

April 19, 1966

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3,247,007

METHOD OF DEVELOPING LATENT ELECTROSTATIC IMAGES
USING SOLID DEVELOPER BODY AND RELATED SOLVENT

Filed July 22, 1964

2 Sheets-Sheet 1

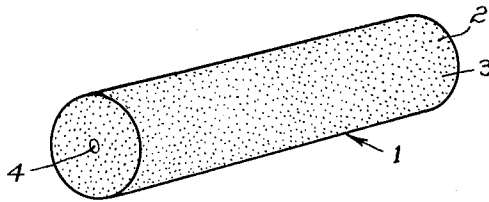


FIG 1

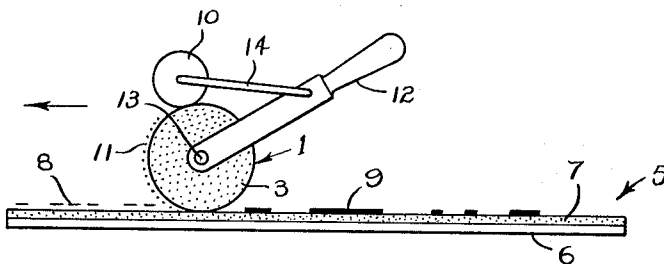


FIG 2

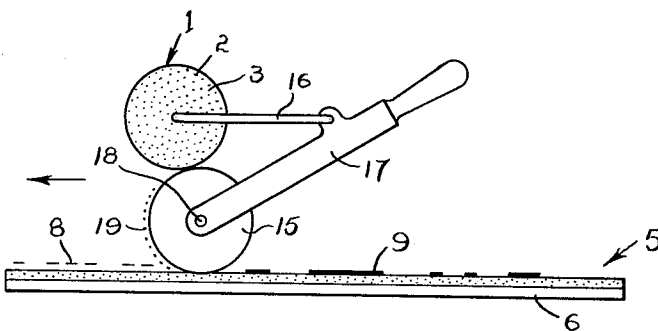


FIG 3

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2 Sheets-Sheet 2

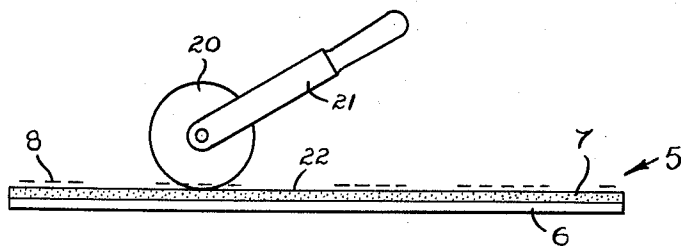


FIG 4.

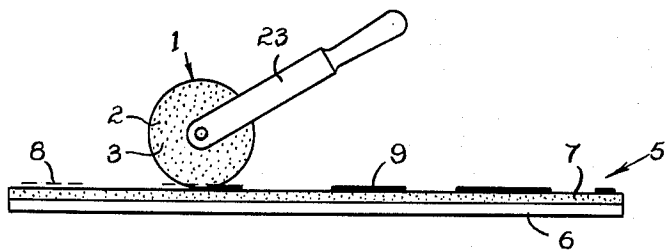


FIG 5.

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METHOD OF DEVELOPING LATENT ELECTROSTATIC IMAGES USING SOLID DEVELOPER BODY AND RELATED SOLVENT

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4 Claims. (Cl. 117—37)

This application is a continuation-in-part of application Serial No. 53,990, filed September 6, 1960 and now abandoned.

This invention relates to electrophotography, and in particular relates to improved method of and means for the rendering visible of latent images produced electrostatically in the known arts of electrophotography and electrostatic printing.

Electrostatic printing is known wherein a patterned electrostatic charge on the surface of an insulator or a photoinsulator or a photoconductor sheet is rendered visible by the application of a powder to such surface whereupon such powder is attracted to the electrostatic charge on the surface to render the pattern visible. Various methods of applying such powders are known, including those well known to those skilled in the art as cascade, powder cloud, magnetic brush, and liquid development.

