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[54] ELECTROSTATIC DEVELOPER PARTICLES
CONTAINING RESIN, COLORANT, METAL SALT
AND PHTHALATE
10 Claims, No Drawings

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[56] References Cited
UNITED STATES PATENTS
3,060,020 10/1962 Greig..... 252/62.1
3,417,019 12/1968 Beyer 252/62.1
FOREIGN PATENTS
944,345 0/1963 Great Britain..... 252/62.1
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ABSTRACT: A finely divided toner comprising a colorant, a thermoplastic resin comprising a vinyl resin, a solid ester of o-phthalic or m-phthalic acid and a solid metal salt of a fatty acid.

ELECTROSTATIC DEVELOPER PARTICLES CONTAINING RESIN, COLORANT, METAL SALT AND PHTHALATE

BACKGROUND OF THE INVENTION

This invention relates to imaging systems, and more particularly, to improved xerographic developing materials, their manufacture and use.

The formation and development of images on the surface of photoconductive materials by electrostatic means is well known. The basic xerographic process, as taught by C. F. Carlson in U.S. Pat. No. 2,297,691, involves placing a uniform electrostatic charge on a photoconductive insulating layer, exposing the layer to a light-and-shadow image to dissipate the charge on the areas of the layer exposed to the light and developing the resulting latent electrostatic image by depositing on the image a finely divided electroscopic material referred to in the art as "toner." The toner will normally be attracted to those areas of the layer which retain a charge, thereby forming a toner image corresponding to the latent electrostatic image. This powder image may then be transferred to a support surface such as paper. The transferred image may subsequently be permanently affixed to the support surface as by heat. Instead of latent image formation by uniformly charging the photoconductive layer and then exposing the layer to a light-and-shadow image, one may form the latent image by directly charging the layer in image configuration. The powder image may be fixed to the photoconductive layer if elimination of the powder image transfer step is desired. Other suitable fixing means such as solvent or overcoating treatment may be substituted for the foregoing heat fixing steps.

Several methods are known for applying the electroscopic particles to the latent electrostatic image to be developed. One development technique, as disclosed by E. N. Wise in U.S. Pat. No. 2,618,552, is known as "cascade" development. In this method, a developer material comprising relatively large carrier particles having finely divided toner particles electrostatically coated thereon is conveyed to and rolled or cascaded across the electrostatic latent-image-bearing surface. The composition of the carrier particles is so selected as to triboelectrically charge the toner particles to the desired polarity. As the mixture cascades or rolls across the image-bearing surface, the toner particles are electrostatically deposited and secured to the charged portion of the latent image and are not deposited on the charged or background portions of the image. Most of the toner particles accidentally deposited in the background are removed by the rolling carrier, due apparently, to a greater electrostatic attraction between the toner and the carrier than between the toner and the discharged background. The carrier and excess toner are then recycled. This technique is extremely good for the development of line copy images.

Another method of developing electrostatic images is the "magnetic brush" process as disclosed, for example, in U.S. Pat. No. 2,874,063. In this method, a developer material containing toner and magnetic carrier particles are carried by a magnet. The magnetic field of the magnet causes alignment of the magnetic carrier into a brushlike configuration. This "magnetic brush" is engaged with the electrostatic image-bearing surface and the toner particles are drawn from the brush to the latent image by electrostatic attraction.

Still another technique for developing electrostatic latent images is the "powder cloud" process as disclosed, for example, by C. F. Carlson in U.S. Pat. No. 2,221,776. In this method, a developer material comprising electrically charged toner particles in a gaseous fluid is passed adjacent to the surface bearing the latent electrostatic image. The toner particles are drawn by electrostatic attraction from the gas to the latent image. This process is particularly useful in continuous tone development.

Other development methods such as "touchdown" development as disclosed by R. W. Gundlach in U.S. Pat. No. 3,166,432 may be used where suitable.

Although some of the foregoing development techniques are employed commercially today, the most widely used commercial xerographic development technique is the process known as "cascade" development. A general purpose office copying machine incorporating this development method is described in U.S. Pat. No. 3,099,943. The cascade development technique is generally carried out in a commercial apparatus by cascading a developer mixture over the upper surface of an electrostatic latent image-bearing drum having a horizontal axis. The developer is transported from a trough or sump to the upper portion of the drum by means of an endless-belt conveyor. After the developer is cascaded downward along the upper quadrant surface of the drum into the sump, it is recycled through the developing system to develop additional electrostatic latent images. Small quantities of toner are periodically added to the developing mixture to compensate for the toner depleted by development. The resulting toner image is usually transferred to a receiving sheet and thereafter fused by suitable means such as an oven. The surface of the drum is thereafter cleaned for reuse. This imaging process is then repeated for each copy produced by the machine and is ordinarily repeated many thousands of times during the usable life of the developer.

Thus, it is apparent from the description presented above as well as in other development techniques, that the toner is subjected to severe mechanical attrition which tends to break down the particles into undesirable dust fines. The formation of fines is retarded when the toner contains a tough, high-molecular-weight resin which is capable of withstanding the shear and impact forces imparted to the toner in the machine. Unfortunately, many high-molecular-weight materials cannot be employed in high-speed automatic machines because they cannot be rapidly fused during a powder-image heat fixing step. Attempts to rapidly fuse a high-melting-point toner by means of oversized high-capacity heating units have been confronted with the problems of preventing the charring of paper-receiving sheets and of adequately dissipating the heat evolved from the fusing unit or units. In some cases, the receiving sheet has actually burst into flames after passage through the fusing unit. Thus, in order to avoid charring or combustion, additional equipment such as complex and expensive cooling units are necessary to properly dispose of the large quantity of heat generated by the fuser. Incomplete removal of the heat evolved will result in operator discomfort and damage to heat-sensitive machine components. Further, the increased space occupied by and the high operating costs of the heating and cooling units often outweigh the advantages achieved by the increased machine speed. On the other hand, low-molecular-weight resins which are easily heat-fused at relatively low temperatures are usually undesirable because these materials tend to form thick films on reusable photoconductor surfaces. These films tend to cause image degradation and contribute to machine maintenance downtime. Many low-molecular-weight resins decompose when subjected to fusing conditions in high-speed copying and duplicating machines. In addition, low-molecular-weight resins tend to form tacky images on the copy sheet which are easily smudged and often offset to other adjacent sheets. Additionally, low-molecular-weight resins are often extremely difficult or even impossible to comminute in conventional grinding apparatus. Also, the toner materials must be capable of accepting a charge of the correct polarity when brought into rubbing contact with the surface of carrier materials in cascade or touchdown development systems. Numerous known carriers and toners are abrasive in nature. Abrasive contact between toner particles, carriers, and xerographic imaging surfaces accelerates mutual deterioration of these components. Replacement of carriers and electrostatic image-bearing surfaces is expensive and time consuming. Xerographic copies should possess good line image contrast as well as acceptable solid area coverage. However, when a process is designed to improve either line image contrast or solid area coverage reduced quality of the other can be expected. Attempts to increase image density by depositing greater quantities of toner particles on the latent electrostatic

image are usually rewarded with an undesirable increase in background deposits. Also, the toner material must be capable of accepting a charge of the correct polarity when brought into rubbing contact with the surface of carrier materials in cascade, magnetic brush or touchdown development systems. Additionally, many materials cannot satisfactorily be transferred by conventional electrostatic systems from reusable imaging surfaces in automatic copying and duplicating machines. Since most thermoplastic materials are deficient in one or more of the above areas, there is a continuing need for improved toners and developers.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to provide a toner overcoming the above-noted deficiencies.

