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(54) **Master batch for production of toners used in electrophotography.**

(57) There is disclosed a method of producing a master batch for the production of toner particles used in electrophotography, which comprises:

- (a) preparing a resin solution;
- (b) preparing a mixture which has a dye or a pigment finely dispersed in the resin solution; and
- (c) removing the solvent from the mixture.

There is also provided a method of producing toner particles for use in electrophotography, which, in addition to the above steps (a), (b) and (c) for the preparation of a master batch, further comprises:

- (d) adding a further amount of a second binder resin to the master batch together with an effective amount of an additive when necessary, to form a second mixture, and kneading the second mixture to a composition; and
- (e) crushing the composition to toner particles.

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MASTER BATCH FOR PRODUCTION OF TONERS USED IN ELECTROPHOTOGRAPHY

BACKGROUND OF THE INVENTION

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Field of the Invention

This invention relates to a master batch for the production of toner particles used in electrophotography, and production of toner particles using such a master batch.

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Description of the Prior Art

An electrophotographic process is well known wherein an electrostatic image is formed on a photoconductor, and the electrostatic image is then developed with a developer which contains toner particles, to provide a toner image, and then the toner image is transferred and fixed on a substrate.

Two methods are well known for developing an electrostatic image on a photoconductor: a one-component developing method and a two-component developing method. The two-component developer is composed of toner particles and carrier particles, and now widely used in a magnetic brush method. In a multicolor or full color electrophotographic process which has been very recently put to practical use, a full color toner image is produced by forming primary color toner images in layers sequentially on a substrate, and accordingly the two-component developing method are mainly employed in the process.

In general, triboelectricity of toner particles has a great influence upon quality of fixed images either in the one-component or in the two-component developing method. When toner particles used in the two-component developing method have an insufficient specific electric charge (an electric charge per weight of toners), the toner particles have an insufficient electrostatic interaction with the carrier particles, so that the toner contaminates the surrounding of the developing device, or adheres to areas having no images on a photoconductor, to produce fog on the resultant fixed image. On the other hand, when toner particles have an excessively large specific electric charge, an insufficient amount of toner particles adheres to an electrostatic image, to produce a fixed image with an insufficient darkness. Thus, when toner particles contain a dye or a pigment dispersed unevenly therein as particles of varied sizes, there arise problems of instability of image darkness, background contamination or fog on the image, but also of filming of toner particles on photoconductors.

In the one-component developing method, toner particles are used which contain magnetic particles therein, and the toner particles are charged by mutual friction or by friction with developing sleeves. However, in the one-component developing method, toner particles are apt to be charged more unstably and insufficiently than in the two-component developing method. Thus, when toner particles contain such particles as have insufficient specific electric charge, the resultant fixed images have a small or varied darkness as well as fog.

In this way, when toner particles have a varied specific electric charge, either in the two-component developing method or the one-component developing method, there arise a number of undesirable problems.

Therefore it is very important that individual toner particles have various additives, in particular, a dye or a pigment as a charge control agent, dispersed as finely and evenly as possible therein so that the individual toner particles are equally electrified, thereby to produce high quality fixed images stably and constantly.

However, it is difficult to disperse a dye or a pigment as a charge control agent or a coloring agent finely and evenly in the individual toner particles by a known conventional method. Such a known conventional method of producing toners comprises admixing a binder resin with a dye or a pigment by an effective agitation to form a mixture, melting and kneading the mixture with, for example, a twin screw extruder, a heating kneader or a heating roll, and then cooling and crushing the mixture to a powder. When needed, the powder is classified to a desirable particle size, and the powder is surface-treated with, for example, colloidal silica, so that the powder has a high fluidity.

Almost all the dyes and pigments which have heretofore been used in the production of toners contain at least in part particles having a larger diameter than the desirable diameter of toners. These particles can not

be finely dispersed in toner particles by a conventional method, with the consequence that the toner particles contain an insufficient amount of dye or pigment therein, or it happens that some of toner particles contain only a single particle of dye or pigment therein.

