APPARATUS FOR DEVELOPING A LATENT ELECTROSTATIC IMAGE WITH A LIQUID AEROSOL

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Filed Mar. 18, 1965, Ser. No. 440,850

Claims priority, application Germany, Apr. 7, 1964, E 42,540

7 Claims. (Cl. 118—637)

ABSTRACT OF THE DISCLOSURE

An apparatus for developing a latent electrostatic image on a photoconductive layer on a photoconductive material with a liquid aerosol containing toner powder and which particularly emphasizes the margins of image areas. The central effect is marked in 2 lines of about 1 mm. in width and below. Under unfavourable conditions, lines of smaller width than in the original are obtained on the copy.

The apparatus is suitable for the development of latent electrostatic images having two development grids, of which one, the development grid electrode, is connected to the development electrode through the supplying matrix of the aerosol and the other, the counterelectrode, is connected to the counter electrode. The apparatus is also suitable for the reproduction of image areas which have been completed later than the image areas to be reproduced and the development grid electrode occurs only to such a slight extent that they are negligible. More

The invention relates to an apparatus for the electro-photographic development of latent electrostatic images, using liquid aerosols which have been prepared electrostatically, a grid electrode being used as developed electrode and a wire mesh as counter electrode.

The electrostatic production of liquid aerosols for the development of electrostatic charge images is disclosed in Belgian Patent No. 616,914. In the process described there, the developer liquid is electrostatically atomized on spray electrodes which have a strongly curved surface. Further embodiments of atomizer electrodes are described in Belgian Patent No. 634,184. The spray electrode described there consists of a hollow cylinder which widens out in the form of a funnel at one end and has a sharp edge. A grid electrode is arranged between the spray electrode and an earthed metal plate which serves as support for the photoconductive material. This apparatus is suitable for the development of images on a stationary electro-photographic layer. In this method, the processes of charging, exposure and development must proceed completely one after the other for each image and in addition, time is required for cleaning the grid electrode. This successive carrying out of the various stages for each image necessitates a relatively long development time, which is especially disadvantageous when several copies of one original have to be prepared.

When using the above mentioned apparatus for developing charge images, a certain distance between the grid electrode and the support carrying the image is necessary in order to ensure that the grid structure does not appear on the reproduction. On copies of writing or on line images, an aberration is frequently observed under these conditions, which will here be termed the central effect. It occurs especially when the images have not been developed sufficiently already or when the development of images is not sufficient. The central effect consists in small image areas, which are uniformly blackened in the original, becoming more strongly blackened in the central parts of the copy than at the periphery due to the aerosol development.

This phenomenon is in contrast to the marginal effect which frequently occurs in electrostatic development with toner powder and which particularly emphasizes the margins of image areas. The central effect is marked in

lines of about 1 mm. in width and below. Under unfavourable conditions, lines of smaller width than in the original are obtained on the copy.

The known development apparatus is suitable for a continuous process since the continuous development would have to be interrupted for cleaning the development grid electrode. Moreover, it would not be possible to keep the metal plate, which serves as support for the electro-photographic material, completely and constantly covered by the paper as the individual sheets of the paper pass through the apparatus. If, however, the surface of the supporting plate is exposed from time to time to the aerosol which is to a large extent held back by the grid electrode lying above the plate but nevertheless penetrates in very small quantities, a thin layer of the deposited aerosol is formed on the plate after a short time, this layer contaminating the paper from the rear surface.

In the known process, the grid electrode is kept at a distance of about 5 mm. from the photoconductive layer containing the latent charge image in order to avoid contamination of the photoconductive layer by the grid and suppress the reproduction of the grid structure in the image.

It is among the objects of the present invention to provide an apparatus for continuous development of photoconductive layers having a latent electrostatic image. It is a specific object of this invention to provide a liquid aerosol development apparatus having means for electrostatically generating the aerosol.

It has now been found that a continuous development can be performed and any contamination of the photoconductive material can be avoided by a liquid aerosol development apparatus having means for electrostatically generating the aerosol, which is characterized by a development grid electrode and a grid-like counterelectrode for the development electrode which serves as support for the photoconductive material to be developed. The apparatus of the invention is further characterized by means for producing a stream of gas preferably air from behind the counterelectrode which flows through the counterelectrode moving in the opposite direction to the liquid aerosol.