It is also known to prepare a developer or toner in solid form containing a pigment or coloring matter bound in the form of a solid stick with a binder comprising a wax or other low melting point material, wherein such binder can be rendered liquid by the application of heat which thus allows the pigment or other coloring particles to become mobile and thus attractable to the latent electrostatic image or pattern. Such thermoplastic binder also serves as a fixing agent for the developed image after the source of heat is removed. Such prior art thermoplastic toners suffer from disadvantages in that the application of heat to electrophotographic surfaces such as selenium or zinc oxide containing coatings causes a loss of electrostatic surface charge with a consequent lowering of developed image intensity, and in addition the thermoplastic material tends to adhere to non-image or background areas and to retain pigment particles in these areas which produces an image of generally low contrast and dirty appearance.

Liquid dispersed toners as known can be made to produce developed images of excellent contrast and resolution but such toners are often of inferior smudge resistance. The smudge resistance of such liquid dispersed toners can be improved by the inclusion with the coloring matter of resins or oils or varnishes, but such toners are generally of limited stability either in concentrated or dispersed form.

Dry electrophotographic toners consist essentially of pigmented particles which are carried to the image by a carrier such as a magnetic particle in the well known magnetic brush method, or on a triboelectrically separable bead in the cascade method or by air movement in the powder cloud method. The toner particles, regardless of their transport means, usually comprise a pigment and a fixing agent, and such fixing agent is employed to fix the pigment particles to the image by a heat fusion process or by solvent action. These toners, consisting as they do of discrete particles, are sensitive to changes in humidity and temperature, and thus must be employed under relatively closely controlled conditions of temperature and humidity for optimum results.

The present invention teaches a method whereby each of the previously mentioned disadvantages may be overcome, in that it provides a stable, high contrast toner

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which is not sensitive to ambient conditions, and which gives image deposits of excellent smudge resistance. Thus the present invention provides an improved method of and means for developing electrophotographic images, and consists in a developer in which pigment or other coloring particulate material is in the form of a dispersion in a solid or substantially solid matrix, which solid matrix is soluble in a liquid of volume resistivity greater than 10^9 ohm cm. and dielectric constant less than about 3.

Such solid developer may be prepared in several ways, such as for instance by melting of the matrix material together with the pigment material which may also incorporate other materials such as resins or oils or oleo-resinous varnishes. Alternatively the matrix material may be dissolved in a suitable solvent and milled with the pigment to obtain the necessary dispersion, after which the solvent may be partially or completely removed by evaporation to leave the developer in substantially solid form. As still further alternative methods of preparation the pigment may be wetted with a solvent for the matrix material, after which the wetted pigment and finely divided matrix material may be blended, or the matrix material may be rendered tacky by the action of heat or a solvent to facilitate blending with the pigment.

According to the present invention the solid obtained after mixing by any preferred method such as previously described becomes a developer material which is used by applying such solid to a surface supporting an electrostatic image or pattern charge in the presence of a solvent which causes the matrix material to become mobile at the moment of development, said developer solidifying afterwards by evaporation of the solvent. Such solvent must of necessity be of an insulating nature, such as one with a volume resistivity in excess of 10^9 ohm cm. and dielectric constant less than about 3 in order that the electrostatic charge shall not be destroyed before development can take place.

When using a developer concentrate in this solid form there is no loss of developer matrix by evaporation, and the developer is chemically stable. The mobility of the developer is restricted at all times other than at the time of development and thus losses and chemical changes are thereby minimised.

As an example of how the invention can be carried into effect, it will now be described with reference to the accompanying drawings in which:

FIG. 1 shows a solid developer stick,

FIG. 2 shows one method of use of the stick in which a roller damps the stick with a solvent for the solid carrier,

FIG. 3 shows an alternative method in which the stick contacts an applicator roller carrying the solvent to release developer to the applicator roller,

FIG. 4 shows how the solvent can first be applied to the electrostatic image, and

FIG. 5 shows how the solid stick developer can then be passed over the wetted image to develop same.