Thus there is proposed an improved method of the production of toner particles to obviate such a problem as above mentioned in Japanese Patent Application Laid-open No. 62-30259. According to the method, at first, a part of a binder resin, and a full amount of a dye or a pigment are mixed, melted and kneaded together, and then cooled and crushed to form a master batch. Then the master batch is mixed with the remainder of the binder resin, melted, kneaded, cooled and crushed to provide toner particles. However, binder resins generally have a low polarity, whereas dyes and pigments generally have a high polarity, so that it is essentially difficult from the chemical standpoint to disperse such dyes or pigments finely and evenly in the binder resins by melt-kneading.

A further method is disclosed in Japanese Patent Application Laid-open No. 61-156054. In the method, at first, a part of a binder resin and a charge control agent are dissolved in an organic solvent, and then the solvent is removed, to form a master batch. The master batch is then melted and kneaded together with the remainder of the binder resin, and the mixture is cooled and crushed to toner particles. However, this method needs a large amount of solvent and costs a great deal, since the charge control agent is in general rarely soluble in organic solvents.

BRIEF SUMMARY OF THE INVENTION

It is, therefore, an object of the invention to provide a method of producing toner particles, either monochromatic or colored, for use in electrophotography which individually have a dye or a pigment evenly dispersed therein as finely divided particles.

It is a further object of the invention to provide a master batch suitably used for the production of such toner particles as above mentioned.

In accordance with the invention, there is provided a method of producing a master batch for the production of toners used in electrophotography, which comprises:

- (a) preparing a resin solution;
- (b) preparing a mixture which has a dye or a pigment finely dispersed in the resin solution; and
- (c) removing the solvent from the mixture.

The resin solution is prepared either by polymerizing monomers in an organic solvent or by dissolving a binder resin in an organic solvent.

Thus, more specifically, in accordance with the invention, there is provided a method of producing a master batch for the production of toners used in electrophotography, which comprises:

- (a) polymerizing monomers in an organic solvent to prepare a resin solution; and
- (b) preparing a mixture which has a dye or a pigment finely dispersed in the resin solution; and
- (c) removing the solvent from the mixture.

Further in accordance with the invention, there is provided a method of producing a master batch for the production of toners used in electrophotography, which comprises:

- (a) dissolving a binder resin in an organic solvent to prepare a resin solution;
- (b) milling and dispersing a dye or a pigment in the resin solution to prepare a mixture; and
- (c) removing the solvent from the mixture.

There is provided a further method of producing a master batch for the production of toner particles used in electrophotography, which comprises:

- (a) dissolving a binder resin in an organic solvent to prepare a resin solution;
- (b) milling and dispersing a dye or a pigment in an organic solvent to prepare a dispersion; and
- (c) mixing the resin solution and the dispersion together to prepare a mixture, and removing the solvent from the mixture.

In accordance with the invention, there is also provided a method of producing toner particles for use in electrophotography, which, in addition to the steps (a), (b) and (c) as above set forth, further comprises:

- (d) adding a further amount of a second binder resin together with an effective amount of an additive when necessary, to form a second mixture, and kneading the second mixture to a composition; and
- (e) crushing the composition to toner particles.

Other features and advantages of the invention will be apparent from the following description taken in connection with the drawings, in which:

Fig. 1 is a graph showing the relation between the number of copied sheets prepared using a developer

according to the invention and the fixed image darkness;

Fig. 2 is a graph showing the relation between the number of copied sheets prepared using a developer of comparative examples and the fixed image darkness;

Fig. 3 is a graph showing the relation between the number of copied sheets prepared using a developer according to the invention and a developer of comparative examples, respectively, and the fixed image darkness;

Fig. 4 is a graph showing a distribution of triboelectricity of toner particles according to the invention;

Fig. 5 is a graph showing a distribution of triboelectricity of toner particles of comparative examples;

Fig. 6 is a graph showing a distribution of triboelectricity of toner particles according to the invention and toner particles of comparative examples, respectively;

Fig. 7 is a graph showing the relation between the number of copied sheets prepared using a developer according to the invention and the fixed image darkness;

Fig. 8 is a graph showing the relation between the number of copied sheets prepared using a developer of comparative examples and the fixed image darkness;

Fig. 9 is a graph showing a distribution of triboelectricity of toner particles according to the invention;

Fig. 10 is a graph showing a distribution of triboelectricity of toner particles of comparative examples;

Fig. 11 is a graph showing the relation between the number of copied sheets prepared using a developer according to the invention and the fixed image darkness;

Fig. 12 is a graph showing the relation between the number of copied sheets prepared using a developer of comparative examples and the toner image darkness;

Fig. 13 is a graph showing a distribution of triboelectricity of toner particles according to the invention; and

Fig. 14 is a graph showing a distribution of triboelectricity of toner particles of comparative examples.

