatic image was then developed by using "toner" to obtain a visual image, and the image was then fixed.

While somewhat satisfactory, with the prior art method, one problem was that it took a long time to expose the photosensitive paper to a pattern of image radiation. Thus, when the charged surface of the photosensitive paper was exposed to its pattern by using a cathode ray tube incorporated in an oscilloscope and the like which consisted of a phosphor having low brightness, a high contrast image could be obtained in the conventional method for forming an electrostatic image on a photosensitive paper, but a long exposure time was required.

In an attempt to alleviate the above problem it has been proposed to elevate the brightness of the light spot produced by the electron beam that impinged upon the screen of the cathode ray tube in order to eliminate the long exposure time. However, it was realized that such a proposal would not solve the problem in that elevated brightness of the light spot on the screen would cause the electrostatic image produced on the photosensitive paper to be dim, thereby preventing a sharp electrostatic image from being obtained. Furthermore, it was realized that a cathode ray tube for high brightness was very expensive.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a new and improved unique method for forming an electrostatic image with high contrast on a photosensitive paper without exposing the photoconductive layer thereof to a pattern of image radiation for a long time in comparison with conventional electrophotographic methods.

It is still another object of the present invention to provide a new and improved unique method for forming an electrostatic image with high contrast on a photosensitive paper without employing a cathode ray tube of high brightness intensity.

Briefly stated, in accordance with the present invention the foregoing and other objects are in one aspect attained by the provision of a method for forming an electrostatic image on a photosensitive member having

a photoconductive layer bonded to a conductive layer by applying a charge of one polarity to the photoconductive layer, and then exposing the photoconductive layer to a pattern of image radiation to thereby form an electrostatic image. The photoconductive layer is then exposed to blanket radiation and then the electrostatic image is developed by using a liquid developer having the same polarity as the charge applied to the photoconductive layer to thereby form a visual image, whereby the time to expose the photoconductive layer to the pattern of image radiation is shortened as compared with conventional electrophotographic methods.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other objects, features and attendant advantages of the present invention will be more readily appreciated as the same becomes better understood from the following detailed description when considered in connection with the accompanying drawings, wherein: FIG. 1 shows a preferred embodiment of the present invention; and

FIG. 2 and FIG. 3 respectively show characteristic curves of light decay and dark decay wherein the solid lines and dotted lines respectively indicate a conventional sample and a sample of the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings wherein like reference numerals refer to identical or corresponding parts throughout the several views and more particularly to FIG. 1 thereof wherein a preferred embodiment of the apparatus for practicing the method of forming an image in electrophotography according to the present invention is shown as including a photosensitive paper having a photoconductive layer bonded to a conductive layer fed from a roll of copying paper 1 which is sent to a cutter 2. The photosensitive paper is cut to a required length by the cutter 2 and is then fed to a conventional charging apparatus 3, wherein the photosensitive paper receives a corona negative discharge thereon. The charged photosensitive paper then enters conventional exposure apparatus 4 and stops there, wherein an electrostatic latent image is formed on the photosensitive paper in accordance with the light-and-dark pattern of the original image which is screened by a cathode ray tube 6 through a mirror 7 and a lens 8. The photosensitive paper is then irradiated over approximately the range of from 5 lux seconds to 20 lux seconds, but preferably over approximately the range of from 10 lux seconds to 15 lux seconds by a tungsten lamp 10, a fluorescent lamp or the like having an intensity of approximately 30 lux which illuminates white and blue color thereon. The photosensitive paper is then developed at a higher density than ordinary liquid toner with the same polarity as the charge applied to the photosensitive paper. Thus, for example the photosensitive paper is developed at a density over approximately the range of 1.2 times to 2 times that of ordinary liquid toner which comprises an electrically insulating carrier liquid, a pigment such as carbon black or coloring agent and a resin. The particles of toner are negatively charged and are repelled by the electrostatic image and attracted by the background area. The photosensitive paper is then sent to a stacker 11 and is fed at a speed of, for example, 0.35cm per second.