It is another object of this invention to provide a xerographic toner which can be fused at higher rates with less heat energy.

It is another object of this invention to provide a toner which is resistant to film formation when employed in conventional xerographic copying and duplicating devices.

It is another object of this invention to provide a xerographic toner which forms high resolution images.

It is another object of this invention to provide a xerographic toner which is resistant to mechanical attrition during the development process.

It is another object of this invention to provide a toner and developer having physical and chemical properties superior to those of known toners and developers.

The above objects and others are accomplished by providing xerographic toner particles comprising a colorant, a thermoplastic resin comprising a vinyl resin, a solid ester of *o*-phthalic or *m*-phthalic acid, and a solid metal salt of a fatty acid. For maximum resistance against agglomeration, the toner should contain from about 2 percent to about 45 percent, by weight, based on the total weight of the toner resin, of a solid ester of *o*-phthalic or *m*-phthalic acid having a melting point between 110° F. to about 175° F. For optimum operation in high-speed xerographic machines employing paper-receiving webs, the toner should have a melting range between about 110° F. to about 300° F. and a melt viscosity of less than about 2.0×10^{14} poise up to temperatures of about 300° F. Toner melting temperatures below about 300° F. are preferred because heat-dissipation and paper-degradation problems are avoided. The developers of this invention contain from about 0.02 percent to about 20 percent by weight, based on the weight of the toner in the final developer mixture, of the solid hydrophobic metal salt of a higher fatty acid. Preferably, the developers of this invention contain from about 0.05 to about 4 percent by weight of the metal salt because maximum reduction of background deposits, improved image density and higher image character resolution are achieved. Without the presence of a solid stable hydrophobic metal salt of a higher fatty acid in the developer, extremely rapid degradation of reusable imaging surfaces, untenably high background, reduced toner image density, poor toner image transfer, reduced carrier particle life, increased difficulty in removing residual toner material from reusable imaging surfaces, and reduced electrical stability occurs. Although the initial electrostatic imaging surface potential may be reduced and abrasion resistance improved when the proportion of metal salt present is increased above about 10 percent, undesirable background deposits increase noticeably. If the charge voltage is reduced to compensate for the presence of metal salt in excess of about 10 percent, the images begin to acquire a "washed out" appearance. It is not essential that the entire surface of each toner particle be coated with the metal salt, e.g., sufficient metal salt is present when about 10 to about 16 percent of the toner particle surfaces are coated with a metal salt. When the metal salt is dispersed in rather than coated on a toner or carrier particle, proportionately more metal salt is necessary in order to maintain a sufficient quantity of the ex-

posed salt at the surface of the toner or carrier particle. The additional amount of metal salt necessary depends to a large extent on the surface area of the developer particles, hence upon the particle diameter selected. Any suitable stable solid hydrophobic metal salt of a fatty acid having a melting point greater than about 57° C. may be employed. Optimum results are obtained when about 0.05 to about 4 percent by weight, based on the weight of the toner, of zinc stearate is available at the outer surfaces of the particles in the developing material.

The developers of this invention containing zinc stearate are preferred because the resulting mixture is characterized by outstanding fusing rates, high cleanability from electrostatic imaging surfaces, greater triboelectric stability, denser toner images and increased resistance to mechanical attrition. Unexpectedly, both the fire hazard and excessive power-consumption problems encountered in high-speed xerographic development processes are obviated when toners containing the above described polymeric esterification product and metal salt are employed.

Any suitable vinyl resin having a melting point of at least about 110° F. may be employed in the toners of this invention. The vinyl resin may be a homopolymer or a copolymer of two or more vinyl monomers. Typical monomeric units which may be employed to form vinyl polymers include: styrene, *p*-chlorostyrene; vinyl naphthalene; ethylenically unsaturated mono-olefins such as ethylene, propylene, butylene, isobutylene and the like; vinyl esters such as vinyl chloride, vinyl bromide, vinyl fluoride, vinyl acetate, vinyl propionate, vinyl benzoate, vinyl butyrate and the like; esters of aliphatic monocarboxylic acids such as methyl acrylate, ethyl acrylate, *n*-butylacrylate, isobutyl acrylate, dodecyl acrylate, *n*-octyl acrylate, 2-chloro-ethyl acrylate, phenyl acrylate, methyl- α -chloroacrylate, methyl methacrylate, ethyl methacrylate, butyl methacrylate and the like; acrylonitrile, methacrylonitrile, acrylamide, vinyl ethers such as vinyl methyl ether, vinyl isobutyl ether, vinyl ethyl ether, and the like; vinyl ketones such as vinyl methyl ketone, vinyl hexyl ketone, methyl isopropenyl ketone and the like; vinylidene halides such as vinylidene chloride, vinylidene chlorofluoride and the like; and *N*-vinyl compounds such as *N*-vinyl pyrrole, *N*-vinyl carbazole, *N*-vinyl indole, *N*-vinyl pyrrolidene and the like; and mixtures thereof. Generally, suitable vinyl resins employed in the toner have a weight average molecular weight between about 3,000 to about 500,000.

Toner resins containing a relatively high percentage of a styrene resin are preferred. The presence of a styrene resin is preferred because a greater degree of image definition is achieved with a given quantity of additive material. Further, denser images are obtained when at least about 25 percent by weight, based on the total weight of resin in the toner, of a styrene resin is present in the toner. The styrene resin may be a homopolymer of styrene or styrene homologues or copolymers of styrene with other monomeric groups containing a single methylene group attached to a carbon atom by a double bond. Thus, typical monomeric materials which may be copolymerized with styrene by addition polymerization include: *p*-chlorostyrene; vinyl naphthalene; ethylenically unsaturated mono-olefins such as ethylene, propylene, butylene, isobutylene and the like; vinyl esters such as vinyl chloride, vinyl bromide, vinyl fluoride, vinyl acetate, vinyl propionate, vinyl benzoate, vinyl butyrate and the like; esters of aliphatic monocarboxylic acids such as methyl acrylate, ethyl acrylate, *n*-butylacrylate, isobutyl acrylate, dodecyl acrylate, *n*-octyl acrylate, 2-chloro-ethyl acrylate, phenyl acrylate, methyl- α -chloroacrylate, methyl methacrylate, ethyl methacrylate, butyl methacrylate and the like; acrylonitrile, methacrylonitrile, acrylamide, vinyl ethers such as vinyl methyl ether, vinyl isobutyl ether, vinyl ethyl ether, and the like; vinyl ketones such as vinyl methyl ketone, vinyl hexyl ketone, methyl isopropenyl ketone and the like; vinylidene halides such as vinylidene chloride, vinylidene chlorofluoride and the like; and *N*-vinyl compounds such as *N*-vinyl pyrrole, *N*-vinyl carbazole, *N*-vinyl indole, *N*-vinyl

pyrrolidene and the like; and mixtures thereof. The styrene resins may also be formed by the polymerization of mixtures of two or more of these unsaturated monomeric materials with a styrene monomer. The expression "addition polymerization" is intended to include known polymerization techniques such as free radical, anionic and cationic polymerization processes.