DETAILED DESCRIPTION OF THE INVENTION

The binder resin used is not specifically limited, but any resin may be used which is known in the art of toners for use in electrophotography. There may be mentioned as such a binder resin, for instance, a homopolymers or copolymers of two or more of radical polymerizable monomers such as styrene, o-methyl styrene, m-methylstyrene, p-methylstyrene, p-chlorostyrene, vinyl acetate, vinyl propionate, methyl acrylate, ethyl acrylate, n-butyl acrylate, isobutyl acrylate, n-octyl acrylate, dodecyl acrylate, 2-ethylhexyl acrylate, stearyl acrylate, 2-chlorostearyl acrylate, phenyl acrylate, methyl α -chloroacrylate, methyl methacrylate, ethyl methacrylate, propyl methacrylate, n-butyl methacrylate, isobutyl methacrylate, n-octyl methacrylate, dodecyl methacrylate, 2-ethylhexyl methacrylate, stearyl methacrylate, phenyl methacrylate, dimethylaminoethyl methacrylate, diethylaminoethyl methacrylate, acrylonitrile, methacrylonitrile, acrylamide, glycidyl acrylate, glycidyl methacrylate, acrylic acid, methacrylic acid, 2-vinylpyridine or 4-vinylpyridine.

Among the above, however, polystyrene or a styreneacrylate or methacrylate such as butyl acrylate or butyl methacrylate is preferred.

The organic solvent used in the preparation of resin solution is such that the binder resin used is soluble therein. It is preferred that the dye or pigment used is readily wetted with the solvent. Since any dye or pigment is generally of high polarity, the solvent used preferably has a polar group therein. Therefore, there may be mentioned as such polar solvents, for example, aliphatic ketones such as methyl ethyl ketone or methyl isobutyl ketone, alkyl esters of lower aliphatic carboxylic acids such as methyl acetate, ethyl acetate, propyl acetate or to butyl acetate, lower aliphatic alcohols such as propanol or butanol, or ethers such as tetrahydrofuran. However, when a dye or a pigment of a relatively low polarity is used, an aromatic hydrocarbon such as toluene or xylene may be used as the solvent. When needed, a mixture of the aliphatic alcohol and the aromatic hydrocarbon may be used as the solvent. However, the solvent used in the invention is not limited to the above exemplified.

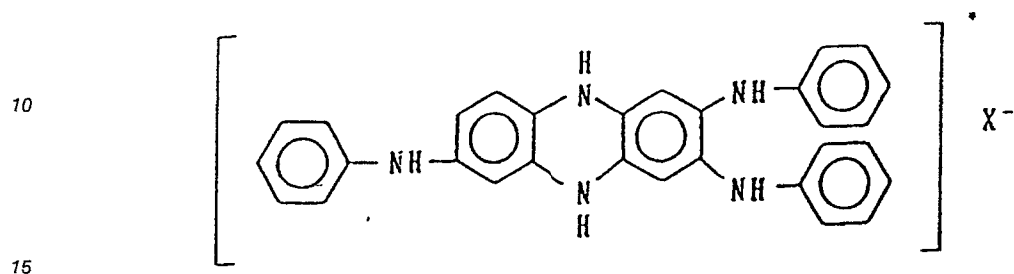
In the preparation of the resin solution, a resin is used in an amount of 1-40 parts by weight, preferably in an amount of 5-20 parts by weight, in relation to 100 parts by weight of the organic solvent.

The resin solution is prepared by dissolving a resin in an organic solvent as hereinbefore set forth, but the resin solution may be prepared by polymerizing a polymerizable monomer in an organic solvent. In the latter method, the resultant resin solution may contain unreacted monomers.

