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DEVELOPMENT OF ELECTROPHOTOGRAPHIC IMAGES

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This invention relates to novel mixtures for developing electrostatic and electrophotographic images and to methods for applying such mixtures.

The manner of obtaining an electrostatic image upon a charged plate is well-known in the art of electrophotography and may be carried out in any one of several ways, as pointed out in U. S. Patent 2,297,691 issued to Chester F. Carlson on October 6, 1942. A common method comprises the steps of coating a conductive metal plate with a photoconductive insulating material (such as anthracene, sulphur, etc.) and charging the surface of the coated metal plate. The charged plate may then be exposed to light through a photographic positive or negative so that all (or portions) of the charge which is on the light-receiving areas leaks off leaving a latent electrostatic image on the plate. The latent electrostatic image thus obtained may be developed by dusting a plate carrying a charge image with a suitable developing powder. Asphaltum, dragon's blood, zein powder, vinsol powder (an extract from long leaf yellow pine tree stumps composed principally of an oxidized form of abietic acid and manufactured by Hercules Powder Company, 908 Market Street, Wilmington, Delaware), resin powder and other similar powders have been found very satisfactory for use in developing electrostatic images. Powders used for this purpose are commonly known as electroscopic powders and are so designated throughout the remainder of this specification being, in general, finely divided resinous materials capable of being attracted and held by electrical charges on electrophotographic plates.

Previously, in the art of electrophotography, there has been considerable difficulty arising from the fact that electroscopic powders, when of the proper degree of fineness for image development, tend to form small balls of powder which leaves streaks as they roll across a plate. Furthermore, some particles of these powders tend to adhere to uncharged areas and, in some cases, are deposited in excessive quantities on the charged areas.

It is accordingly an object of this invention to provide a mixture for developing electrostatic images whereby streaks and smears caused by clots of powder are eliminated.

Another object of this invention is to provide a new and improved composition which eliminates the deposition of electroscopic powder on uncharged areas and avoids excessive deposition on charged areas during the developing of electrophotographic images.

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A further object of this invention is to achieve sharper and clearer images than have heretofore been possible in the electrophotographic process by more accurately distributing the electroscopic powder on electrostatically charged plates in accordance with the charged and non-charged areas.

Other objects and advantages of this invention will become apparent from the following detailed description thereof.

In general, the invention comprises electroscopic powder-granular carrier mixtures for developing electrophotographic images, and to methods of applying the mixture.

It will be apparent that the following disclosure is susceptible to modification and that variations may be made without departing from the broad scope of this invention which is herein described in its preferred form for the purpose of clearly setting forth the principles involved.

It has been discovered that latent electrostatic images may be developed by applying a mixture comprising an electroscopic powder in combination with a granular carrier to electrostatic charge images such, for example, as the electrostatic charge images formed on electrophotographic plates. Preferably, the mixture is applied by repeated flowings over the latent image while intermittently removing excess powder by tapping and/or by frequently dispersing by means of compressed air.

It has been found, in general, that any substance of such configuration as to roll easily over a plate, and having a surface having an affinity for a finely divided resinous powder and capable of holding such powder in a loosely-bound manner, being substantially larger in size than such powder is suitable for use and may be defined as a carrier in the developer mixture. Tests indicate that preferred materials are more accurately defined as crystalline substances whose crystalline structure tends toward the spherical or equidimensional. For example, all granular materials having a cubic, rhombic, hexagonal, or tetragonal crystalline structure have proven satisfactory. Substances having a monoclinic structure have proven unsatisfactory except when capable of being broken up by being passed through a sieve or by some similar action, as has been done with potassium chlorate. Agents which meet all of the above requirements are referred to as carriers or, more specifically, as granular carriers.

Some materials which have been found to be satisfactory carriers are sodium chloride, am-

monium chloride, aluminum potassium chloride, Rochelle salt, sodium nitrate, aluminum nitrate, potassium chlorate (after treatment as noted above), methyl methacrylate resin, granular zircon, and other similar granular materials.

Generally, it is preferred that the carrier particles be substantially larger than the electroscopic powder particles. Carriers ranging in size from 30-mesh to 325-mesh have proved satisfactory, with the best results apparently being obtained with granular carriers which are capable of being passed through a 30-mesh screen and being collected on a 60-mesh screen.

In preparing the mixture of electroscopic powder and granular carrier, no special precautions need be observed. It has been found that the ratio of electroscopic powder to carrier is not critical although it is preferred that there be sufficient electroscopic powder in the mixture to cover, or nearly cover, each carrier grain with a single layer of powder.

