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ELECTROSTATIC PRINTING WITH TWO GROUPS OF PARTICLES OF SAME COMPOSITION AND DIFFERENT SIZE

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ABSTRACT OF THE DISCLOSURE

A method of electrostatic printing with powders which are composed of a mixture of two batches of powder particles, the powder particles of the two batches having the same composition and charge but different average diameters. The powder mixture consists of from 1 to 4 parts by weight of a batch having a smaller diameter for each part of the batch having the larger diameter.

This invention relates to electrostatic printing wherein charged powder particles are applied to a substrate bearing an opposite charge. More particularly, it relates to a method of electrostatic printing wherein the particles are prearranged into a pattern before being applied to a substrate which bears a blanket charge. This application is a continuation-in-part of our application Ser. No. 496,178, filed Oct. 14, 1965.

Methods of printing electrostatically in which charged particles prearranged into a pattern are applied to substrate bearing a blanket charge opposite in polarity are generally of two major types. U.S. Patent No. 3,081,698 describes one type wherein the powder particles are charged and prearranged into a pattern by being brushed through a stencil or screen having apertures arranged in the pattern into which the powder particles are to be arranged. The particles which pass through the screen arranged in the pattern are attracted to the charged substrate beyond the screen.

The other type is a method involving gravure printing such as that described in copending application S.N. 372,226 filed June 3, 1964 in which powder is formed into a pattern by being deposited into the cells of a gravure plate. The powder is then charged and transferred to the substrate having a blanket charge of opposite polarity.

Both the electrostatic screen printing and gravure printing have been hampered by problems of a similar nature in the selection of the powder to be used. The powder used either clogged the screen and gravure plate or resulted in poorly filled in, unclear and blurred printed images or resulted in a combination of both defects. It appears that the defects are related to particle size. We have found that smaller size particles have a size range in the order of from 2 to 10 microns diameter tend to clog the screen or the gravure plate while those having a larger particle size range in the order of from 20 to 40 or 50 microns diameter yield poor fill in, blurring and unclear images when used. Also the use of particles of intermediate size range e.g. in the order of from 10 to 25 microns diameter result in a combination of both clogging and blurring and lack of fill in.

However, unexpectedly we have found that the use of two batches of particles of the same composition mixed together, and charged by corona discharge to a uniform charge will give excellent results with the elimination of the clogging and the lack of fill in, blurring and lack of clearness if one batch is predominantly made up of smaller particles having an average diameter in the range of 2 to

12 microns and the other batch is made up of particles having an average particle diameter at least 1.5 times the average particle diameter of the batch of smaller particles.

It has been found that best results are achieved if the proportions of the two batches are selected so that from 1 to 4 parts by weight of the batch having the smaller average diameter are used for each part of the batch having the larger average diameter. Such a distribution of particles can not be achieved by using a single batch of particles made by any of the conventional methods for milling, grinding or otherwise breaking down particles. We have found that it may be achieved by mixing two batches of particles of the same composition but of differing size. Conventional milling and grinding techniques for particles produce particles having a Gaussian distribution with the percentage of the total particle weight having a given particle diameter increasing as the average particle diameter is approached.

The following examples will illustrate the practice of this invention:

Example 1

50 parts of a first powder composition of 80% polystyrene and 20% carbon black having a particle size distribution over the range of from 2 to 14 microns particle diameter and an average particle size of 6.5 microns in diameter are thoroughly and completely mixed with 50 parts of a second powder composition of 80% polystyrene and 20% carbon black having a particle size distribution over the range of from 4 to 42 microns particle diameter and an average particle size of 24.5 microns in diameter.

Using the apparatus of FIGURE 2 in U.S. Patent No. 3,081,698, the mixture is used to print upon a plywood substrate. The results are excellent; the printed characters are well filled in and clear and there is no clogging of the stencil screen. On the other hand, the first powder composition when used alone causes extensive clogging of the stencil screen and the second composition when used alone results in poorly filled in characters which are blurred. As a further control, a powder composition of 80% polystyrene and 20% carbon having an average particle size of 10 microns in diameter is prepared by conventional milling means such as jet milling. This powder is compared to the mixture of this example which also has an average particle size of 10 microns on the apparatus of FIGURE 2 in U.S. Patent No. 3,081,698. The mixture displays clearer printed characters with less blurring than does the control. Also, after a period of from five to ten minutes, the control begins to clog the stencil screen.

Example 2

65 parts of a first powder composition of 31% titanium dioxide pigment, 16.1% iron oxide yellow, 37.9% polystyrene and 10.0% of a copolymer of α methyl styrene and vinyl toluene having a melting point of 120° C. having a particle size distribution over the range of from 2 to 12 microns particle diameter and an average particle size of 5.6 microns in diameter are thoroughly and completely mixed with 35 parts of a second powder composition of 31% titanium dioxide pigment, 16.1% iron oxide yellow, 37.9% polystyrene and 10% of said copolymer having a particle size distribution over the range of from 2 to 30 microns particle diameter and an average particle size of 9.4 microns in diameter.

