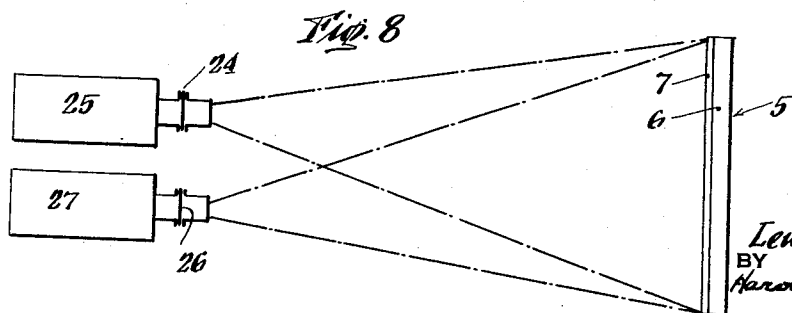
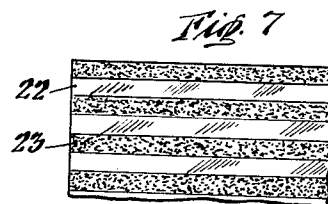
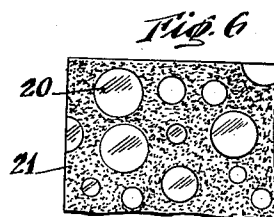
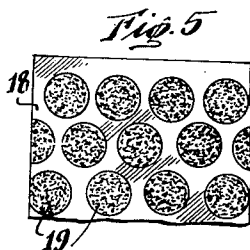
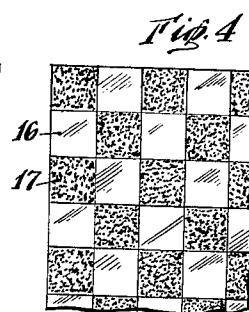
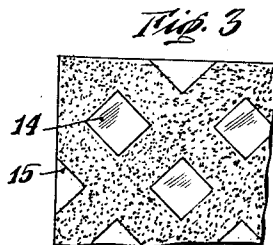
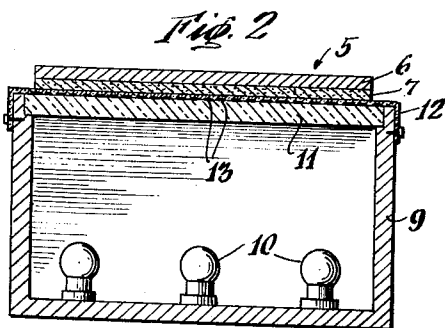
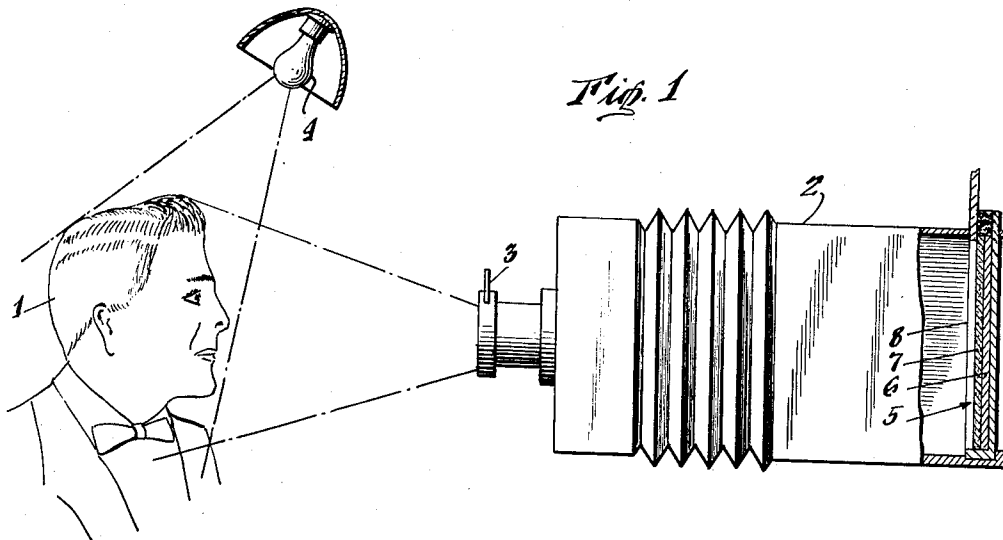


June 3, 1952

L. E. WALKUP
ELECTROPHOTOGRAPHY
Filed March 9, 1949

2,598,732



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2,598,732

ELECTROPHOTOGRAPHY

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Application March 9, 1949, Serial No. 80,551

4 Claims. (Cl. 95—1.9)

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This invention relates to electrophotography and has for its object to improve such processes.

Another purpose of the invention is to improve the rendition of subject matter having variations in tonal value throughout all or part of the area being reproduced.

A further object is to improve the development of electrophotographic plates.

Other objects will be apparent from the following detailed description and the appended claims.

According to one aspect of the invention, the electrophotographic plate, consisting of a layer of photoconductive insulating material on a conductive backing, is exposed in sequence or simultaneously to a continuous tone subject and a screen pattern of uniformly distributed, finely divided light and dark areas.

In the drawings:

Fig. 1 is an elevation, partly in section, illustrating the exposure of a charged electrophotographic plate to a continuous tone subject;

Fig. 2 illustrates another step comprising exposure of the charged plate to a screen pattern;

Figs. 3, 4, 5, 6 and 7 are enlarged views of small areas of five suitable screens, and

Fig. 8 illustrates a method of simultaneous exposure to a continuous tone subject and a screen pattern.

While a preferred embodiment of the invention is described herein, it is contemplated that considerable variation may be made in the method of procedure and the construction of parts without departing from the spirit of the invention. In the following description, and in the claims, parts will be identified by specific names, for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

In the process of electrophotography as disclosed in Carlson Patent No. 2,297,691, a plate comprising a coating of photoconductive insulating material on a conductive backing is given a uniform electric charge over its surface and is then exposed to the subject matter to be reproduced by camera, projection or contact exposure. This exposure discharges the plate areas in accordance with the light intensity which reaches them, thereby creating an electrostatic latent image on or in the plate coating. Development is effected with a finely divided material, such as an electroscopic powder, which is brought into contact with the coating and is held thereon electrostatically in a pattern corresponding, in general, to the electrostatic latent image. Final-

ly, the powder image is transferred to a suitable base, such as paper, and fixed thereon by fusion or use of a solvent.

One development method comprises dusting the plate with a finely divided, dyed resin powder and removing the excess powder with an air blast. Another method comprises cascading over the plate a developer which consists of a finely divided, pigmented resin powder clinging to a coarser granular carrier as described in application for U. S. Patent Ser. No. 24,674, filed May 1, 1948, by Lewis E. Walkup and Edward N. Wise, whereby some of the resin powder is transferred to the plate in the areas carrying the charge image.

Excellent results have been obtained with this process for line work such as black letters or lines on a white background, and for half-tones. On continuous tone rendition, such as is necessary in portraiture, pictorial photography, the copying of X-ray radiographs and the like, the results have tended to be somewhat contrasty, however. A smoother gradation of tone would be desirable, and also a more uniform rendition of large black areas.

The present invention is intended to afford a method and apparatus for improving continuous tone rendition and the rendering of large black areas.

Referring to the drawings, in which certain embodiments of the invention are illustrated, Fig. 1 shows one method of recording a continuous tone electrostatic latent image on an electrophotographic plate. In this method the subject 1, such as a person or thing to be reproduced, is posed before a conventional camera 2 provided with the usual lens and shutter mechanism 3 and is illuminated by a light source 4. The plate 5 comprising a conductive backing layer 6 coated with a layer of photoconductive insulating material 7, such as anthracene, sulfur or selenium, is held in plate holder 8 in position for exposure in the back of the camera.

Prior to insertion in the camera the surface of layer 7 has applied to it a uniformly distributed electrostatic charge by frictionally rubbing it with a cloth or brush or by passing it under a corona discharge wire or row of needles, as shown and described, for example, in application for U. S. Letters Patent Ser. No. 55,526, filed October 20, 1948, by John J. Rheinfrank, now abandoned.

Exposure is made as shown in Fig. 1 by conventional methods such as by flooding the subject 1 with light and opening shutter 3 for a period sufficient to substantially discharge the

plate in the lightest areas of the image. The exposure time and intensity of illumination can readily be determined by making one or two trial exposures with the plate and developing the plate with powder.

According to one method of carrying out the present invention, the plate 5 is exposed by contact to a screen pattern, as shown in Fig. 2, for example, either prior to or after the continuous tone exposure of Fig. 1. For instance, the plate 5 is laid with the photoconductive insulating layer 7 face down on top of exposure box 9 containing lamps 10 and having a glass top panel 11 which is covered with a thin transparent sheet 12 of cellophane, cellulose acetate or the like which carries a screen pattern 13 printed or otherwise applied to its under surface. The lamps are turned on momentarily to expose layer 7 to the image or shadow of the screen pattern which consists of alternate black and transparent areas. This results in a corresponding electrostatic pattern on the layer 7 by substantially discharging the small areas or spots of the plate where light strikes it through the transparent areas, or at least reducing the charge on such areas to a fraction of its original value.

If exposure has previously been made to a continuous tone image as shown in Fig. 1, the plate is now ready for powder development. If the screen exposure is made first, the plate is ready for the continuous tone exposure of Fig. 1.

A variety of screen patterns may be used for screen 12, several examples of small areas of which are shown, greatly enlarged, in Figs. 3, 4, 5, 6 and 7. Thus in Fig. 3, the transparent areas 14 comprise rows of small squares entirely surrounded by black or opaque areas 15. In Fig. 4, a checkerboard pattern of transparent and opaque areas 16 and 17 is used. In Fig. 5, the transparent area 18 is continuous and is covered with circular black or opaque dots 19. In Fig. 6, the screen comprises a black or opaque background 21 covered with a random distribution of transparent dots 20 of various sizes. Fig. 7 shows a further variation in which the screen comprises alternate rulings of transparent lines 22 and opaque lines 23.

Any one of several screen sizes may be used, the finer sizes generally giving the more natural or higher quality results in continuous tone rendition. Thus, while a coarse screen having 50 or 60 dots or lines to the linear inch will be useful for some purposes, such as in the direct production of half-tone images, finer screens, such as those having 100, 200, 300, 400 and even more dots or lines to the inch will give more nearly a continuous tone appearance to the finished print. With the finer screens the screen pattern may be barely perceptible as such in the finished print and the copy will have the appearance of a continuous tone photograph. The contrasty appearance obtained without the use of the screen exposure step is eliminated or greatly reduced and large black areas are rendered with apparently uniform density throughout.

While it is not desired to be limited to any particular theory of operation, it is known from other experiments that the developing powder, upon deposition, tends to form a heavier deposit along the edges of black areas than in the center of the black areas. This is thought to be possibly due to the configuration of the electrostatic field above the plate, tending to form a concentration of electrostatic lines of force at the edges of charged areas. With the screen pattern super-

imposed, the charged areas are broken up into smaller charged areas thereby altering the configuration of the force lines to avoid concentration at the edges of large areas and cause a large number of lesser concentrated force areas corresponding to the screen pattern.

Instead of exposing the plate to the screen pattern in the exposure box, as shown in Fig. 2, it is possible to make the screen exposure in the camera of Fig. 1 by placing a sheet having a black-and-white screen pattern in front of the camera and exposing the plate thereto either before or after the continuous tone exposure.

Such a black-and-white screen would be similar to any of the screens of Figs. 3 to 7 except that the transparent areas would be white, and the same effect can be had by placing any of the screens of Figs. 3 to 7 against a white background while exposing.

It is also possible to secure the same result by placing a transparent screen such as shown in Figs. 3 to 7 carrying an opaque pattern in the camera in front of and adjacent to or in contact with the plate and expose to a white field or white opaque screen located at a distance in front of the lens, either before or after the continuous tone exposure, and where reference is made to white areas or white background, any color that will reflect light and affect the electrostatic image on the plate may be used in place of white.

It is also possible, in making prints of continuous tone photographs, for example, to carry out both exposures by contact without the use of a camera. For example, the original to be copied is substituted for screen 12 on the copying box 9 for the continuous tone exposure step preceding or following the screen exposure.

While the invention has been illustrated in Fig. 1 in the rendition of three dimensional subject matter it is obvious that the same method can be used for copying two dimensional material such as paintings, photographs, X-ray shadowgraphs and grained wood surfaces placed in front of the camera.

Fig. 8 illustrates a further method of exposure in which the plate 5 is exposed, simultaneously or in sequence, to a projected continuous tone image from film 24 projected by enlarger 25 and a screen pattern from film or slide 26 projected by enlarger 27. Upon development the results are substantially the same as with the other methods.

Although the invention has been described as particularly applicable for the rendition of continuous tone subject matter, it is also contemplated that it may be used to effect improvement in the copying of black and white material, particularly where the subject contains large black areas. In this case the copies present a more uniform density of rendition over the dark areas.

While the present invention, as to its objects and advantages, has been described herein as carried out in a specific embodiment thereof, it is not desired to be limited thereby but it is intended to cover the invention broadly within the spirit and scope of the appended claims.

I claim:

1. In an electrophotographic process wherein the surface of a layer of photoconductive insulating material is provided with an electric charge, exposed to a light image of the subject to be reproduced and then developed by depositing a finely divided electrostatically attractable material under the influence of the charge pattern re-

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maining on said layer, the method of improving large area reproduction and continuous-tone rendition comprising additionally exposing the layer to a finely-divided uniformly-distributed pattern of light and shadow prior to developing. 5

2. In an electrophotographic process wherein the surface of a layer of photoconductive insulating material is provided with an electric charge, exposed to a light image of the subject to be reproduced and then developed by depositing a finely divided electrostatically attractable material under the influence of the charge pattern remaining on said layer, the method of improving large area reproduction and continuous-tone rendition comprising additionally exposing the layer to a finely-divided uniformly-distributed pattern of light and shadow after exposure to the light image and prior to developing. 10 15

3. In an electrophotographic process wherein the surface of a layer of photoconductive insulating material is provided with an electric charge, exposed to a light image of the subject to be reproduced and then developed by depositing a finely divided electrostatically attractable material under the influence of the charge pattern remaining on said layer, the method of improving large area reproduction and continuous-tone rendition comprising additionally exposing the layer to a finely-divided uniformly-distributed pattern of light and shadow prior to exposure to the light image. 20 25 30

4. The method of making an improved electrostatic latent image which comprises charging a

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surface of a layer of photoconductive insulating material with an electrostatic charge and then projecting a continuous tone image and screen pattern simultaneously from two separate optical systems onto the photoconductive insulating material while simultaneously engaging the side of said layer opposite to said charged surface with a conductive backing, thus leaving an electrostatic latent image on said surface corresponding to said continuous tone image with said screen pattern superimposed thereon, whereby large area reproduction and continuous-tone rendition are improved.

LEWIS E. WALKUP.

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