The vinyl resins, including styrene type resins, may also be blended with one or more other resins if desired. When the vinyl resin is blended with another resin, the added resin is preferably another vinyl resin because the resulting blend is characterized by especially good triboelectric stability and uniform resistance against physical degradation. The vinyl resins employed for blending with the styrene type or other vinyl resin may be prepared by the addition polymerization of any suitable vinyl monomer such as the vinyl monomers described above. Other thermoplastic resins may also be blended with the vinyl resins of this invention. Typical nonvinyl-type thermoplastic resins include: rosin-modified phenol formaldehyde resins, oil-modified epoxy resins, polyurethane resins, cellulosic resins, polyether resins and mixtures thereof. When the resin component of the toner contains styrene copolymerized with another unsaturated monomer or a blend of polystyrene and another resin, a styrene component of at least about 25 percent, by weight, based on the total weight of the resin present in the toner is preferred because denser images are obtained and a greater degree of image definition is achieved with a given quantity of additive material.

The combination of the resin component, colorant and additive, whether the resin component is a homopolymer, copolymer or blend, should have a blocking temperature of at least about 110° F. and a melt viscosity of less than about 2.5×10^{14} poise at temperatures up to about 450° F. When the toner is characterized by a blocking temperature less than about 110° F. the toner particles tend to agglomerate during storage and machine operation and also form undesirable films on the surface of reusable photoreceptors which adversely affect image quality. If the melt viscosity of the toner is greater than about 2.5×10^{14} poise at temperatures above about 450° F., the toner material of this invention does not adhere properly to a receiving sheet even under conventional xerographic machine fusing conditions and may easily be removed by rubbing.

Any suitable solid substituted or unsubstituted ester of o-phthalic or m-phthalic acid may be employed in the toners of this invention. Typical solid esters of o-phthalic and m-phthalic acid include disodecyl 4,5-epoxytetrahydrophthalate, dicyclohexyl phthalate, diphenyl phthalate, dimethyl isophthalate diethoxyethyl phthalate, triphenylphthalate, dihydroabiethyl phthalate and the like. Esters having a melting point between about 110° F. to about 175° F. are preferred because the toners containing these additives possess greater storage stability. Maximum resistance against toner agglomeration is achieved when the toner contains from about 2 percent to about 45 percent by weight, based on the total weight of the toner resin, of the solid ester. As the relative quantity of additive in the toner is increased above about 45 percent, the mechanical strength, creep resistance and permanency of the ultimate fused toner image begins to decrease rapidly. Thus, when a toner consisting essentially of 100 percent ester material is employed in automatic copying and duplicating machines, extensive toner dust is formed and the fused toner images tend to crumble and flake off receiving sheets when the sheets are folded. When less than about 2 percent of the additive is employed in the toner, the toner fusing, flow and triboelectric properties are substantially the same as a toner which does not contain the additives. If desired, mixtures of additives may be employed in the toner. An increase in the relative quantity of additive tends to reduce the melt viscosity of the ultimate toner. Optimum results are obtained when the toner contains from about 2 percent to about 15 percent by weight, based on the total weight of the toner resin, of diphenyl phthalate because the resulting toner is charac-

terized by excellent resistance to creep, high mechanical strength and improved imaging properties.

It is to be understood that the specific formulas given for the units contained in the additives and resins of this invention represent the vast majority of the units present, but do not exclude the presence of other monomeric units or reactants than those which have been shown. For example, some commercial materials such as polystyrenes, and polychlorinated polyphenyl compounds contain trace amounts of homologues or unreacted or partially reacted monomers. Any minor amount of such substituents may be present in the materials of this invention.

Any suitable stable solid hydrophobic metal salt of a fatty acid having a melting point greater than about 57° C. may be employed with the toner resin of this invention. The metal salt should be substantially insoluble in water. Water-soluble metal salts lack the proper electrical properties and are adversely affected by humidity changes normally occurring in the ambient atmosphere. However, a large proportion of salts commonly regarded as insoluble, actually dissolve to a slight extent. To effectively carry out the purposes of this invention, the solubility of the salt should be negligible. The salts having the desired specific characteristics include many salts of linear saturated fatty acids, unsaturated fatty acids, partially hydrogenated fatty acids and substituted fatty acids and mixtures thereof. The metal salts may be tumbled or milled with the toner or carrier particles or intimately dispersed in each toner or carrier particle. However, the latter embodiment is less desirable than the tumbled or milled mixture because a greater quantity of metal salt is required to provide a sufficient quantity of metal salt, exposed at the surface of the developer particles. The metal salts are preferably mixed with toner materials by tumbling preformed finely divided metal salt particles with preformed finely divided toner particles. The tumbling process is continued until the preformed metal salt particles are uniformly distributed throughout the mass of toner particles. Excellent toner mixtures are obtained when the preformed toner particles are tumbled with preformed metal salt particles having a size range between about 0.5 to about 50 microns. The tumbled mixtures are preferred because the resulting treated toners exhibit extremely stable imaging characteristics under widely fluctuating humidity conditions.

Typical fatty acids from which stable solid hydrophobic metal salts may be derived include: caproic acid, enanthic acid, caprylic acid, pelargonic acid, capric acid, undecylic acid, lauric acid, tridecoic acid, myristic acid, pentadecanoic acid, palmitic acid, margaric acid, stearic acid, nondecylic acid, arachidic acid, behenic acid, stilingic acid, palmitoleic acid, oleic acid, ricinoleic acid, petroselinic acid, vaccenic acid, linoleic acid, linolenic acid, eleostearic acid, licanic acid, parinaric acid, gadoleic acid, arachidonic acid, cetoleic acid, and mixtures thereof. Typical stable solid metal salts of fatty acids include: cadmium stearate, barium stearate, lead stearate, iron stearate, nickel stearate, cobalt stearate, copper stearate, strontium stearate, calcium stearate, cadmium stearate, magnesium stearate, zinc oleate, manganese oleate, iron oleate, cobalt oleate, copper oleate, lead oleate, magnesium oleate, zinc palmitate, cobalt palmitate, copper palmitate, magnesium palmitate, aluminum palmitate, calcium palmitate, lead caprylate, lead caproate, zinc linoleate, cobalt linoleate, calcium linoleate, zinc ricinoleate, cadmium ricinoleate and mixtures thereof.