The solid stick 1 (see FIG. 1) comprises coloring or toner particles 2 embedded in a solid matrix 3. The stick is shown with end apertures 4 so that it can be engaged on a handle or support to allow it to be used as a roller.

In each of the figures of the drawings the same numerals are used on the solid stick, and also in FIGS. 2, 3, 4 and 5 the same numerals are used on the photoconductor sheet 5 which comprises a backing 6 and photoconductor film 7, the dotted lines 8 indicating an electrostatic latent image while the solid lines 9 indicate the developed image.

In the embodiment of FIG. 2 the solid stick 1 is contacted with a roller 10 which forms the applicator for the solvent which carries at least on its surface a quantity of solvent for the developer matrix. The roller 10 may

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have a sponge-like composition. The solvent dissolves portion of the matrix material 3 forming a mobile layer 11 on the surface of the stick, which layer contains toner particles suspended in a solution of matrix material in solvent. The thus mobilised toner particles are thus free to be attracted to the latent electrostatic image 8 forming the image deposit 9.

The solid stick 1 is carried on a handle 12 having pins 13 engaging the apertures 4, while the liquid solvent applicator roller 10 is carried on a wire member 14 which pivotally engages the handle 12 and on which the roller 10 is rotationally engaged.

In the embodiment shown in FIG. 3 it will be seen that the relative arrangement of solid stick 1 and wetting or applicator roller 15 has been reversed in relation to the image bearing sheet. In this instance the wetting roller 15 is rotationally supported on a wire member 16 which pivots on the handle 17 which in turn has pins 18 on which the roller 15 rotates, the roller 15 being in contact with the image bearing photoconductor sheet, and being contacted by the solid stick 1. The action of the solvent on the surface of the stick 1 causes a layer of toner particles 2 to be released into the mobile layer 18 carried on the wetting roller 15 to the latent image 8 which develops to form the image deposit 9.

In this embodiment shown in FIGS. 4 and 5 an applicator roller 20 on a handle 21 is first run over the sheet 5, the applicator roller 20 carrying the solvent and applying it to the surface 22 of the photoconductor film 7. The developer stick 1 on a handle 23 is then run over the wetted surface 22 and this solvent then releases the developer from the stick 1 to the electrostatic image areas 8 to develop the image.

The developer stick may be stored in the form of a solid mass for long periods, and while it is preferable to use such a developer in its solid form by the application of a solvent for the matrix at the time of development only, it is also possible to use such a stick as a developer concentrate for the make up of a liquid developer. It is also possible to first wet the surface to be developed with a liquid of high volume resistivity such as greater than 10^9 ohm cm. which will not destroy an electrostatic image, and to then bring the solid developer stick into contact with the wet surface. If the liquid is a solvent for the matrix material, pigment particles will be released from the solid mass by solution of part of the matrix thus allowing development of the image to take place.

As further illustration of how the invention can be carried into effect reference will now be made to the following examples:

Example 1

A photoconductor coating was prepared as follows:

	Grams
Photoconductive zinc oxide -----	100
Short oil alkyd resin, such as Rhodene M8/50 ----	60
Toluene -----	60
Driers:	
Cobalt naphthenate, 15% -----	1
Manganese naphthenate, 4% -----	0.5

The components were blended by ball milling and then coated by any known means on a relatively conductive backing such as a paper web and dried.