It has also been shown that the degree of contrast in the developed image may be varied by varying the ratio of carrier to electroscopic powder. Mixtures wherein the ratios of carrier to powder was as great as 100:1 have been used successfully and it does not appear that there is any limit to ratios which will work. Satisfactory ratios are largely determined by the particular powder-carrier combination used.

Micronized electroscopic powders have proven very satisfactory. These micronized particles are usually between one-tenth micron and twenty microns in diameter. However, micronizing of the powders is not essential and the powder size is not important in general, except that in any particular instance the powder particles should be substantially smaller than the carrier granules.

It is an essential characteristic of these carrier-powder mixtures that they be good insulators. Conductive combinations tend to discharge the electrophotographic plate without developing the electrostatic image. However, it has been found that the granular carriers need not be insulators provided that the electroscopic powder is present in sufficient quantity to render the combination insulating. This is an additional reason for the requirement for sufficient electroscopic powder to cover each carrier grain with a layer of powder.

After due consideration and observation, it is believed that this invention functions according to the following mechanism: Each granular carrier grain picks up a number of the smaller particles of electroscopic dusting powder. As the carrier rolls over the plate, the particles of dusting powder drop off upon contacting a charged area on the plate surface (the attraction between the powder and the charged plate area being stronger than the attraction of the carrier for the powder). Furthermore, the carriers will pick up any electroscopic particles which might tend to adhere to uncharged areas so that the net result is an even distribution of powder over the charged areas and a total absence of powder on the uncharged areas.

Examples of mixtures of electroscopic powders and granular carriers which have proven satisfactory for developing latent electrostatic images are listed below. These examples are merely illustrative of suitable mixtures and are not to be interpreted as limiting the present invention.

Example 1

Asphaltum powder was mixed with powdered ammonium chloride in the ratio of 1 gram of

asphaltum to from 7 to 10 grams of ammonium chloride; the ammonium chloride being of such a size as to pass through an 80-mesh screen and to be held on a 230-mesh screen. This mixture, when applied to a plate bearing an electrostatic image, produced a clear, distinct image, without smears or signs of excessive powder collections on charged areas.

Example 2

A mixture of one part gilsonite with five parts of 100-200-mesh sodium chloride as a carrier was found to be very satisfactory for dusting images of line drawings and typewritten copy on charged electrophotographic plates.

Example 3

An electroscopic dusting powder made up of 4 parts of Velsicol AD623 (a chlorinated derivative of naphthalene manufactured by the Velsicol Corporation, 120 E. Pearson St., Chicago, Illinois) to one part of polystyrene was mixed with ammonium chloride (100-mesh) as a carrier and the mixture was found to produce good images, especially with a 1:1 ratio of powder to carrier.

Other tests have shown that any of the suitable electroscopic powders may be used with carriers to produce sharp, clearly defined electrophotographic images.

It will be apparent from the above description that means and methods have been discovered for producing superior electrophotographic images wherein certain undesirable features of previous means and methods have been overcome.

Variations and changes will, of course, suggest themselves to those skilled in the art according to the different conditions encountered in the use of this invention. For example, the mixture of carrier and dusting powder may be applied by means of a dusting box of the type wherein the developing mixture is caused to traverse the charged plate. This and similar obvious variations of the preferred method are intended to be included within the broad scope of the invention, which is defined in the following claims:

What is claimed is:

1. A method of producing a powder image on an electrically charged image consisting of transporting within the attraction range of the charged image particles of insulated attractable pigmented powder of a size in the order of .10 to 20 microns held on substantially equidimensional larger granular carrier particles by attraction, said carrier particles being of a size in the order of 30 to 60 mesh and having less attraction for the pigmented particles than has the charged image, rolling said carrier particles covered by insulated pigmented particles over the image to present the pigmented particles held on the surfaces of the carrier particles to the charged image, the pigmented particles being attracted from the carrier particles to the charged image, and removing the carrier particles less the image adhering pigmented particles from the surface of the charged image to thereby produce a powder image superimposed on and held by the charged image.

2. A method of producing a powder image on an electrically charged image consisting of transporting within the attraction range of the charged image particles of insulated attractable pigmented powder of a size in the order of .10 to 20 microns held on substantially equidimensional granular carrier particles of a size to pass through a 30-mesh screen and be collected on a 60-mesh

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screen, said carrier particles having less attraction for the pigmented particles than has the charged image, rolling said carrier particles covered by insulated pigmented particles over the image to present the pigmented particles held on the surface of the carrier particle to the charged image, the pigmented particles being attracted from the carrier particles to the charged image, and removing the carrier particles less the pigmented particles from the surface of the charged image to thereby produce a powder image superimposed on and held by the charged image.

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