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2,917,460

POWDER COMPOSITIONS USEFUL AS ELECTROSCOPIC TONERS

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1 Claim. (Cl. 252-62.1)

The present invention relates to powder compositions useful as electroscopic toners and particularly to such powder compositions as may be used as the electroscopic powder or toner in the development of electrostatic, electrophotographic or electrophotographic images by methods which have been known in the art. Electrophotography, or as it is sometimes termed, xerography, is disclosed in Carlson Patents Nos. 2,297,691 and 2,551,582.

In general, the electrophotographic process comprises preparing a conducting plate with a coating of a photo-conductive chemical material which is electrically conductive only when exposed to light, charging the coated surface with an electrostatic charge, exposing said charged surface in any of the ways that a photographic negative may be exposed, so as to permit the discharge of the electrostatic charge at all portions of the photo-conductive material which have been exposed to light, then contacting said photo-conductive surface of the plate with an electroscopic powder or toner, which may be of a composition according to the present invention, whereby the powder then adheres to those surface area portions only from which the charge was not bled off by exposure to light as aforesaid. The powder image thus formed depends upon the powder adhering to the charged portions of the photo-conductive material and not adhering to the uncharged or discharged portions thereof. This powder image is then transferred onto a paper or card or other material on which it is to be developed, this transferring operation being effected by bringing into contact with the powder image on the photo-conductive material surface as aforesaid, a paper, card or other material on which the image is to be permanently affixed, and preferably causing a relatively high tension electrical charge to assist in transferring the powder onto the paper, etc. by moving the plate and the paper in face-to-face contact with each other through a zone across which there is a high tension electrical charge.

The next operation is to cause the powder image, which is very lightly adhering to the paper, to be permanently affixed thereto. This has been done in accordance with the prior art by any one of three principal methods: first, by physical pressure, the powder has been forced into the interstices of the paper on which the image is to be permanently affixed, or in this instance, impressed. This method is not desirable under all circumstances as the amount of pressure required may be so great as to change the dimensions of the paper or card, so that in case of cards to be used in mechanical card handling machines, the change in dimensions may result in faulty operation of the card handling machines.

A second method for fixing the powder image is to expose the powder image produced as aforesaid to the vapor of a solvent, some small portion of the solvent vapor being caused to condense onto the powder image,

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resulting in at least partially dissolving at least one of the constituents of the electroscopic powder and causing the solution thus formed to flow into the interstices of the paper to make a permanent record. This subject matter is disclosed to a greater extent in the application of Greaves, Serial No. 401,285, filed December 30, 1953, now Patent No. 2,726,166, issued December 6, 1955.

A third way is to subject the powder image and the paper on which it is disposed to heat sufficient to melt at least one of the constituents of the powder or the powder as a whole, so that the molten droplets so formed may be absorbed in the interstices of the paper to make a permanent image thereon. It has been found in carrying on the process with tabulator cards such as are used in standard types of office machines, that the temperature required to melt the powder, which has heretofore been available commercially, is so high (in the order of 275°-300° F.), that the heat to which the paper or card stock is subjected causes undue dehydration and consequent warping thereof.

Attempts have been made to use various types of liquid plasticizers in conjunction with the resin, which is a base ingredient of electroscopic toners of this kind. The result has been that the composite powder will fuse at a low enough temperature to prevent damage to the card or paper; but on the other hand, the use of the amounts of liquid plasticizers which have been necessary to effect this result has caused the powder particles to be tacky at ordinary temperatures, so that the powder could not be handled properly and in a desirable manner. In some instances the use of liquid plasticizers has caused the powder to adhere physically, due to its sticky character, to the uncharged portions of the photo-conductive material surface. This has resulted in the requirement for frequent cleaning of the plates, which is an undesired operating condition.

The present invention seeks to overcome these several difficulties by providing an electroscopic powder or toner composition or range of compositions, such that the powder as a whole can be fused at a temperature sufficiently low that it will not undesirably affect the paper or card stock exposed to this temperature as aforesaid, while at the same time preventing tackiness and other undesired operation of the process incident to stickiness or tackiness of the powder prior to its intentional exposure to heat as aforesaid.

Summarizing the present invention, it comprises an electroscopic powder composition including one or more resins, preferably thermoplastic in character and serving as a powder base, a coloring material to impart a desired color to the powder and to the permanent mark made upon the development thereof as aforesaid, and a material which will cause the powder as a whole to have a relatively low fusion point. This added material may be generically termed a solid organic compound, i.e. a compound which is a solid at room temperatures and which has a sharp melting point at somewhat above room temperature, so that it will not be tacky or tend to cause the composition as a whole to be tacky or sticky at handling temperatures, while at the same time it can be brought to or above its sharp melting point as aforesaid at a temperature sufficiently low so that it can then serve as a solvent for the resin and serve to render the powder as a whole fusible at a relatively low temperature. There are a number of materials which qualify under all these requirements and which have melting points in the range of about 85° C. to about 120° C. and which when melted are solvents for a number of thermoplastic resins which

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may be used therewith and are miscible with such resins when dissolved.

Turning now to the details of the present invention, the resins which may be used as a powder base for material of this kind are all in the class of thermoplastic resins. These resins, which are considered herein as ingredient (a) may be, for example, polystyrene, poly- α -methylstyrene, lower alkyl polyacrylates and lower alkyl polymethacrylates in which each of said lower alkyl includes alkyl radicals having from 1 to 4 carbon atoms. These resins are generally known for use in electroscopic powders.