Where the solid hydrophobic metal salt of a higher fatty acid is to be physically mixed with or applied as a coating on toner or carrier particles, the metal salt is preferably present in an amount from about 0.02 percent to about 10 percent based on the weight of the toner in the final developer mixture. Optimum results are obtained with about 0.05 to about 4 percent of the metal salt. Although the initial electrostatic imaging surface potential may be reduced and abrasion resistance improved when the proportion of metal salt present is increased above about 10 percent, undesirable background deposits increase noticeably. If the charge voltage is reduced to compen-

sate for the presence of metal salt in excess of about 10 percent, the images begin to acquire a "washed out" appearance. It is not essential that the entire surface of each toner particle be coated with the metal salt, e.g., sufficient metal salt is present when 10 to 16 percent of the toner particle surfaces are coated with a metal salt. When the metal salt is dispersed in rather than coated on a toner or carrier particle, proportionally more metal salt is necessary in order to maintain a sufficient quantity of exposed salt at the surface of the toner or carrier particle. The additional amount of metal salt necessary depends to a large extent on the surface area of the particles, hence upon the particle diameter selected. The use of small quantities of calcium stearate as a pigment wetting agent in zinc oxide developing powders is known as disclosed by Greig in U.S. Pat. No. 3,053,688 at column 5, line 41 and Greig et al. in Canadian Pat. No. 633,458 at column 9, line 8. However, the quantity of calcium stearate used by Greig and Greig et al. to facilitate the wetting of pigments dispersed in zinc oxide developing powders is insufficient to provide an effective quantity of exposed calcium stearate at the surface of the toner particle for the purposes of the instant invention. When less than about 0.02 percent metal salt based on the weight of the toner is actually available at the surface of the toner particle, its triboelectric, flow, abrasion, transfer and image-forming properties are substantially the same as a toner or carrier which does not contain a metal salt of a fatty acid. Obviously, with a given quantity of metal salt based on the weight of the toner, a greater volume of the salt is available at the surface of the toner or carrier when the metal salt is added to a mixture of preformed colored toner particles or carriers than when it is intimately dispersed within each toner particle or carrier. If the concentration of metal salt is increased to the point where the toner consists essentially of 100 percent metal salt, the metal salt will form slippery films on the electrostatic image-bearing surface and carrier particles which interfere with powder image transfer, background removal and cleaning. U.S. Pat. No. 3,083,117 discloses a method of applying reactive toners containing 100 percent iron stearate to an electrostatic image and then transferring the developed image to a transfer sheet wet with an alcoholic solution of gallic acid. The iron stearate reacts with the gallic acid to form a black reaction product. In addition to the problems encountered when toner containing 100 percent metal salt is employed, electrostatic development methods of the foregoing type require liquid pretreatment of the receiving sheet with an attendant increase in cost and inconvenience. Further, curling, image bleeding, and offset, often occur when moistened receiving sheets are used. Additional equipment to dispose of toxic and flammable fumes may also be necessary.

Excellent results are obtained with zinc stearate. When the toner and developer particles of this invention are treated with zinc stearate, particularly in the range of about 0.05 to about 4 percent by weight based on the total weight of toner, better flow, less background, higher density images at lower initial charging voltages, and higher machine speeds with less power are achieved. Drum wear is markedly reduced.

Any suitable pigment or dye may be employed as the colorant for the toner particles. Toner colorants are well known and include, for example, carbon black, nigrosine dye, aniline blue, Calco Oil Blue, chrome yellow, ultramarine blue, duPont Oil Red, Quinoline Yellow, methylene blue chloride, phthalocyanine blue, Malachite Green Oxalate, lampblack, Rose Bengal and mixtures thereof. The pigment or dyes should be present in the toner in a sufficient quantity to render it highly colored so that it will form a clearly visible image on a recording member. Thus, for example, where conventional xerographic copies of typed documents are desired, the toner may comprise a black pigment such as carbon black or a black dye such as Amaplast Black dye, available from the National Aniline Products Inc. Preferably, the pigment is employed in an amount from about 3 percent to about 20 percent, by weight, based on the total weight of the colored toner. If the toner colorant employed is a dye, substantially smaller quantities of colorant may be used.

The toner compositions of the present invention may be prepared by any well-known toner-mixing and comminution technique. For example, the ingredients may be thoroughly mixed by blending, mixing and milling the components and thereafter micropulverizing the resulting mixture. Another well-known technique for forming toner particles is to spray dry a ball-milled toner composition comprising a colorant, a resin and a solvent.

Generally, the degree of quality of toner fix at a given fuser temperature decreases with an increase in toner melt in viscosity. As discussed above, if the melt viscosity of the toners of this invention is greater than about 2.5×10^{14} poise at temperatures above about 450° F., the toner materials do not adhere properly to a receiving sheet even under conventional xerographic machine fusing conditions. Thus, the melt viscosity value of the toners of this invention aids in the determination of the degree of flow and penetration of the toner into the surface of a receiving substrate such as paper during the heat-fixing step. The expression "melt viscosity," as employed herein, is a measure of the ratio of shear stress to shear rate in poise at a given temperature. All viscosity measurements are determined with an Instron Capillary Rheometer, Model TTC.

When the toner mixtures of this invention are to be employed in a cascade development process, the toner should have an average particle size by weight percent less than about 30 microns and preferably between about 4 and about 20 microns for optimum results. For use in powder cloud development methods, particle diameters of slightly less than 1 micron are preferred.

Suitable coated and uncoated carrier materials for cascade development are well known in the art. The carrier particles comprise any suitable solid material, provided that the carrier particles acquire a charge having an opposite polarity to that of the toner particles when brought in close contact with the toner particles so that the toner particles adhere to and surround the carrier particles. When a positive reproduction of the electrostatic images is desired, the carrier particle is selected so that the toner particles acquire a charge having a polarity opposite to that of the electrostatic image. Alternatively, if a reversal reproduction of the electrostatic image is desired, the carrier is selected so that the toner particles acquire a charge having the same polarity as that of the electrostatic image. Thus, the materials for the carrier particles are selected in accordance with its triboelectric properties in respect to the electroscopic toner so that when mixed or brought into mutual contact one component of the developer is charged positively if the other component is below the first component in the triboelectric series and negatively if the other component is above the first component in a triboelectric series. By proper selection of materials in accordance with their triboelectric effects, the polarities of their charge when mixed are such that the electroscopic toner particles adhere to and are coated on the surfaces of carrier particles and also adhere to that portion of the electrostatic image-bearing surface having a greater attraction for the toner than the carrier particles. Typical carriers include sodium chloride, ammonium chloride, aluminum potassium chloride, Rochelle salt, sodium nitrate, aluminum nitrate, potassium chlorate, granular zircon, granular silicon, methyl methacrylate, glass, silicon dioxide and the like. The carriers may be employed with or without a coating. Many of the foregoing and other typical carriers are described by L. E. Walkup et al. in U.S. Pat. No. 2,638,416 and E. N. Wise in U.S. Pat. No. 2,618,552. An ultimate coated carrier particle diameter between about 50 microns to about 1,000 microns is preferred because the carrier particles then possess sufficient density and inertia to avoid adherence to the electrostatic images during the cascade development process. Adherence of carrier beads to xerographic drums is undesirable because of the formation of deep scratches on the surface during the imaging-transfer and drum-cleaning steps, particularly where cleaning is accomplished by a web cleaner such as the web disclosed by W. P. Graff, Jr. et al. in U.S. Pat. No. 3,186,838. Also print deletion occurs when carrier beads adhere to xerographic imaging surfaces. Generally speaking,

satisfactory results are obtained when about 1 part toner is used with about 10 to 200 parts by weight of carrier.