Referring now to FIGS. 2 and 3 the present invention will be more readily apparent from the characteristic curves of light decay and dark decay therein shown. In FIGS. 2 and 3 the solid lines and dotted lines respectively indicate a conventional sample and a sample of

the present invention. A characteristic curve of light decay is shown by the dotted line 13 of FIG. 2 when weak light emitted from the tungsten lamp 10 (FIG. 1) irradiates uniformly the photosensitive paper exposed to the pattern of image radiation of the cathode ray tube 6 (FIG. 1). According to FIG. 2, it is seen that conventionally an amount of exposure time 15 is required to reach an adequate surface potential point 14 whereby the photosensitive paper will be developed to form a visual image. On the other hand, with the present invention, it is seen that the photosensitive paper need be exposed to the pattern of image radiation to form an electrostatic image according to the dark-and-light pattern of the original at the exposure time 16 which corresponds to only 50% to 60% of a conventional adequate amount of exposure time 15. In other words, with the present invention, when the surface potential is decreased to the potential point 17 which corresponds to the potential point 14 of the prior art after the surface of the photosensitive paper is exposed to the tungsten lamp 10, the photosensitive paper is developed. As a result, an adequate amount of exposure time may be decreased with the present invention to approximately the exposure amount 18 as shown in FIG. 2 because the time required to be decreased to a potential point 17 after exposing the photosensitive paper to blanket radiation is short enough to be negligible.

A decaying condition of an unexposed surface potential of a charged photosensitive paper can be understood from FIG. 3 wherein it is seen that in the dark decay characteristic curve the surface potential conventionally decreases in a curve 19 having a radius of curvature and is maintained at a high potential corresponding to point 21 after exposing the photosensitive paper to a pattern of image radiation as shown by the solid line.

On the other hand, according to the present invention, the dark decay characteristic curve of the surface potential declines in a substantial linearity as shown by the dotted line 20 of FIG. 3 as a result of exposing the photosensitive paper to blanket radiation by means of the tungsten lamp 10 (FIG. 1) and the like. The point 22 as shown in FIG. 3 is the surface potential at the time when the photosensitive paper is developed by the liquid toner having the same polarity as the charge applied to the photosensitive paper. If the amount of time of exposing of the photosensitive paper to tungsten lamp 10 (FIG. 1) is predetermined, so that the difference between the potential at the light decay point 17 of the image area and that at the dark decay of the non-image area point 22 may be great and then the photosensitive paper is developed, then a visual image having a high contrast and a good spread of toner can be obtained by exposing the photosensitive paper to blanket radiation. Furthermore, the charge for attracting the

toner discharged on the photosensitive paper deteriorates by receiving blanket radiation from the tungsten lamp and the like, so that the power attracting the toner becomes weak. Accordingly a visual image having a high contrast and a good spread of toner can be obtained by using liquid developer having a higher toner density over approximately the range of 1.2 times to 2 times that of ordinary liquid developer, the density of which is generally about 0.1%.

As mentioned above, it should now be apparent that according to the present invention, the amount of exposure may be decreased to about 50% of the amount of conventional exposure time by exposing the photosensitive paper to a tungsten lamp and the like. It should further be apparent that with the present invention if the intensity of the lamp and the material of the photosensitive paper are predetermined that the exposure time may be shortened to about 50% of conventional exposure time. It should be further understood that the details of the method for forming an electrostatic image described above may be varied by those skilled in the art in an obvious manner without departing from the spirit of the present invention. Therefore the preceding detailed description of a preferred embodiment of the present invention is not intended to limit the scope of the invention which is to be determined only from the following claims.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a method for forming an electrostatic image on a photosensitive member having a photoconductive layer bonded to a conductive layer, the improvement comprising the steps of:

applying a charge of one polarity to said photoconductive layer;

exposing said photoconductive layer to a pattern of image radiation generated by a cathode ray tube to form an electrostatic latent image;

exposing said photoconductive layer to blanket radiation having an intensity of approximately 30 lux for a period of 5 lux seconds to 20 lux seconds; and developing said electrostatic latent image by using liquid toner comprised of liquid developer and toner having a density of .12% to .2% having the same polarity as the charge applied to said photoconductive layer to form a visual image in approximately 50% to 60% of the time normally encountered through the use of a cathode ray tube exposure source.

2. In a method for forming an electrostatic image on a photosensitive member according to claim 1, the amount of said blanket radiation is in the range of from approximately 10 lux seconds to 15 lux seconds.

3. In a method for forming an electrostatic image on a photosensitive member according to claim 1, said blanket radiation is accomplished by a tungsten lamp.

4. In a method for forming an electrostatic image on a photosensitive member according to claim 1, said blanket radiation is accomplished by a fluorescent lamp.

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