In the development apparatus of the present invention the photoconductive material is placed between the development electrode and the counterelectrode, so that the electrostatic images on the latent electrostatic image contacts the development electrode and the rear of the photoconductive material is placed on the counterelectrode. No contamination of the photoconductive layers occurs even when the photoconductive material is moved between the electrodes. This was very unexpected since it had to be assumed that as the photoconductive layer glides along the development grid electrode, this layer would be contaminated by the liquid developer aerosol and moreover, it had to be assumed that when the photoconductive layer made contact with the development grid electrode, a transfer of charge would take place which would disturb the latent charge image on the photoconductive layer.

If the development of the image takes place on a stationary photoconductive material on which a development grid electrode is placed, an image is produced which shows a grid pattern. The reproduction of the grid structure is, however, prevented by movement of the electro-photographic paper if the movement takes place obliquely to the position of the grid lines, e.g., at an angle of between 0 and 45°.

Transfers of charges between the photoconductive layer bearing a charge pattern in accordance with the image to be reproduced and the development grid electrode occur only to such a slight extent that they are negligible. More
over, such transfers of charges can be prevented by coating the surface of the grid with a thin insulating layer of lacquer on the side facing the paper.

For use as counterelectrode for the electrophotographic paper, a conductive wire mesh parallel to the grid electrode, the distance being chosen to be so small that the electrophotographic paper slides with the photoconductive layer along the development grid electrode and with its paper support over the wire mesh of the counter electrode through the development station. The counterelectrode has preferably a mesh size of between 10 and 50 meshes per cm. The development grid electrode and the wire mesh of the counterelectrode are preferably conductively connected together or connected to a variable voltage through a voltage source.

So long as the side of the grid electrode opposite to the atomized electrode is covered by the photoconductive layer, the aerosol sprayed from the atomizer electrode cannot be deposited on that side of the grid electrode but only on the surface facing the atomizer electrode.

In order to keep the parts of the development grid electrode which come into contact with the photoconductive layer and the wire mesh of the counterelectrode free from droplets of the liquid aerosol when no electrophotographic material is situated between the electrode, a steady stream of air is blown through the counter electrode and the development grid in a direction against the electrode, and the stream by the atomizer electrode. In this way, the particles of the aerosol can effectively be held back from the electrodes. On the other side of the grid, on the other hand, the electrostatic field is so powerful that deposition is hardly impaired. By the term "electric wind" we understand the following phenomenon: Electric charges or charged particles, which flow in a certain direction cause an agitation of the air or any gas being present in that space in the same direction. This effect appears as a blast or draught of the gas.

A preferred embodiment of the invention involves two or more rollers having an absorbent covering are rolled over the grid, these absorbent rollers being preferably so arranged that the atomizer electrode lies between two rollers and is moved by them simultaneously in order to clean the surface of the development grid electrode with which the atomizing electrode from the droplets of the developer aerosol can be a result of the combination of these two necessary movements, the deposition of aerosol and hence the development can proceed continuously with simultaneous cleaning of the development grid electrode.

A preferred embodiment for the apparatus according to the invention is shown in FIG. 1. It consists of a development grid electrode 1 with a wire mesh as counterelectrode 2 arranged parallel thereto, the distance between the grid and the mesh being maintained so small that an electrophotographic paper 3 lying between them has its photoconductive layer 4 bearing the latent electrostatic image in contact with the grid electrode 1 and its rear surface at the same time in contact with the counterelectrode 2. The counterelectrode 2 is connected to the grid 1 through a voltage source which preferably has a low internal resistance. The voltage can be adjusted in the region of 0 v to 300 v. One of the electrodes 1 or 2 is grounded and connected to the voltage source 100 in such a manner that the grid electrode 1 has a negative potential as compared with the counterelectrode 2. Above the grid electrode 1 and the counterelectrode 2 there is arranged a ventilator 5 which blows a stream of air, uniformly distributed over the whole grid by the deflector plate 6, through the wire mesh of the counterelectrode and the development grid electrode. To protect against traces of slipping and against discharges, the grid electrode is coated with a thin insulating layer on the surface remote from the atomizer electrode. The grid lines of the development grid electrode extend obliquely at an angle between 0 and 45°, preferably 23°, to the direction of sliding of the electrophotographic paper. Two rollers 7 equipped with absorbent covers 8 press against the surface of the grid electrode 1 and the mesh electrode facing the atomizer electrode. The rollers are attached to a movably supported 9 and together with this support they are moved parallel to the grid in two directions by a suitable device such as a cross-hatched screw 10 which in turn is driven by a motor 11.