The toner composition of the instant invention may be employed to develop latent electrostatic images on any suitable electrostatic latent image-bearing surface including conventional photoconductive surfaces. Well-known photoconductive materials include vitreous selenium, organic or inorganic photoconductors embedded in a nonphotoconductive matrix, organic or inorganic photoconductors embedded in a photoconductive matrix, and the like. Representative patents in which photoconductive materials are disclosed include U.S. Pat. No. 2,803,542 to Ullrich, U.S. Pat. No. 2,970,906 to Bixby, U.S. Pat. No. 3,121,006 to Middleton, U.S. Pat. No. 3,121,007 to Middleton, and U.S. Pat. No. 3,151,982 to Corrin.

DESCRIPTION OF PREFERRED EMBODIMENTS

The following examples further define, describe and compare methods of preparing the toner materials of the present invention and of utilizing them to develop electrostatic latent images. Parts and percentages are by weight unless otherwise indicated.

EXAMPLE I

A sample of Xerox 813 toner particles sold by the Xerox Corp., Rochester, N.Y., is employed as a control. Copies of a standard test pattern are made with the toner in a modified 813 Xerox copying machine. The fuser temperature is regulated with a proportional temperature controller and is monitored by means of a thermocouple mounted in the center of the upper fuser plate. The fuser unit comprises plates mounted about 0.75 inches apart. The toner images on 8 inch by 13 inch copy sheets are transported through the fuser at twice the normal rate, i.e., at 3 inches per second. Since the standard Xerox 813 copy machine drive motor stalls and overheats when the machine is operated at twice the normal speed, a motor having twice the power output is employed. After passage through the fuser, the copy sheets are fastened to a full page abrading cylinder having a diameter of about 4.75 inches. A conventional 813 cleaning web is pressed against the copy sheet by a spring-loaded roller under a spring tension of about 40 pounds. By rotating the cylinder bearing the copy sheet, the entire toner image on the copy sheet is abraded by frictional contact with the web. A minimum fuser temperature is established when all the test characters are legible after an abrasion run of five revolutions of the abrading cylinder. Xerox 813 carrier beads are employed with the toner during the development step. The minimum fuser temperature at which legible copies are obtained with the Xerox 813 toner is found to be about 600° F. Some of the copy samples are found to contain glowing embers as they emerge from the toner fuser. Further, micrograph studies of the reusable imaging surface after 5,000 cycles reveals considerable wear and degradation of the surface.

EXAMPLE II

A toner mixture is prepared comprising about 10 parts by weight of carbon black (Neo Spectra Mark II) about 85 parts by weight of a copolymer of 65 parts by weight of styrene and about 35 parts by weight of n-butylmethacrylate, and 5 parts by weight of dicyclohexyl phthalate. This phthalate has a melting point of about 140° F. After melting and preliminary mixing, the composition is rubber milled to yield a uniformly dispersed composition of the carbon black in the thermoplastic resin body. The resulting mixed composition is cooled and then finely subdivided in a jet pulverizer to yield toner particles having an average particle size of about 10 to about 15 microns. The toner has a melt viscosity of about 0.5×10^{14} poise at about 285° F. and a blocking temperature of about 135° F. About 1 part by weight of the pulverized toner particles are mixed with about 0.01 parts by weight of zinc stearate particles having a particle size from about 5 to about

40 microns, and about 99 parts by weight of Xerox 813 carrier beads and substituted for the developer in the testing machine described in example I. Under substantially identical test conditions, it is found that the original standard Xerox 813 drive motor can be used and that the minimum fuser temperature at which legible copies are obtained after an abrasion run of five revolutions of the abrading cylinder is about 570° F. This is a reduction of about 40° F. from the fuser temperature required for the control sample of example I. No glowing embers are observed on the copy samples as they emerge from the toner fuser. Micrograph studies of the reusable imaging surface after 5,000 cycles reveals less wear and degradation of the imaging surface than the imaging surface of example I.

EXAMPLE III

A toner mixture is prepared comprising about 10 parts by weight of carbon black (Super Carbobar), about 80 parts by weight of a copolymer of 65 parts by weight of styrene and 35 parts by weight of n-butyl methacrylate, and about 10 parts by weight of diphenyl phthalate. This phthalate has a melting point of about 156° F. After melting and preliminary mixing, the composition is fed into a rubber mill and thoroughly milled to yield a uniformly dispersed composition of the carbon black in the thermoplastic resin body. The resulting mixed composition is cooled and then finely subdivided in a jet pulverizer to yield toner particles having an average particle size of about 6 to about 12 microns. This toner has a melt viscosity of about 0.5×10^{14} poise at 275° F. and a blocking temperature of about 125° F. About 1.5 parts by weight of the pulverized toner particles are mixed with about 0.01 parts by weight of zinc stearate particles having a particle size between about 5 to about 40 microns, and about 99 parts by weight of Xerox 813 carrier beads and substituted for the 813 developer in the testing machine described in example I. Under substantially identical test conditions, it is found that the original standard Xerox 813 drive motor can be used and that the minimum fuser temperature at which legible copies obtained after an abrasion run of five revolutions of the abrading cylinder is about 545° F. This is a reduction of about 65° F. from the fuser temperature required for the control sample of example I. No glowing embers are observed on the copy samples as they emerge from the fuser. Micrograph studies of the reusable imaging surface after 5,000 cycles reveals less wear and degradation of the imaging surface than the imaging surface of example I.

EXAMPLE IV

A toner mixture is prepared comprising about 10 parts by weight of Sudan Black BN dye, about 80 parts by weight of a copolymer of about 65 parts by weight of styrene and about 35 parts by weight of n-butyl methacrylate, and about 10 parts by weight of dihydroabietyl phthalate. This phthalate has a melting point of about 149° F. After melting and preliminary mixing, the composition is fed into a rubber mill and thoroughly milled to yield a uniformly dispersed composition of the carbon black in the thermoplastic resin body. The resulting mixed composition is cooled and then finely subdivided in a jet pulverizer to yield toner particles having an average particle size of about 10 to about 15 microns. This toner has a melt viscosity of about 0.5×10^{14} poise at about 275° F. and a blocking temperature of about 125° F. About 1 part by weight of the pulverized toner particles are mixed with about 0.05 parts by weight of zinc oleate having a particle size range between about 0.5 to about 35 microns and about 99 parts by weight of 813 Xerox carrier beads and substituted for the 813 developer in the testing machine described in example I. Under substantially identical test conditions, it is found that the original standard Xerox 813 drive motor can be used and the minimum fuser temperature at which legible copies are obtained after an abrasion run of five revolutions of the abrading cylinder is about 550° F. This is a reduction of 60° F. from the fuser temperature required for the control sample of example I. No

glowing embers are observed on the copy samples as they emerge from the fuser. Micrograph studies of the reusable imaging surface after 5,000 copies reveals less wear and degradation of the surface than the imaging surface of example I.

