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METHOD FOR DEVELOPING COPIES USING ELECTROPHOTOGRAPHIC LAYERS

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This invention relates to a method for developing copies using electrophotographic layers by means of a heating effect after producing a latent image in the electrophotographic layer. The invention further relates to a material for carrying out this method.

It is known to charge an electrophotographic layer in an electric field and to produce a charge distribution corresponding to the original in this layer by exposure. This charge distribution forms a latent image in the layer. For developing this latent image, the layer is dusted with a pigment powder which adheres to the layer according to the dimensions of the charge distribution corresponding to the latent image. For fixing, the pigment powder is fused. This method on the one hand requires a considerable expenditure on equipment and furthermore has the disadvantage that the distribution of the developer powder can only be poorly controlled. Furthermore, the developer powder dust spreads to all parts of the apparatus so that, if no special protective precautions are taken, the efficiency of the apparatus is reduced. In addition, it is comparatively difficult to spread the powder in uniform consistency.

For avoiding the latter difficulty, recourse has been had to the so-called wet development, in which the surface carrying the electrostatic image is exposed to a liquid developer having a liquid phase of electrical resistance so high that disintegration of the latent image is prevented, in which a pigment, which is electrically selective with respect to the image charge, is dispersed, and which includes a control material making the pigment electrically selective. In this process, the liquid phase must then be evaporated. For the application of the liquid and for the evaporation thereof, further special equipment is necessary, protective measures for the parts of the apparatus which are not of use in the evaporation steps being necessitated by the evaporation. In addition, in this latter method the original advantage of a dry development is lost.

The invention is based on the problem of providing a method and material which, using latent charge images in a dry process, enable development and if required fixing without the disadvantages of the known processes.

This problem is solved in that the electrophotographic layer is exposed to a source of heat radiation and that a heat distribution corresponding to the latent image is produced in this layer and in that this layer is exposed to said heat radiation when in engagement with heat-reactive developing material, i.e. material which reacts or dissolves at a fixed temperature, whereby the material melts in accordance with the latent image and forms a visible image.

One feature of the invention lies in that the latent charge image of an electrophotographic layer has, in particular for heat rays of long wavelengths such as infrared rays, a (heat) conductivity different from that of the layer outside the image or without image representation.

The expression "electrophotographic layer" relates to materials which can ordinarily be used in electrophotographic processes. Advantageously, the coated backings which have been employed previously in electrophotographic processes can be used as the electrophotographic layer. According to an advantageous embodiment of the

invention, developer materials in combination with a heat-reactive material are provided on the electrophotographic sheet with the electrostatic latent image and are exposed to heat rays.

Advantageously, the developer substances are arranged on a separate backing, which is first brought into contact with the electrophotographic layer after the production of the electrostatic image and then has the heat ray applied thereto. This contact is advantageously effected under pressure, the layer and the backing with the developer substances for example being pressed together in frame-like supports.

The invention includes the provision of developer materials which, at a fixed temperature, carry out chemical and/or physical reactions in accordance with the dimensions of the electrostatic latent image.

In the preferred embodiment of the invention, which uses a special backing for the developer substances, a known developer powder comprising pigment materials is uniformly distributed on the backing by means of a fusible means such as a wax or a low melting resin which may have a colophony base. For carrying out this process, the backing is exposed to a heat ray when the developer substance on the special backing has been brought in contact with the electrophotographic sheet in which the electrostatic latent image is located, the developer layer side of the special backing lying against the electrophotographic sheet. Advantageously, the heat ray is applied from the side of the electrophotographic sheet which latter in this manner acts as a selective heat filter. This process has the advantage that the fixing is carried out in the same step as the developing since the pigment particles of the developer which are set free in the region of the electrostatic latent image by liquification of the fusible substance are fused to the electrophotographic sheet. After a sufficient period of time of heat ray application a visible image has been formed on the backing. This visible image corresponds to the latent image in the electrophotographic layer. Thereupon the electrophotographic layer is separated from the backing which carries said visible image.

An infra-red source is advantageously used for producing the heat ray. It is pointed out, however, that the rays from the heat source may have wavelengths between from the end of the visible light to and including the infrared region.

Within the scope of the above embodiment, the invention includes the use of developer substances on a special backing, whereby the developer substances are released by a heating effect at a fixed temperature, are transferred to the electrophotographic layer in accordance with the dimensions of the electrostatic latent image therein and are fixed on this layer.

According to a different embodiment, developer substances are used which under the effect of heat rays of a fixed temperature carry out a colour change on the special backing for the developer substances and/or with materials on the electrophotographic layer.

It is pointed out that the use of a selective heat filter in the form of an electrostatic latent image ensures the accurate reproduction of the original independently of colour variations on the original.

The developer material for carrying out this process contains, in one embodiment, pigment materials in uniform distribution in a fusible substance on a backing. As fusible substances are used waxes, for example paraffin wax or ceresin wax, which are particularly stable and have, for example, a melting point between 60° and 80° C. The invention includes as fusible substance resins having low melting points, for example of colophony basis.