This film is charged and exposed in the known manner to produce an electrostatic latent image on the photoconductor surface. The image is developed by contacting the sheet with a wetted solid developer stick of the following composition:

	Grams
Phthalocyanine blue -----	1
Colophony -----	20

The stick is prepared by heating the colophony to a temperature above its melting point and then adding the pigment by stirring. The mix is then cast into the

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desired shape and allowed to cool. Wetting the so formed stick with toluene dissolves sufficient of the colophony to free pigment particles which thus become available for developing the electrostatic image. The image becomes fixed by evaporation of the solvent from the photoconductor surface, as the previously dissolved colophony adheres to the pigment and the photoconductor surface.

Example 2

The colophony of Example 1 is replaced with an equal quantity of naphthalene.

Example 3

The colophony of Example 1 is replaced with the natural resin guaiacum.

Example 4

	Grams
Carbon black -----	1
Reflex blue -----	0.3
Hydrogenated rosin -----	20
Solvesso 100 -----	40

The components are blended by ball milling and the mixture thus produced is cast into the required shape and allowed to solidify by solvent evaporation. For use as a developing means the so formed stick is wetted with Solvesso 100 which frees the pigment which thus becomes available for developing an electrostatic image.

Example 5

	Grams
Fastel Pink B supra -----	1
Polybutylmethacrylate -----	25
Perchloroethylene -----	15

The polybutyl methacrylate was blended with the perchlorethylene to form substantially swollen acrylic particles in the consistency of a paste. The pigment was then added and the mix homogenised by triple roll milling. Evaporation of substantially all of perchloroethylene formed a solid stick which was usable for development of electrostatic images when wetted with the solvent Solvesso 100.

Example 6

The colophony of Example 1 was replaced with an equal weight of beeswax.

Example 7

The colophony of Example 1 was replaced with an equal weight of paraffin wax.

Materials mentioned by trade names in the specification. Rhodene M8/50, a short oil linseed alkyd resin by Polymer Corporation, oil length 40%, acid value 10 max., Sp. Gr. 0.987-0.997.

Solvesso 100, an aromatic hydrocarbon solvent, Flash Point 118° F., K.B. value 93, manufactured by Esso Standard Oil Company.

Fastel Pink B Supra, an organic lake red pigment by I.C.I.

The high resistivity solvents employed in the present invention preclude dissipation of the electrostatic image during development, affording clear, high-intensity developed images. The high mobility of the pigment particles in the solvent precludes substantial deposition of the pigment in background areas, avoiding the low-contrast "dirty" appearance presented using some prior art techniques. The developed images exhibit excellent smudge resistance. The process of the invention is not affected by substantial changes in ambient temperature and humidity. The developer bodies employed may be stored for indefinite periods without deterioration, producing consistent results when put to use.

What I claim is:

1. A method of developing and fixing a latent electrostatic image on an image bearing surface by means

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of a solid developer body of substantial size comprising a suspension of pigment particles immobily suspended in a binder which is normally in a solid state and which in solution in a solvent of volume resistivity greater than 10^9 ohm cm. and dielectric constant less than 3 has an electrical resistance sufficiently high to avoid dissipation of the latent electrostatic image during development, comprising the steps of moving said solid developer body and said image bearing surface in relation to each other, wetting the developer body with said solvent whereby a portion of said binder is dissolved, contacting the latent electrostatic image with the dissolved binder, said pigment being released with dissolving of said binder and developing said latent electrostatic image by migrating to and depositing on said image under the influence of the latent electrostatic field and allowing said solvent to evaporate whereby the dissolved binder adheres and fixes the released pigment on said surface.

2. The method according to claim 1 wherein said solvent is applied to the surface of the solid developer body by an applicator and wherein such wetted developer body is moved in contact with the image bearing surface.

3. The method according to claim 1 wherein said

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solvent is applied to the surface of the solid developer body by an applicator which applicator contacts the image bearing surface and carries to such surface pigment particles rendered mobile by the solvating action of the solvent on the solid developer body in contact with the applicator.

4. The method according to claim 1 wherein the solid developer body traverses the electrostatic image, and wherein said solvent is applied to the image bearing surface and thereby wets the surface of the solid developer body as such body traverses the image.

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