EXAMPLE V

A toner mixture is prepared comprising about 10 parts by weight of carbon black, about 75 parts by weight of a copolymer of about 80 parts by weight of styrene and about 20 parts by weight of isobutylmethacrylate, and about 15 parts by weight of dicyclohexyl phthalate. After melting and preliminary mixing, the composition is fed into a rubber mill and thoroughly milled to yield a uniformly dispersed composition of the dye in the thermoplastic resin body. The resulting mixed composition is cooled and then finely subdivided in a jet pulverizer to yield toner particles having an average particle size of about 6 to about 9 microns. This toner has a melt viscosity of about 0.5×10^{14} poise at about 275° F. and a blocking temperature of about 130°. As in all the examples, the blocking temperature is determined by initially heating the toner particles in an air-circulating oven at about 100° F. for a 24-hour period and, thereafter, increasing the temperature in 10° increments every 24 hours. The blocking temperature is that temperature at which a mild crushing action with a spatula is required to restore any toner agglomerates formed to the original finely divided particulate form. About 2 parts by weight of the pulverized toner particles are mixed with about 0.015 parts by weight of zinc stearate particles having a size range from about 5 to about 40 microns and about 99 parts by weight of 813 Xerox carrier beads and substituted for the 813 developer in the testing machine described in example I. Under substantially identical test conditions, it is found that the original standard Xerox 813 drive motor can be employed and that the minimum fuser temperature at which legible copies are obtained after an abrasion run of five revolutions of the abrading cylinder is about 540° F. This is a reduction of 60° F. from the fuser temperature required for the control sample of example I. No glowing embers are observed on the copy samples as they emerge from the fuser. Micrograph studies of the reusable imaging surface after 5,000 cycles reveals less wear and degradation of the surface than the imaging surface of example I.

EXAMPLE VI

A toner mixture is prepared comprising about 10 parts by weight of carbon black, about 75 parts by weight of a copolymer of about 80 parts by weight of styrene and about 20 parts by weight of isobutylmethacrylate, and about 15 parts by weight of dimethyl isophthalate. After melting and preliminary mixing, the composition is fed into a rubber mill and thoroughly milled to yield a uniformly dispersed composition of the pigment and phthalate in the thermoplastic resin body. The resulting mixed composition is cooled and then finely subdivided in a jet pulverizer to yield toner particles having an average particle size of about 6 to about 9 microns. This toner has a melt viscosity of about 0.5×10^{14} poise at about 280° F. and a blocking temperature of about 130° F. About 1 part by weight of the pulverized toner particles are mixed with about 0.01 parts by weight of zinc stearate particles having a size range from about 0.5 to about 30 microns, and about 99 parts by weight of 813 Xerox carrier beads and substituted for the 813 developer in the testing machine described in example I. Under substantially identical test conditions, it is found that the original standard Xerox 813 drive motor can be employed and that the minimum fuser temperature at which legible copies are obtained after an abrasion run of five revolutions of the abrading cylinder is about 560° F. This is a reduction of 50° F. from the fuser temperature required for the control sample of example I. No glowing embers are observed on the copy sheet samples as they emerge from the fuser. Micrograph studies of the imaging surface after 5,000 cycles reveals less

wear and degradation of the surface than the imaging surface of example I.

EXAMPLE VII

A toner mixture is prepared comprising about 10 parts by weight of carbon black, about 65 parts by weight of a copolymer of about 90 parts by weight polystyrene and about 10 parts by weight of isobutylmethacrylate, and about 25 parts by weight of dicyclohexyl phthalate. After melting and preliminary mixing, the composition is fed into a rubber mill and thoroughly milled to yield a uniformly dispersed composition of the carbon black and phthalate in the thermoplastic resin body. The resulting mixed composition is cooled and then finely subdivided in a jet pulverizer to yield toner particles having an average particle size of about 10 to about 15 microns. This toner has a melt viscosity of about 0.5×10^{14} poise at about 250° F. and a blocking temperature of about 110° F. About 1 part by weight of the pulverized toner particles are mixed with about 0.1 parts by weight of zinc oleate having a particle size from about 0.5 to about 25 microns, and about 99 parts by weight of 813 Xerox carrier beads and substituted for the 813 developer in the testing machine described in example I. Under substantially identical test conditions, it is found that the original standard Xerox 813 drive motor can be used and that the minimum fuser temperature at which legible copies are obtained after an abrasion run of five revolutions of the abrading cylinder is about 500° F. This is a reduction of 110° F. from the fuser temperature required for the control sample of example I. No glowing embers are observed on the copy sheet samples as they emerge from the fuser. Micrograph studies of the reusable imaging surface after 5,000 cycles reveals less wear and degradation of the surface than the imaging surface of example I.

EXAMPLE VIII

A toner mixture is prepared comprising about 10 parts by weight of carbon black (Neo Spectra Mark II), about 65 parts by weight of polystyrene and 25 parts by weight of diphenyl phthalate. After melting and preliminary mixing, the composition is rubber milled to yield a uniformly dispersed composition of the carbon black in the thermoplastic resin body. The resulting mixed composition is cooled and then finely subdivided in a jet pulverizer to yield toner particles having an average particle size of about 10 to about 15 microns. The toner has a melt viscosity of about 0.5×10^{14} poise at about 255° F. and a blocking temperature of about 115° F. About 1 part by weight of the pulverized toner particles are mixed with about 0.01 parts by weight of zinc stearate particles having a particle size from about 5 to about 40 microns, and about 99 parts by weight of Xerox 813 carrier beads and substituted for the developer in the testing machine described in example I. Under substantially identical test conditions, it is found that the original standard Xerox 813 drive motor can be used and that the minimum fuser temperature at which legible copies are obtained after an abrasion run of five revolutions of the abrading cylinder is about 510° F. This is a reduction of about 100° F. from the fuser temperature required for the control sample of example I. No glowing embers are observed on the copy samples as they emerge from the toner fuser. Micrograph studies of the reusable imaging surface after 5,000 cycles reveals less wear and degradation of the imaging surface than the imaging surface of example I.