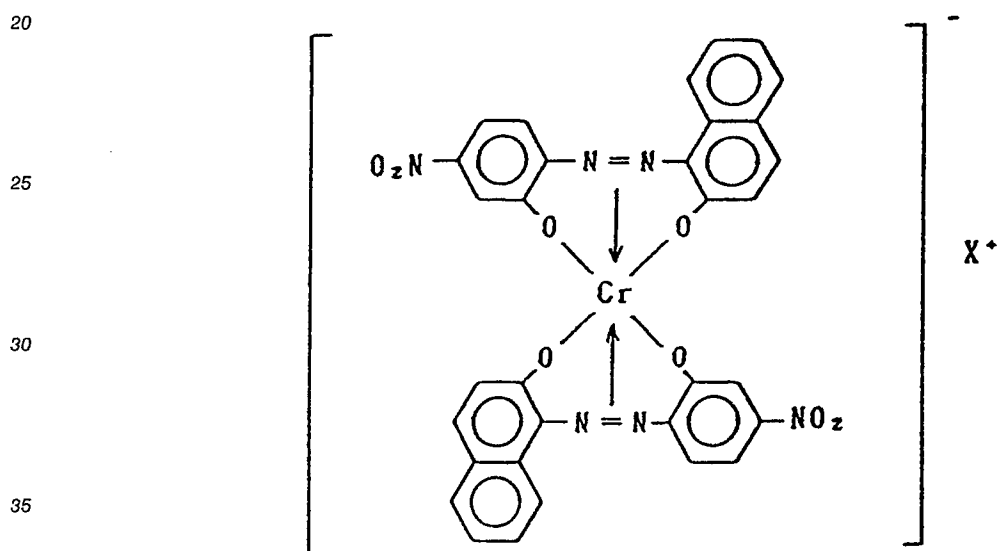
Then a dye or a pigment is added to the resin solution, and milled and dispersed therein by use of a conventional milling means such as a ball mill, thereby to prepare a mixture of resin, dye or pigment, and

solvent. When desirable, a dispersing agent such as ethylene-vinyl acetate copolymers may be used in the preparation of the mixture. When such a dispersing agent is used, a relatively low polar organic solvent is preferably used as a medium for the mixture. The dye or pigment functions as a coloring agent and/or a charge control agent in the resultant toner particles.

5 The dye or pigment used in the invention is not specifically limited, and there may be mentioned, for examples, a proton donating dye such as a nigrosine dye represented by:



wherein X^- is an anion species, and a proton accepting dye such as a chromium containing dye represented by:



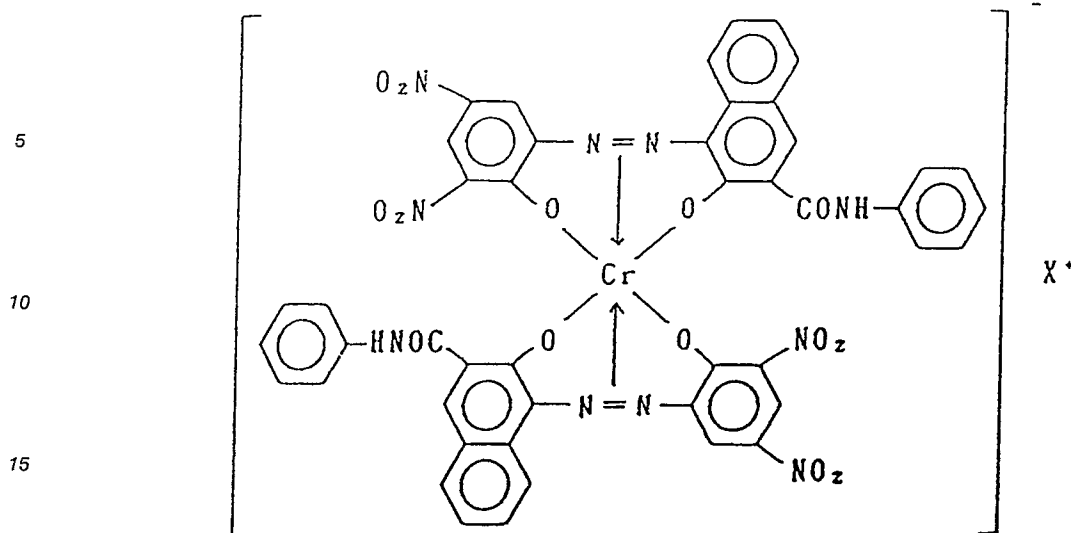
wherein X^+ is a cation species, or "Spiron Black TRH" (by Hodogaya Kagaku Kogyo K.K., Japan) represented by:

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wherein X^+ is a cation species.