Using the apparatus of FIGURE 2 in U.S. Patent No. 3,081,698, the mixture is used to print upon a plywood substrate. The results are excellent; the printed characters are well filled in and clear and there is no clogging of the stencil screen. On the other hand, the first powder composition when used alone causes extensive clogging of the stencil screen and the second composition when used alone results in relatively poorly filled in characters which are

blurred. As a further control, a powder composition of 31% titanium dioxide pigment, 16.1% iron oxide yellow, 37.9% polystyrene and 10.0% of said copolymer having an average particle of 7 microns in diameter is prepared by conventional milling means such as jet milling. This powder is compared to the mixture of this example which also has an average particle size of 7 microns on the apparatus of FIGURE 2 in U.S. Patent No. 3,081,698. The mixture displays clearer printed characters with less blurring than does the control. Also after a period of from five to ten minutes, the control begins to clog the stencil screen.

Example 3

The compositions of each of Examples 1 and 2 are used in gravure electrostatic printing methods such as that described in copending application S.N. 372,226 filed June 3, 1964 in which the powder is deposited in the cells of a gravure plate and the powder is then charged and transferred to a surface having a blanket charge of opposite polarity. Again, using this apparatus, with each of the compositions of Examples 1 and 2, the mixture gave excellent results with printed characters which are well filled in, clear and no clogging of the recesses in the plate while the component with the smaller particle size clogs the recesses in the gravure plate when used alone, the component with the larger particle size produces poorly filled in characters which are blurred when used alone and the composition having the same average particle size as the composition but prepared without mixing results in both more blurring of printed characters and more clogging of the gravure plate than does the mixture.

Example 4

The following composition is used:

Composition of 85% Epon 1004 (epoxy resin produced by the condensation polymerization of Bis Phenol A $[(C_6H_4OH)_2—C—(CH_3)_2]$ and epichlorohydrin having an average molecular weight of 1350, an epoxide equiva lent weight of 870–1025 and about 1.3 to 1.6 epoxides per molecule and 15% Cyan Blue pigment.

The first component of the above composition has a particle size distribution over range of 1 to 19 microns diameter and an average particle size of 4.6 microns diameter.

The second component of the composition has a particle size range 4 to 30 microns and an average size of 16.9 microns diameter.

A mixture of 60 parts by weight of said first component and 40 parts of said second component are used.

In accordance with the procedures set forth in Examples 1 and 3, the mixture as well as the individual components are tested in accordance with the screen printing and gravure procedures set forth in Examples 1 and 3. The results are the same as with the composition of Example 1.

Also, a powder of the same chemical composition as that of this example having an average particle size of 10.7 microns in diameter which is the same average diameter as that of the mixture is prepared by conventional means. This powder shows more blurring of characters and more clogging than the mixture in both the apparatus of Example 1 and Example 3.

The powder particles used in the examples have been given for purposes of illustration only and there is no intent to limit the practice of this invention to only such

powders. Any of the powder compositions used in electrostatic printing and copying may be used as long as they are prepared by the mixture of two batches and result in the particle size distribution described in this specification. The pigment particles which adhere to the substrate are most preferably fixed to the surface, particularly when the printed materials are to be used as permanent records. The fixing may be done conventionally by heating, spraying with a transparent liquid binder or any of the methods set forth in Patent No. 3,081,698.

Unless otherwise indicated, all proportions set forth in this specification and claims are by weight.

While there have been described what is at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed to cover all such changes and modifications as fall within the true spirit and scope of the invention.

We claim:

1. A method of electrostatic printing wherein a preformed image of charged powder particles are applied to a substrate bearing an opposite charge, the improvement which comprises applying to said substrate a mixture of two batches of particles having the same composition and the same charge but different average diameters, said mixture containing from 1 to 4 parts by weight of the batch having the smaller average diameter being used for each part of the batch having the larger average diameter, the smaller average diameter being from 2 to 12 microns and the larger average diameter being at least 1.5 times the size of the smaller diameter.

2. The method of claim 1 wherein the method of electrostatic printing is one in which charged powder particles prearranged into a pattern are applied to a substarte bearing a blanket opposite charge.

3. The method of claim 2 wherein the powder particles are charged by corona discharge.

4. The method of claim 2 wherein the charged particles are prearranged into the pattern by passing the particles through the openings in a stencil prior to applying said particles to the substrate, the openings corresponding to the pattern.

5. The method of claim 2 wherein the particles are prearranged into the pattern by depositing the particles in the cells of a gravure engraving corresponding to the pattern prior to applying said particles to the substrate.

6. The method of claim 4 wherein said particles are pigmented polystyrene.

7. The method of claim 5 wherein said particles are polystyrene pigmented with carbon black.

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