EXAMPLE IX

A toner mixture is prepared comprising about 10 parts by weight of carbon black (Super Carobar), about 70 parts by weight of polymethylmethacrylate and 20 parts by weight of dihydroabietyl phthalate. After melting and preliminary mixing, the composition is rubber milled to yield a uniformly dispersed composition of the carbon black in the thermoplastic resin body. The resulting mixed composition is cooled and then finely subdivided in a jet pulverizer to yield

toner particles having an average particle size of about 6 to about 12 microns. The toner has a melt viscosity of about 0.5×10^{-4} poise at about 265° F. and a blocking temperature of about 120° F. About 1 part by weight of the pulverized toner particles are mixed with about 0.01 parts by weight of lead linoleate particles having a particle size from about 3 to about 35 microns, and about 99 parts by weight of Xerox 813 carrier beads and substituted for the developer in the testing machine described in example I. Under substantially identical test conditions, it is found that the original standard Xerox 813 drive motor can be used and that the minimum fuser temperature at which legible copies are obtained after an abrasion run of five revolutions of the abrading cylinder is about 530° F. This is a reduction of about 80° F. from the fuser temperature required for the control sample of example I. No glowing embers are observed on the copy samples as they emerge from the toner fuser. Micrograph studies of the reusable imaging surface after 5,000 cycles reveals less wear and degradation of the imaging surface than the imaging surface of example I.

EXAMPLE X

A toner mixture is prepared comprising about 10 parts by weight of carbon black, about 75 parts by weight of a copolymer of 90 parts by weight of styrene and about 10 parts by weight of vinylidene chloride, and 15 parts by weight of diphenyl phthalate. After melting and preliminary mixing, the composition is rubber milled to yield a uniformly dispersed composition of the carbon black in the thermoplastic resin body. The resulting mixed composition is cooled and then finely subdivided in a jet pulverizer to yield toner particles having an average particle size of about 7 to about 12 microns. The toner has a melt viscosity of about 0.5×10^{-4} poise at about 275° F. and a blocking temperature of about 125° F. About 1 part by weight of the pulverized toner particles are mixed with about 0.01 parts by weight of zinc stearate particles having a particle size from about 5 to about 40 microns, and about 99 parts by weight of uncoated glass beads and substituted for the developer in the testing machine described in example I. Under substantially identical test conditions, it is found that the original standard Xerox 813 drive motor can be used and that the minimum fuser temperature at which legible copies are obtained after an abrasion run of five revolutions of the abrading cylinder is about 565° F. This is a reduction of about 65° F. from the fuser temperature required for the control sample of Example I. No glowing embers are observed on the copy samples as they emerge from the toner fuser. Micrograph studies of the reusable imaging surface after 5,000 cycles reveals less wear and degradation of the imaging surface than the imaging surface of example I.

EXAMPLE XI

A toner mixture is prepared comprising about 10 parts by weight of carbon black (Neo Spectra Mark II), about 80 parts by weight of a copolymer of 70 parts by weight of styrene and about 30 parts by weight of vinyl acetate, and 10 parts by weight of dicyclohexyl phthalate. After melting and preliminary mixing, the composition is rubber milled to yield a uniformly dispersed composition of the carbon black in the thermoplastic resin body. The resulting mixed composition is cooled and then finely subdivided in a jet pulverizer to yield toner particles having an average particle size of about 10 to about 15 microns. The toner has a melt viscosity of about 0.5×10^{-4} poise at about 280° F. and a blocking temperature of about 135° F. About 1 part by weight of the pulverized toner particles are mixed with about 0.01 parts by weight of zinc stearate particles having a particle size from about 5 to about 40 microns, and about 99 parts by weight of coated carrier beads and substituted for the developer in the testing machine described in example I. Under substantially identical test conditions, it is found that the original standard Xerox 813 drive motor can be used and that the minimum fuser temperature at which legible copies are obtained after an abrasion run of five revolutions of the abrading cylinder

is about 560° F. This is a reduction of about 50° F. from the fuser temperature required for the control sample of example I. No glowing embers are observed on the copy samples as they emerge from the toner fuser. Micrograph studies of the reusable imaging surface after 5,000 cycles reveals less wear and degradation of the imaging surface than the imaging surface of example I.

EXAMPLE XII

A toner mixture is prepared comprising about 10 parts by weight of carbon black, about 70 parts by weight of a copolymer of 80 parts by weight of styrene and 20 parts by weight of acrylonitrile, and 20 parts by weight of dicyclohexyl phthalate. This phthalate has a melting point of about 140° F. After melting and preliminary mixing, the composition is rubber milled to yield a uniformly dispersed composition of the carbon black in the thermoplastic resin body. The resulting mixed composition is cooled and then finely subdivided in a jet pulverizer to yield toner particles having an average particle size of about 5 to about 14 microns. The toner has a melt viscosity of about 0.5×10^{-4} poise at about 260° F. and a blocking temperature of about 120° F. About 1 part by weight of the pulverized toner particles are mixed with about 0.05 parts by weight of cobalt palmitate particles having a particle size from about 5 to about 40 microns, and about 99 parts by weight of uncoated glass carrier beads and substituted for the developer in the testing machine described in example I. Under substantially identical test conditions, it is found that the original standard Xerox 813 drive motor can be used and that the minimum fuser temperature at which legible copies are obtained after an abrasion run of five revolutions of the abrading cylinder is about 520° F. This is a reduction of about 90° F. from the fuser temperature required for the control sample of example I. No glowing embers are observed on the copy samples as they emerge from the toner fuser. Micrograph studies of the reusable imaging surface after 5,000 cycles reveals less wear and degradation of the imaging surface than the imaging surface of example I.

EXAMPLE XIII

A control toner mixture is prepared comprising about 5 parts by weight of carbon black and about 90 parts by weight of a polymeric esterification product of a linear alcohol, hexamethylene glycol, and a dicarboxylic acid, sebacic acid. This polymer, hexamethylene sebacate, has a molecular weight of about 20,000 and a melting range of about 144° to 156° F. After melting and preliminary mixing, the composition is fed into a rubber mill and thoroughly milled to yield a uniformly dispersed composition of the carbon black in the thermoplastic resin body. The resulting mixed composition is cooled and then finely subdivided in a jet pulverizer to yield toner particles having an average particle size of about 7 to about 12 microns. About 1 part by weight of the pulverized toner particles are mixed with about 99 parts by weight of Xerox 813 carrier beads and substituted for the 813 developer in the testing machine described in example I. The toner images after fusing are extremely faint, poorly defined and almost illegible. After about 70 imaging cycles, a heavy film of the toner is found on the surface of the modified Xerox 813 xerographic drum.

EXAMPLE XIV

A sample of toner particles of the type described in example II is tested for its imaging characteristics. About 1 part by weight of the pulverized toner particles are mixed with about 0.0025 parts by weight of zinc stearate particles having a particle size of about 0.5 to about 40 microns and about 99 parts by weight of uncoated glass carrier beads and substituted for the developer in the testing machine described in example XIII. Under substantially identical test conditions, the resulting toner images are highly legible and very dense. A slight haze is found on the surface of the xerographic drum.