Attached to the same support is the container 12 for the developer liquid with the electrostatic atomizer electrode 13 which is driven by a motor 14 by way of an insulating driving element 15, e.g., a drive belt. Atomizer apparatus of this kind are described in Belgian Patent No. 634,184. The atomizer electrode is arranged between rollers 8 in such a way that sufficient space is left to enable the aerosol produced to be deposited on the grid. The developer container 12 with atomizer electrode 13 is secured in insulated manner on the support 9. The high voltage required for the atomization is supplied through a metal tip 16 which sweeps over a metal rail 17 being fixed in an insulated manner during the movement of the support 9 but without touching the rail. In this case the high potential required for the electrostatic atomizing is conducted from rail 17 to the metal tip 16 and the atomizer electrode through a corona which is formed at the metal tip. The rail is connected to a high voltage source having, for example, preferably a voltage of 10 to 30 kv.

During the development of a latent electrostatic image, the electrophotographic paper slides between the grid 1 and the mesh 2, the movement of the paper taking place obliquely to the direction of the grid lines of the development electrode. As a result of this, the atomizer electrode 13 with the rollers 7 at the same time performs a pendulous motion perpendicularly to the direction of travel of the electrophotographic material. The deflection from the central position is sufficient to enable the surfaces over which the rollers move to make contact with each other or overlap.

The apparatus supplied sharp images without disturbing marginal or central effects. Apart from rendering charge images visible, it may also be used for sensitizing surfaces either in areas corresponding to images or in a mosaic pattern or homogeneously, according to the process of Belgian Patents Nos. 653,517 and 653,694.

In the developing apparatus of the invention there may be employed any developer liquid which has been found suitable for electrostatisical atomizing, such as described in Belgian Patent No. 619,914.

Any type of electrophotographic materials can be developed in the apparatus of the present invention. Particularly suitable are the ordinary electrophotographic elements comprising a supported photoconductive layer which essentially consists of zinc oxide as photoconductive compound dispersed in an insulating binding agent, such as silicone resins, styrene-butadiene copolymers, styrene-alkyl resins, silicone-alkyl resins, soya-alkyl resins, polyvinylchloride, polyvinylacetate and the like. Suitable electrophotographic materials have been described in prior art.

The present invention is preferably performed with photoconductive layers which yield negatively charged latent electrostatic images and with a liquid aerosol, the droplets of which are positively charged. The development grid electrode has either no potential or a slightly negative potential for example up to — 20 v.

We claim:

1. In an apparatus for developing a latent electrostatic image on a photoconductive layer of a photoconductive material with a liquid aerosol comprising an atomizing electrode for spraying developer aerosol, said atomizer electrode being in liquid communication with a source...
of developer liquid, a grid electrode arranged between the electrostatic atomizing electrode and the photoconductive layer bearing the latent electrostatic image to be developed, said grid electrode being parallel to the photoconductive layer, and a counterelectrode supporting the photoconductive material, the improvement consisting of said counterelectrode being electrically conductive wire mesh, means for generating a stream of a gas from behind the counterelectrode and through the counterelectrode, flowing in the opposite direction to the liquid aerosol, said grid electrode and said counterelectrode being arranged at a distance essentially corresponding to the thickness of the photoconductive material so that the photoconductive layer contacts the grid electrode and the rear surface of the photoconductive material contacts the counterelectrode, said counterelectrode being connected to the grid electrode through voltage source means, and said voltage source means applying a different potential to said grid electrode than the potential of said counterelectrode.

2. An apparatus as defined in claim 1 characterized in that the grid electrode is coated on the side, which is opposite the atomizing electrode, with a thin insulating layer.

3. An apparatus as defined in claim 1 characterized in that said means for generating a stream of gas is a ventilator arranged behind the counterelectrode.

4. An apparatus as defined in claim 1, characterized in that a deflector plate for the uniform distribution of the air stream is arranged behind the counterelectrode.

5. An apparatus as defined in claim 1 characterized in that movable rollers having absorbent covers are arranged on that side of the grid electrode which is opposite the counterelectrode for the purpose of cleaning the grid.

6. An apparatus as defined in claim 5, characterized in that the rollers are attached on both sides of the atomizer electrode to a support which is movable parallel to the grid electrode.

7. An apparatus as defined in claim 6 characterized in that said support is reciprocatingly movable in two directions.

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U.S. Cl. X.R.

96—1; 117—17.5, 37