Carbon black is preferably used as a coloring agent in the production of monochromatic toner particles whereas a variety of azo dyes or phthalocyanine pigments are preferably used in the production of colored toner particles.

The dye or pigment is used in an amount of 1-10 parts by weight, preferably in an amount of 2-50 parts by weight, in relation to 100 parts by weight of the organic solvent used for the production of resin solution.

The organic solvent is then removed from the mixture by any conventional means such as heating or drying under reduced pressure or frozen drying thereby to provide a master batch of the invention. The master batch may be crushed or milled, when needed.

The resultant master batch has a dye or a pigment dispersed therein as finely divided particles of not more than about $5\text{ }\mu\text{m}$, and about $1\text{ }\mu\text{m}$ in preferred embodiments, even when the dye or pigment contains particles larger in diameter than the preferred toner particles.

A master batch is generally defined as a colored material composed of a resin having a colorant dispersed therein in a high content. Such a master batch has hitherto been produced by melting and kneading together a mixture of a resin and a coloring agent in the absence of a solvent, cooling the resultant kneaded mass and then crushing or granulating the mass, as hereinbefore set forth. However, a resin is generally of low polarity whereas many dyes or pigments are of high polarity, so that the above mentioned conventional methods fail to provide a master batch in which dyes or pigments are evenly dispersed therein as finely divided particles. In contrast to this prior art, a master batch is produced according to the invention by dissolving a resin in an organic solvent to prepare a resin solution, milling and dispersing a dye or a pigment in the resin solution to prepare a mixture, and then the solvent is removed from the mixture. Thus, the method of the invention provides a master batch which contains a dye or a pigment evenly dispersed therein as finely divided particles.

In accordance with the invention, there is provided a further method of producing a master batch for the production of toner particles used in electrophotography, which comprises:

- (a) dissolving a binder resin in an organic solvent to prepare a resin solution;
- (b) milling and dispersing a dye or a pigment in an organic solvent to prepare a dispersion; and
- (c) mixing the resin solution and the dispersion together to prepare a mixture, and removing the solvent from the mixture.

The resin solution is prepared in the same manner as hereinbefore set forth. In this second method of producing a master batch, a dispersion of a dye or pigment in an organic solvent is prepared, and then the dispersion is admixed with the resin solution to prepare a mixture.

The solvent used in the preparation of the dispersion of a dye or a pigment is such that the dye or pigment used is readily wetted therewith. It is preferred that the solvent is the same as the solvent in the resin solution. However, the solvent used for the preparation of the dispersion may be different from the solvent in the resin solution if the resin is soluble therein when the resin solution and the dispersion are mixed together to prepare a mixture.

A dye or a pigment is milled with a conventional crushing means such as a ball mill and dispersed in a solvent to prepare a dispersion. In the preparation of the dispersion, a dye or pigment is used in an amount

of 1-40 parts by weight, preferably in an amount of 2-50 parts by weight, in relation to 100 parts by weight of the organic solvent used. When desirable, a dispersing agent such as ethylene-vinyl acetate copolymers may be used in the preparation of the dispersion. When such a dispersing agent is used, a relatively low polar organic solvent is preferably used as a medium for the dispersion.

5 In the preparation of a mixture of the resin solution and the dispersion, the dispersion is mixed with the resin solution so that the resultant master batch contains the dye or pigment in a required or predetermined amount. Then the solvent is removed from the mixture by any conventional means as hereinbefore mentioned thereby to provide a master batch of the invention. The master batch may be crushed or milled, when needed.

10 Similarly with the master batch prepared by the first method, the resultant master batch prepared by the second method also has a dye or a pigment dispersed therein as finely divided particles of not more than about 5 μm , and about 1 μm in preferred embodiments, even when the dye or pigment contains particles larger in diameter than the preferred toner particles.

15 As a further aspect of the invention, there is provided a method of producing toner particles for use in electrophotography. The method, in addition to the steps of (a), (b) and (c) for the preparation of a master batch, further comprises:

(d) adding a further amount of a second binder resin to the master batch together with an effective amount of an additive when necessary, to form a second mixture, and kneading the second mixture to a composition; and

20 (e) crushing the composition to toner particles.