The second essential ingredient according to the present invention and the one in which the invention particularly resides is a solid organic compound identified as ingredient (b) herein and consisting essentially of a compound which is solid at room temperatures, which has a sharp melting point in the range of about 85° C. to about 120° C., and which when melted is a solvent for and is miscible with at least one material of ingredient (a) above. Examples of ingredient (b) with the melting point of each in degrees centigrade in parentheses immediately thereafter respectively are: acenaphthene (93.5), acetanilide (113), o-acetoacetotoluidide (105), o-acetotoluidide (101), o-chloroacetoacetanilide (103), 2-chloro-4-nitroaniline (106), p-dibromobenzene (86.9), P,P'-methylenedianiline (93), α -naphthol (95), β -naphthol (85), 2-naphthylamine (110), m-nitroaniline (112), 4-nitrobiphenyl (97), sorbitol hexoacetate (98), and 2,4-toluenediamine (97). It will be noted that the materials hereinabove listed as examples of ingredient (b) do not fall in any one chemical classification, but rather are effective by reason of their physical characteristics, namely, their melting points respectively and the fact that when melted they are solvents for and miscible with at least one of the resins with which they may be used as illustrated more particularly in the examples which follow. It is believed that there is no chemical reaction taking place or at least none is depended upon in accordance with the present invention between ingredient (a) and ingredient (b), or any materials coming under these two classifications. On the other hand, ingredient (b), when brought to or above its melting point, must be a solvent for at least one of the materials of ingredient (a) used therewith.

The third ingredient which is a common one in accordance with conventional prior art practice in electroscopic powders or toners is a coloring material. This material may be any suitable dye, a pigment or some combination of both. In accordance with the present invention, the use of a pigment, such as carbon black, has been found to be desirable. The present invention is further not limited to reproduction of material on a black and white basis, but other colored dyes and/or pigments may be used as desired.

The invention is further illustrated by the following examples of operative combinations of the several ingredients as follows:

Example I

	Parts by weight
(a) Polystyrene	20
Ethyl polyacrylate	15
(b) Acetanilide	50
(c) Carbon black	15

The above ingredients in the proportions stated were blended together by melting the ingredients (a) and (b) together in a pot, adding the carbon black and stirring until a homogeneous mixture was obtained. The melt so made was allowed to cool until solid and then crushed and ground in a ball-mill, "Mikropulverizer" or similar apparatus to a particle size of 2-40 microns. The resulting powder will not film or smear in an automatic xerographic machine, is not tacky at room temperatures, and will fuse sufficiently for heat-fixing at about 210° F.

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Example II

	Parts by weight
(a) Polystyrene	15
Methyl polymethacrylate	45
(b) p-Dibromobenzene	30
(c) Carbon black	10

The above ingredients were blended and ground as in Example I. The powder was found operative for the purposes stated and had a fusing point of about 185° F.

The composition given for this example is also effective by substituting either β -naphthol or P,P'-methylenedianiline for the p-dibromobenzene, constituting ingredient (b) of this example. The fusion point upon either of these substitutions is substantially the same.

Example III

	Parts by weight
(a) Methyl polymethacrylate	25
(b) o-Acetotoluidide	60
(c) Carbon black	14.5
Black dye	0.5

The above ingredients were blended and ground as in Example I. The powder was found operative for the purpose stated and had a fusing point of about 190° F.

Example IV

	Parts by weight
(a) Polystyrene	30
Methyl polymethacrylate	10
Butyl polymethacrylate	30
(b) o-Acetoacetotoluidide	20
(c) Carbon black	10

The above ingredients were blended and ground as in Example I. The powder was found operative for the purposes stated and had a fusing point of about 205° F.

Example V

	Parts by weight
(a) Poly- α -methylstyrene	30
Methyl polymethacrylate	50
(b) 4-nitrobiphenyl	18
(c) Dye	2

The above ingredients were blended and ground as in Example I. The powder was found operative for the purposes stated and had a fusing point of about 220° F. The composition of this example in the proportions given is also operative by substituting either sorbitol hexoacetate or 2-chloro-4-nitroaniline for the 4-nitrobiphenyl, constituting ingredient (b) of this example. Either of these substitutions causes substantially no change in the fusion temperature.

While there have been described herein a number of alternatives and substituents which may be employed in compositions embodying the present invention, other alternatives will occur to those skilled in the art from the teachings hereinabove set out. I do not wish to be limited, therefore, except by the scope of the appended claim, which is to be construed validly as broadly as the state of the prior art permits.

What is claimed is:

A powder composition useful as an electroscopic toner, said composition being in the form of particles of about 2-40 microns in size and each being substantially a solid solution of the following ingredients: (a) thermoplastic resin consisting essentially of polystyrene 30 parts by weight, methyl polymethacrylate, 10 parts by weight and butyl polymethacrylate 30 parts by weight, (b) a solid organic compound consisting essentially of o-acetoacetotoluidide, 20 parts by weight, and (c) a coloring material consisting essentially of carbon black, 10 parts by weight, the composition as a whole having a fusion point of about 205° F., said thermoplastic resin (a) and said solid organic compound (b) being such that these two materials together will have a melting point sufficiently low as to be below the temperature at which it is

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possible detrimentally to affect the quality of the paper stock with which said powder composition is used as an electroscopic toner, and said two materials together being substantially non-tacky at the lower temperature at which said powder composition is applied onto a light-exposed plate coated with a photo-conductive material for developing an electrostatic image into a powder image thereon.

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References Cited in the file of this patent

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2,788,288	Rheinfrank et al.	Apr. 9, 1957