As pigment material, carbon black is advantageously used in the above embodiment. Also within the scope

of the invention lies the use of developer materials with accurately defined melting points and which have been previously used in electrophotographic processes, advantageously those powders being used which have the lowest possible melting point. As an example, the developer material may comprise a combination of substantially 15% carbon black and substantially 85% of so-called highest wax type S with a melting point of about 80° C. This developer material is applied to a paper, for example of low quality.

According to a further example, the developer layer applied to the second backing has the composition quoted below.

In this connection, there is referred to a backing which after exposure of the photoconductive layer or the photoconductive layer backing, if this layer is arranged on a special backing, is exposed to heat rays while being pressed against the photoconductive layer or photoconductive layer backing.

Composition of developer layer

15 grammes Wax KP
2 grammes emulsifier 2106
10 ml. paraffin oil
100 ml. distilled water
2 grammes potash
3 grammes special black dye IV

In the foregoing the chemical nomenclature for the trade names used for the several components is as follows:

Wax type S is a product of Farbwerke Hoechst and comprises a mixture of high molecular mono- and dicarbonacid which is produced by oxidation of raw montan wax.

Wax KP is a product of Farbwerke Hoechst and is a mixture of esters produced by a reaction of raw montan wax oxidate with low molecular alcohol.

Emulsifier 2106 is a product of Farbwerke Hoechst and is a polyoxiethyleneoleylether having a melting point of 39–40° C.

Special black dye IV is a product of Degussa containing 89% C, 1.1% H, .7% N, .3% S, and 8.9% O.

According to the Fiat Final Report No. 737 of March 8, 1946, page 14, the wax type S is produced by a chrom acid oxidation of raw montan wax and is composed of 80% by weight of wax acid and 15 to 20% by weight of the original wax ester.

The same Fiat Final Report No. 737 on page 19 discloses the production of Wax KP by an esterification of a wax acid produced from raw montan wax by means of a chrom acid oxidation with multivalent alcohols.

The Emulsifier 2106 is an organic substance emulsifiable in water and composed of a mixture of different polyglycol-ether as disclosed in the German patent specification No. 1,020,426.

Special black dye IV is generally used for printing and copying inks, dye bands, carbon papers and lacquers, and its composition is about

	Percent
Carbon (C)	89.0
Hydrogen (H)	1.1
Nitrogen (N)	7.0
Sulphur (S)	3.0
Oxygen (O)	8.9

It is pointed out that in each case the photoconductive layer is advantageously sheet-shaped, being arranged on a special carrier or being self-supporting.

For carrying out the invention, there is furthermore proposed a material which comprises a chemical sheet on a backing, on which sheet the stable parts effect a colour change above a fixed temperature. Using this material, the developed image is produced on the backing of this material, while the electrophotographic layer can be again used after discharging and a new charging.

The process according to the invention has substantial advantages. By carrying out the development and if required fixing in a dry process only comparatively simple apparatus with a heat ray source is required, which in addition can easily be combined with a known exposure device. Furthermore, the handling of the developer substances, in particular in comparison with the developer powder used in electrophotographic processes, is considerably simplified. In this connection, it is to be noted that the storage ability is improved, since the greatest, independence from environmental influences from the point of view of normal temperature and humidity variations exists.

In addition, the production of the backing having the developer substance layer is considerably simpler than the production of the previously used developer powder which requires special carrier particles.

What I claim is:

1. The method of making a copy from an electrostatic latent image produced in an electrophotographic layer, in which the electrophotographic layer is brought into contact by pressure with a second layer containing developer substances which when subjected to heat react with said electrophotographic layer and the latent image therein, exposing said contacting layers to a source of heat rays to produce said reaction in said second layer, whereby said developer substances become active in accordance with the differential heat conductivity throughout said electrophotographic layer as determined by the latent image therein so as to form a copy of the latter, and then separating said electrophotographic layer from said second layer which latter carries now a visible image.

2. A method as claimed in claim 1, in which the second layer contains developing materials which on being heated by infra-red rays carry out reactions according to the latent image and produce the visible image in the second layer.

3. A method as claimed in claim 1, in which the second layer contains developing substances which on being heated by infra-red rays carry out reactions according to the latent image and produce the visible image in the second layer, said developing substances carry out chemical reactions and react with substances in said electrophotographic layer.

4. A method as claimed in claim 1, in which the second layer contains developer substances which on being heated by infra-red rays carry out reactions according to the latent image and produce the visible image in the second layer, said second layer containing substances which carry out a color change at a fixed temperature and react in dependence with the degree of heat transfer caused by the heat conduction of the electrophotographic layer.

5. A method as claimed in claim 1, in which the second layer is applied to a backing.

6. A method as claimed in claim 1, in which said substances in said second layer comprise pigment powder with a fusible means uniformly applied to a backing, and the layer side of this backing is brought into contact with the electrophotographic layer whereby upon application of said heat rays said fusible means melts according to the electrostatic latent image and the pigment powder is transferred to the electrophotographic layer, adheres thereto and is fixed on this layer by the action of said heat rays.

7. A method as claimed in claim 1, in which said source of heat rays is applied from the side of the electrophotographic layer.

8. A method as claimed in claim 1, in which said source of heat rays consists of rays in the region at the end of the visible light, including infra-red rays.

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