EXAMPLE XV

A control sample containing 1 part colored preformed toner particles of the type described in example II having an average particle size of about 10 to about 15 microns is mixed with about 99 parts of coated glass beads having an average particle size of about 250 microns and then cascaded across an electrostatic image-bearing drum surface. The developed image is then transferred by electrostatic means to a sheet of paper whereon it is fused by heat. The residual powder is removed from the electrostatic imaging surface by a cleaning web of the type disclosed by W. P. Graff, Jr. et al. in U.S. Pat. No. 3,186,838. After the copying process is repeated 25,000 times, the copies and electrostatic image-bearing surface are examined for quality and wear, respectively. The copies possess sharp line contrast and minimal background deposition. However, an examination of the imaging surface reveals the effects of considerable wear.

EXAMPLE XVI

About 0.01 parts of zinc stearate having a particle size distribution from about 5 microns to about 40 microns is gently folded into 1 part of a colored preformed toner particle of the type described in example XV. The resulting developer mixture is cooled and then thoroughly milled in a Szegvari attritor for about 10 minutes. The developing procedure of example XV is repeated with a new drum and with the foregoing milled mixture substituted for the toner of example XV at a relative humidity of about 50 percent of 70° F. and at a relative humidity of 80 percent at 80° F. Copies prepared with the milled sample possess higher density solid area coverage than copies prepared with the control sample. Further, micrograph studies of the electrostatic image-bearing surface reveals less wear than on the image-bearing surface of example XV. Considerably less torque is necessary to drive the drum when the stearate additive is employed and a lower voltage is required to transfer the toner images to a receiving sheet.

EXAMPLE XVII

About 0.01 parts zinc stearate having a particle size distribution from about 5 microns to about 40 microns is gently folded into about 10 parts of a colored preformed toner particle of the type described in example XIV. The resulting mixture is then tumbled in a sealed container for 15 minutes. About 1 part of the tumbled mixture is mixed with 99 parts of carrier beads having an average particle size of about 250 microns. The resulting developer mixture is employed in a cascade developing process as described in example XIV at a relative humidity of 80 percent at 80° F. The resulting fused toner images are denser under both humidity conditions than the images obtained in example XVI.

The expression "developing material" as employed herein is intended to include electroscopic toner material or combinations of toner material and carrier material.

Although specific materials and conditions are set forth in the foregoing examples, these are merely intended as illustrations of the present invention. Various other suitable toner resin, additives, colorants, and other components, such as those listed above may be substituted for those in the examples with similar results. Other materials may also be added to the toner to sensitize, synergize, or otherwise improve the fusing properties or other desirable properties of the system.

Other modifications of the present invention will occur to those skilled in the art upon a reading of the present disclosure. These are intended to be included within the scope of this invention.

What is claimed is:

1. A solid xerographic-developer material comprising finely divided toner particles uniformly electrostatically coated on a

carrier surface capable of retaining said toner particles by electrostatic attraction, said toner particles having a particle size range of up to about 30 microns, a blocking temperature of at least about 110° F., a melt viscosity less than about 2.5×10^{14} poise at temperatures up to about 450° F., and comprising a colorant selected from the group consisting of a pigment and a dye, a thermoplastic resin consisting essentially of a vinyl polymer having a melting point of at least about 110° F., about 2 percent to about 45 percent by weight, based on the total weight of said resin, of a solid diester having a melting point between about 110° F. and 175° F. and selected from the group consisting of o-phthalic and m-phthalic acid esters of monohydric alcohols, and from about 0.02 percent to about 20 percent by weight, based on the weight of said toner particles of at least one solid, stable hydrophobic metal salt of a fatty acid having a melting point greater than about 57° C. and available at the external surfaces of the toner particles.

2. A solid xerographic-developer material according to claim 1 wherein said solid diester is diphenyl phthalate.

3. A solid xerographic-developer material according to claim 1 wherein said solid diester is dihydroabietyl phthalate.

4. A solid xerographic-developer material according to claim 1 wherein said solid diester is dicyclohexyl phthalate.

5. A solid xerographic-developer material according to claim 1 wherein said finely divided dry toner material contains at least about 25 percent by weight, based on the total weight of said thermoplastic resin in said toner, of a styrene resin.

6. A solid xerographic-developer material according to claim 1 wherein said solid, stable hydrophobic metal salt of a fatty acid is zinc stearate.

7. A solid xerographic developer material according to claim 7 wherein said finely divided toner particles are uniformly electrostatically coated on a carrier surface consisting essentially of carrier particles having an average particle diameter between about 50 to about 1,000 microns.

8. A solid xerographic-developer material according to claim 7 wherein said solid xerographic-developer material comprises about 1 part by weight of said finely divided dry toner material and from about 10 to about 200 parts by weight, of said carrier particles.

9. A treated solid xerographic-toner material having a particle size range of up to about 30 microns, a blocking temperature of at least about 110° F., a melt viscosity less than about 2.5×10^{14} poise at temperatures up to about 450° F., and comprising a colorant selected from the group consisting of a pigment and a dye, a thermoplastic resin consisting essentially of a vinyl polymer having a melting point of at least about 110° F., about 2 percent to about 45 percent by weight, based on the total weight of said resin, of a solid diester having a melting point at least about 110° F. and selected from the group consisting of o-phthalic and m-phthalic acid esters of monohydric alcohols, and from about 0.02 percent to about 20 percent by weight, based on the weight of said toner particles of at least one solid, stable hydrophobic metal salt of a fatty acid having a melting point greater than about 57° C. and available at the external surfaces of the toner particles.

10. A solid xerographic developer material comprising finely-divided toner particles uniformly electrostatically coated on a carrier surface capable of retaining said toner particles by electrostatic attraction, said toner particles having a particle size range of up to about 30 microns, a blocking temperature of at least about 110° F., a melt viscosity less than about 2.5×10^{14} poise at temperatures up to about 450° F., and comprising a colorant selected from the group consisting of a pigment and a dye, a thermoplastic resin consisting essentially of a vinyl polymer having a melting point at least about 110° F., and a solid diester having a melting point at least about 110° F. and selected from the group consisting of o-phthalic acid esters and m-phthalic acid esters of monohydric alcohols.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,609,082 Dated September 28, 1971

Inventor(s) J. H. Moriconi et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

IN THE SPECIFICATION:

Column 3, line 44, please delete " 2.0×10^{14} " and insert $--2.0 \times 10^{-4}--$.

Column 5, line 34, please delete " 2.5×10^{14} " and insert $--2.5 \times 10^{-4}--$.

Column 5, line 40; and Column 8, line 12, please delete " 2.5×10^{14} " and insert $--2.5 \times 10^{-4}--$.

Column 9, line 72; and Column 10, line 29, please delete " 0.5×10^{14} " and insert $--0.5 \times 10^{-4}--$.

Column 10, line 63; Column 11, line 20 and line 60; Column 12, line 17 and line 47; Column 13, line 33 and Column 14, line 22, please delete " 0.5×10^{14} " and insert $--0.5 \times 10^{-4}--$.

IN THE CLAIMS:

Column 16, line 5, line 44 and line 63, please delete " 2.5×10^{14} " and insert $--2.5 \times 10^{-4}--$.

Column 16, line 32, please delete "7" and insert $--1--$.

Signed and sealed this 4th day of April 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents