A device in which a pigment solution is discharged into a carrier through a small diameter nozzle while the pigment is applied with a voltage with the polarity opposite to that of an electrostatic latent image to be developed. The pigment is attracted toward an electrically conductive roller partially immersed in a carrier and applied with a voltage with the polarity opposite to that of the pigment so that the pigment is transported by the roller above the level of the carrier into contact with the surface of a copy sheet having an electrostatic latent image formed thereupon at the uppermost portion thereof, whereby the electrostatic latent image is developed.
ELECTRONOGRAPHIC COPYING MACHINE

BACKGROUND OF THE INVENTION

The present invention relates to an electronographic copying machine and more particularly to a wet type electronographic-copying machine of the type in which the pigment particles in a carrier are electrostatically charged and attracted toward an electrostatic latent image upon a copy sheet, thereby accomplishing the development.

In the conventional wet-type electronographic process, the developing solution comprises carrier having high electrical resistance sufficient enough to prevent the dissipation or destruction of an electrostatic latent image during development. Pigment particles are dispersed in the carrier and a control agent is adapted to coat the pigment particles so that the electrostatic charge imparted thereto may have a suitable polarity for development.

The use of such control agent, however, causes various disadvantages. That is, the materials that can be used as control agent are limited; the control effect of the control agent varies due to temperature variation because the control of the charge by the control agent is based upon the electrochemical characteristic. The effect is also reduced when some impurities, especially organic substances are mixed into the carrier; and when the compound forming the electrostatic latent image bearing body are dissolved into the carrier by the contact therewith, the developing solution will become chemically unstable so that the uniform dispersion of the pigment particles is adversely affected.

Therefore, there have been proposed a method and device for eliminating such defects by using independently a carrier having a high electrical resistance and a pigment which actually develops an electrostatic latent image.

However, such method has various defects. For example, since the copy paper sheet (including those whose base is formed from synthetic resins) must be immersed into the developing solution, the base or support materials must not be dissolved into the developing solution or must have a large thickness and must be flexible. Therefore, the selection of the materials for the base or support of the copy sheet is limited. Furthermore, since the whole body of the copy sheet is immersed into the developing solution, it takes a long time for drying so that the drier must have a high capacity, thus increasing the cost.

SUMMARY OF THE INVENTION

In brief, the present invention provides a wet-type electronographic-copying machine of the type in which a developing solution consisting of a carrier and pigment is used and only one surface of a copy sheet comes into contact with the developing solution.

In the electronographic-copying machine of the present invention, a pigment solution is discharged through a small diameter nozzle into the carrier. The pigment is provided with an electrostatic charge with the polarity opposite to that of an electrostatic latent image, for example positive polarity. The pigment is attracted toward a roller made of an electrically conductive material, partially immersed in the carrier and having a potential with the polarity opposite to that of the pigment so that the pigment is carried by the roller above the level of the carrier and into contact with the surface of the copy sheet having the electrostatic latent image formed thereupon at the uppermost position of the roller or the vicinity thereof, whereby the electrostatic latent image is developed.

Therefore, one of the objects of the present invention is to provide an electronographic-copying machine utilizing the above described developing solution consisting of a carrier and pigment.

Another object of the present invention is to provide a copying machine simple in construction.

A further object of the present invention is to provide copy sheet inexpensive in cost and easy in handling by extending the range of the materials that may be used as the support or base of the copy sheet.

A still further object of the present invention is to reduce the fabrication cost of the electronographic-copying machine.

The above and other objects of the present invention will become more apparent from the following description taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF DRAWING

FIG. 1 is a longitudinal sectional view of a developing device of one embodiment of an electronographic-copying machine; and

FIG. 2 is a perspective view of a nozzle to be used in the embodiment shown in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, reference numeral 1 denotes a developing solution container; 2, an electrically conductive roller having the peripheral surface provided with screen-like small ridges like a printing plate screen and being adapted to rotate about a shaft 4; 5, a container of a solution containing pigment to be referred to as "pigment solution" hereinafter; and 6, an elongated and small diameter nozzle made of an electrically conductive material and extended from the pigment solution container 5. The nozzle 6 serves as a "capillary action" electrode and its tip end is open in the vicinity of the roller 2. Reference numeral 7 designates a carrier; 8, a pigment solution; and 9 a power source for applying a voltage across the nozzle 6 and the roller 2. A copy paper sheet 10 is moved in the direction indicated by the arrow B in light contact with the top of the roller 2 or the vicinity thereof at a speed equal to the peripheral speed of the roller 2. In this case, the copy paper 10 has its surface or light sensitized layer directed downwardly. A developing solution 11 consists of the carrier 7 and the pigment particles ejected through the nozzle 6 and carried over the peripheral surface of the drum 2. The developing solution has a predetermined viscosity. An electrostatic latent image 12 over the copy sheet 10 is developed by the developing solution 11 into a visible image 13.

Next the mode of operation of the device having the construction as described above will be described. The roller 2 having a portion exposed above the level of the carrier rotates in the direction indicated by the arrow A. A voltage is applied across the nozzle 6 and the roller 2 for example as shown in FIG. 1 and the pigment solution 8 is discharged or ejected from the tip end of
the nozzle 6 into the carrier 7. In case of the embodiment shown in FIG. 1, the pigment is positively charged and dispersed into the carrier 7. Then, the pigment is electrostatically attracted toward the roller 2 and carried over the top portion of the drum 2 together with the carrier. Since the copy paper 10 is moving in the direction indicated by the arrow B in light contact with the roller 2 with the surface bearing thereupon the electrostatic latent image 11 being directed downwardly, the electrostatic latent image 11 is developed by the pigment so that the visible image 12 is developed. The developed copy paper is dried by a drier not shown.

As shown in FIG. 2, when a plurality of nozzles are bundled into a nozzle assembly 6, the pigment electrode contact surface area may be increased so that the pigment may be more effectively imparted with the electrostatic charge.

The density of openings or the mesh of the screen formed upon the peripheral surface of the roller 2 may be determined depending upon the viscosity of the developing solution.

In case of the embodiment described above, the tip end of the nozzle 6 has been described and shown as being open in the carrier 7, but the tip end of the nozzle may be disposed above the surface of the carrier so that the pigment solution may be dropped upon the carrier.

From the foregoing, it will be seen that many advantages may be accrued from the present invention. That is, the device of the present invention is simple in construction; the development may be made without the use of a control agent; since only the sensitized surface of a copy sheet is in contact with the developing solution, the range of the materials that can be used as a base or support of the copy sheet is widely extended; a drier for drying the developed copy sheet may be simple in construction; and the costs of a photo-copying machine and its copy paper sheets can be remarkably reduced.

I claim:

1. An electronograph-copying machine for passing paper therethrough to be developed, comprising: a developer container having developer solution therein; an electrically conductive roller having rough-edge surfaces on its periphery, said roller partially immersed in said solution and positioned so that the copy paper passing therethrough contacts the upper peripheral point thereof; a pigment container having pigment solution therein, said pigment container located closely adjacent said developer container; an electrically conductive nozzle means extending from said pigment container and having an opening adapted to discharge pigment solution into said solution container at a location in the close vicinity of the periphery of said roller; electrical circuit means including a power source connected between said nozzle means and said roller to apply a voltage therebetween so that the pigment solution has a positive charge applied thereto; said roller being rotated to carry said charged pigment solution up to said copy sheet for developing a latent image thereon.

2. An electronograph-copying machine according to claim 1 in which the open end of said nozzle means is positioned to discharge beneath the upper level of said developer solution.

3. An electronograph-copying machine according to claim 1 in which the rough-edge periphery of said roller comprises a mesh-like surface, and said nozzle means comprise a plurality of nozzles bundled together and discharging pigment solution onto said mesh-like surface.