The second binder resin may be either the same as or different from the first binder resin used in the production of the master batch. But when the second binder resin is different from the first, it is preferred that the second binder resin is compatible with the first binder resin.

25 The additives used in the production of toner particles are well known in the art of toner production, and are added in an effective amount to the master batch together with the second binder resin so that the resultant toner particles have desirable or designed properties. For instance, the additive may be a magnetic material to provide toner particles with magnetic properties or a polyolefin wax such as polyethylene wax or polypropylene wax to provide toner particles with antioffset properties. A dye or a pigment such as hereinbefore mentioned may also be incorporated into toner particles as an additive in this stage. Magnetic oxides such as ferrite or magnetite, or other magnetic metals are used as the magnetic material. The magnetic material is used in an amount of 30-300 parts by weight, preferably of 30-100 parts by weight, in relation to 100 parts by weight of the total amount of binder resin used.

30 As a still further aspect of the invention, such a master batch may be produced according to the invention as contains a dye or a pigment or other additives in such an amount that toner particles require. Such a master batch is crushed and milled as it is or after being mixed with additives to provide toner particles. The master batch in this sense does not contain a dye or a pigment in a high content, but it is referred to as a master batch in the invention.

35 The above master batch may be produced by either method set forth hereinbefore. More specifically, a dye or pigment is added to and mixed with a solution of resin, the dye or pigment is milled and dispersed in the solution, and then the solvent is removed from the mixture to provide a master batch. Alternatively, a dispersion of dye or pigment is added to and mixed with a solution of resin to disperse the dye or pigment in the solution, and then the solvent is removed from the mixture to provide a master batch. In these methods, however, a dye or pigment is used in an amount of 0.5-10 parts by weight, preferably 1-5 parts by weight in relation to 100 parts by weight of resin.

40 When the toner of the invention is used as a two-component developing agent, the toner is mixed with a carrier material such as a powder of iron, ferrite or magnetite as well known in the art of electrophotography. The two-component developing agent contains the toner in an amount of 2-20 by weight, preferably of 5-10% by weight.

45 The resultant toner particles have a uniform distribution of specific electric charge and coloring agent so that they produce either monochromatic or full color toner images with a sufficient darkness constantly free from fogs or contamination thereon. Further, there arises no problem of filming of toners on a photoconductive body.

50 The invention will now be described more specifically with reference to examples, however, the invention is not limited thereto.

55 Example 1

One part by weight of a nigrosine dye (Nigrosine Base EX available from Orient Kagaku Kogyo K.K.) as a charge controlling agent and 0.4 parts by weight of ethylene-vinyl acetate copolymer (Soablene CH available from Nippon Gosei Kagaku Kogyo K.K.) as a dispersing agent were added to 10 parts by weight of xylene. The mixture was milled in a ball mill over a period of 50 hours to provide a dispersion of dye.

5 An amount of 80 parts by weight of styrene and 20 parts by weight of butyl methacrylate were copolymerized in xylene using azobisisobutyronitrile as a polymerization initiator, to prepare a solution of low molecular weight styrenic copolymer having a weight average molecular weight of 2.0×10^4 , a glass transition temperature of 72°C and an acid value of 0.1.

10 An amount of 60 parts by weight of styrene and 40 parts by weight of butyl methacrylate were bulk-copolymerized and then solution-copolymerized in xylene, to prepare a solution of high molecular weight styrenic copolymer having a weight average molecular weight of 3.0×10^5 , a glass transition temperature of 60°C and an acid value of 0.1.

The solution of low molecular weight styrenic copolymer and the solution of high molecular weight styrenic copolymer were mixed together in an equal weight ratio. The above mentioned dispersion of charge controlling agent was added to the resin solution, and the mixture was stirred. The mixture was then heated under reduced pressure to remove the solvent therefrom, and the resultant mass was crushed to provide a master batch.

