METHOD OF VISUALIZING AN ELECTROSTATIC CHARGE IMAGE
BY EXPOSURE TO CHARGED PARTICLES OF BORON OXIDE
Filed June 4, 1964
METHOD OF VISUALIZING AN ELECTROSTATIC CHARGE IMAGE BY EXPOSURE TO CHARGED PARTICLES OF BORON OXIDE


Filed June 28, 1964, Ser. No. 72,717

Claims priority, application Netherlands, June 6, 1963, 293,748

5 Claims. (Cl. 96—1)

The invention relates to a method of visualizing an electrostatic charge image on an image carrier by means of finely divided material, which carrier is suitable for repeated use.

Such methods, with variations, by which a visible image is obtained through an electrostatic latent charge image, are known. As finely divided material by means of which the latent image is visualized, use is made of all kinds of pulverulent substances, preferably resinous substances, such as rubber copal, rubber sandarac, coumarone indene resin, resin-resin or other substances such as lycopodium, talcum, soot or aluminium bronze. After a charge image has been visualized and before a new charge image has been applied to the charge carrier, the powder or, in case the image is transferred to another carrier to obtain a permanent print, the remainder of the powder should be thoroughly removed. To this end also several methods are known. The powder may be removed by brushing, in which event an electrostatic field may facilitate this rubbing operation, in certain cases, the powder may be blown away by compressed air. It has also been suggested for this purpose to cause granular material having a polarity opposite to that of the powder to flow over the image carrier.

These known methods of cleaning the image carrier all have one or more disadvantages. Either it is difficult to remove the whole remainder of powder, or the image carrier is readily damaged, or the method is circuitous. In the long run, damage of the image carrier adversely affects the quality of the image.

The method in accordance with the invention provides the possibility of removing the powder image without touching the image carrier. Moreover, the measures required for removing the powder image are simpler with this method than with the known methods.

The invention is characterized in that the charge image is visualized by means of finely divided boron oxide.

At low temperature, boron oxide has a comparatively high vapor tension. If, for example, the image carrier is left for 1 to 2 hours at room temperature, the boron oxide has disappeared as a result of sublimation. Preferably, it is heated to a temperature of at least approximately 40° C; the rate of sublimation is then sufficiently high to remove the powder from the image carrier within a reasonable time, that is to say of the order of 1 minute.

It should be noted that xerographic plates exhibit fatigue phenomena after they have been charged and discharged several times. It is known to regenerate the xerographic plate by heating the latter to a temperature of approximately 40° C to 60° C. Consequently, when use is made of a xerographic image carrier, use of the invention has the advantage that the regeneration of the plate and the removal of the remainder of boron oxide are carried out in one operation.

In the most suitable method of visualizing an electrostatic latent charge image in accordance with the invention, an organic boron compound is burned, while the fumes thereof are brought in the proximity of the charge image. For example, this compound is the boric acid triethyl ester.

A further preferred embodiment of the method in accordance with the invention consists in that the fumes originating from the organic boron compound are guided through an electric discharge. Consequently, the boron oxide particles are statically charged, as a result of which the selectivity with which the boron oxide particles are deposited on the charge image is improved and the rate of deposition is increased. This method also provides the possibility of converting the latent charge image at will into a negative visible image or into a positive visible image by choice of the polarity of the potential of the image carrier and of the boron oxide particles respectively.

In the method in accordance with the invention use is preferably made of an electrostatic latent charge image obtained by exposure to light according to an image pattern on a carrier at least the surface of which consists of photoconductive material. Such materials are known for this purpose. Examples are selenium, anthracene, anthraquinone, sulphur, mixtures of anthracene and sulphur and mixtures of selenium and sulphur.

The thermal treatment for removing the boron oxide may be carried out in known manner. For this purpose, heating by means of infrared radiation is very suitable. Moreover, a further usual possibility of improving that is to say of intensifying, the image contrast is obtained. For this purpose, the surface of the image carrier should have a high coefficient of absorption for this radiation. At the areas at which the quantity of boron oxide present per surface unit is small, the boron oxide sublimates more rapidly than at areas at which the quantity present per surface unit is larger. During the radiation, the contrast variation of the image can be followed and the radiation can be stopped when the desired quality is obtained.

The boron oxide is white-colored and an image obtained by the method in accordance with the invention can be observed on a contrasting substratum with normal light. When the substratum has a low contrasting action or a strong reflection, the image can be observed with laterally incident light.

An electrostatic image in itself is distinguished by a satisfactory effect, while it also has an excellent definition. An image consisting of boron oxide is not particularly suitable for transfer to a carrier to obtain a permanent print. In practice, however, there are several cases in which the image obtained is only observed or photographed.

An image-projection system is known, for example, for the projection of radar images from a cathode-ray tube, in which use is made of an endless belt on which a plurality of plates having a photoconducting surface are provided. Each plate is provided with a uniform electrostatic charge and exposed in that the image of the screen of the cathode-ray tube is projected thereon, whereupon the charge image thus obtained is visualized by means of powder and this image is epiphotographically projected onto a screen; finally, the powder is removed from the plate. Use is made of several, for example three, projectors each of which projects the image of one of a plurality of successive plates onto one of the other onto one screen. In this image-projection system, the method in accordance with the invention may advantageously be used.

Another possibility of using the invention resides in the fact that on a photo-conducting plate provided with an electrostatic charge, an X-ray image is caused to be converted into a charge image, consequently without the intermediary of a luminescent screen. In this manner, an image is obtained which has a much greater definition than can be realized with photographic paper sensitive
to X-rays or with the intermediary of a luminescent screen. The definition thus obtained is 200 lines/mm., as can be proved with the aid of photographs of very fine gauze, whereas the definition of X-ray films is only 100 lines/cm.

Excellent photographs can be made of the powder image, so that on the film details are obtained in the X-ray image which cannot be realized with other methods of fixing the X-ray image on the film.

The invention will now be described more fully with reference to the accompanying drawing.

FIG. 1 is a cross-sectional view of a casing in which an electrographic image carrier 1 is disposed. The image carrier 1 consists of a polished selenium plate having dimensions of 13 x 18 cms. The casing itself consists of an aluminum frame in one side 2 of which provision is made of a slot provided with a light-tight closure, through which slot the image carrier can be introduced. The image carrier is electrically insulated from the casing by means of material 3. A suitable cover 4 covers the image side of the selenium plate in a light-tight manner and can be slid away when the charge is provided, the exposure is carried out and the image-producing powder is removed.

The selenium plate is charged in the open casing in the absence of light with the aid of a punctiform electrode which is brought to a potential of +25 kv. with respect to earth. This charging process lasts 1 minute: the charge on the plate then is 4μ A./sec. (4μ coul.).

An X-ray shadow image is directly projected onto the plate thus charged, which results in a negative consisting of positive charges. In the interval between the charging and the irradiation of the selenium plate, the casing is closed of course. As shown in FIG. 2, the closed casing is now disposed on a chamber 5 which is open on the upper side, this open side being completely covered by the casing. The slide 4 is opened. On the lower side of the chamber provision is made of a funnel-shaped inlet 6 which projects together with a tube 7 into the chamber through the bottom thereof. Below the funnel 6, a spirit burner 9 is disposed which is filled with triethyl borate. In the tubular inlet 7, an electrode 8 is disposed which is brought to a potential of —10 kv., with respect to earth. The spirit burner is lighted and the fumes of boron oxide hydrate rise through the funnel, are charged negatively and reach the positively charged image on the selenium plate. The powder image has formed after 15 to 30 seconds. If this powder image is photographed with laterally incident light, the positive X-ray image is directly obtained on the photographic plate.

The powder image is removed in that the selenium plate is heated to a temperature of approximately 40° C. for 2 to 4 minutes. This thermal treatment may be carried out, for example, by subjecting the rear side of the selenium plate to a hot air current.

What is claimed is:

1. A method of xerographic reproduction including the steps of providing an electrostatic charge on a photoconducting carrier, irradiating the charged carrier to produce an electrostatic latent image thereon, forming a visual image on said carrier corresponding to said electrostatic latent image, and heating said carrier to remove the visual image and regenerate the carrier, the improvement comprising the step of exposing the electrostatically charged carrier to charged particles of boron oxide to form a visual photographic image.

2. A method as claimed in claim 1 in which boron oxide is removed from the image carrier by heating the latter to a temperature of approximately 40° C. to 60° C.

3. A method as claimed in claim 1 in which boron oxide is obtained by burning an organic boron compound.

4. A method as claimed in claim 1 in which at least the surface of the image carrier more strongly absorbs heat radiation than boron oxide and that after the boron oxide is provided, the side of the carrier coated therewith is subjected to heat radiation to obtain an increase in gradation.

5. A method of fixing an X-ray image as claimed in claim 1 in which the carrier is exposed to X-ray radiation to form an electrostatic charge image and the visual image is photographed with laterally incident light.

References Cited by the Examiner

UNITED STATES PATENTS

2,691,345 10/1954 Huebner ------------ 252—621
2,863,767 12/1958 Vuyverberg et al. 117—17.5
3,178,281 4/1965 Jarvis -------------- 250—65

RALPH G. NILSON, Primary Examiner.

W. F. LINDQUIST, Assistant Examiner.