15 An amount of 101 parts by weight of the master batch (composed of 100 parts by weight of binder resin and one part by weight of charge controlling agent) was mixed with three parts by weight of low molecular weight polypropylene (available from Sanyo Kasei Kogyo K.K.), 1.5 parts by weight of carbon black (MA-8 available from Mitsubishi Kasei Kogyo K.K.) and 60 parts by weight of magnetite powder (EPT-50 available from Toda Kogyo K.K.) melt-kneaded with a twin screw extruder, and then milled with a jet mill. The resultant powder was classified to provide toner particles of 5-20 microns.

20 The toner was applied to a commercial copying machine (Model NP-150 available from Canon K.K.) and 10000 sheets of copies were made continuously to evaluate copied images. The results are shown in the Table 1, while the relation between the number of sheets copied and the image darkness is shown in Fig. 1. All of the images were clear and had no background contamination. No filming was observed on the photoconductor.

25 The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured by use of a charge distribution testing machine (available from Hosokawa Micron K.K.). As the results are shown in Fig. 4, the toner was found to have a narrow distribution of triboelectricity.

35 Example 2

Three parts by weight of the nigrosine dye and 1.2 parts by weight of the ethylene-vinyl acetate copolymer, both the same as used in the Example 1, were added to 30 parts by weight of xylene. The mixture was milled in a ball mill over a period of 50 hours to provide a dispersion of charge controlling agent.

40 The solution of low molecular weight styrenic copolymer and the solution of high molecular weight styrenic copolymer, both the same as in the Example 1, were mixed together in an equal weight ratio. The above mentioned dispersion of charge controlling agent was added to the resultant solution, and the mixture was stirred. The mixture was then heated under reduced pressure to remove the solvent there from, and the resultant mass was crushed to provide a master batch.

45 An amount of 103 parts by weight of the master batch (composed of 100 parts by weight of binder resin and three parts by weight of charge controlling agent) was mixed with three parts by weight of the low molecular weight polypropylene, 1.5 parts by weight of carbon black and 60 parts by weight of magnetite powder, all the same as in the Example 1, melt-kneaded with a twin screw extruder, and then milled with a jet mill. The resultant powder was classified to provide toner particles of 5-20 microns.

50 In the same manner as in the Example 1, 10000 sheets of copies were made continuously to evaluate copied images. The results are shown in the Table 1, while Fig. 1 shows the relation between the number of copied sheets and the image darkness. All of the sheets were found to have clear images without background contamination. No filming was observed on the photoconductor.

55 The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured in the same manner as in the Example 1. As the results are shown in Fig. 4, the toner was found to have a narrow distribution of triboelectricity.

Example 3

Three parts by weight of the nigrosine dye and 1.2 parts by weight of the ethylene-vinyl acetate copolymer, both the same as used in the Example 1, were added to 30 parts by weight of xylene. The mixture was milled in a ball mill over a period of 50 hours to provide a dispersion of charge controlling agent.

The solution of low molecular weight styrenic copolymer and the solution of high molecular weight styrenic copolymer, both the same as in the Example 1, were mixed together in an equal weight ratio. The above mentioned dispersion of charge controlling agent was added to the resultant solution in such an amount that the resultant mixture contained one part of charge controlling agent in relation to 10 parts by weight of solid resin, and the mixture was stirred. The mixture was then heated under reduced pressure to remove the solvent therefrom, and the resultant mass was crushed to provide a master batch.

An amount of 11 parts by weight of the master batch (composed of 10 parts by weight of binder resin and one part by weight of charge controlling agent) was mixed with 90 parts by weight of styrene-butyl methacrylate copolymer (a mixture of the aforesaid low molecular weight styrenic copolymer and high molecular weight styrenic copolymer in an equal weight ratio), 3 parts by weight of the low molecular weight polypropylene, 1.5 parts by weight of carbon black and 60 parts by weight of magnetite powder, all the same as in the Example 1, melt-kneaded with a twin screw extruder, and then milled with a jet mill. The resultant powder was classified to provide toner particles of 5-20 microns.

In the same manner as in the Example 1, 10000 sheets of copies were made continuously to evaluate copied images. The results are shown in the Table 1, while Fig. 1 shows the relation between the number of copied sheets and the image darkness. All of the sheets were found to have clear images without background contamination. No filming was observed on the photoconductor.

The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured in the same manner as in the Example 1. As the results are shown in Fig. 4, the toner was found to have a narrow distribution of triboelectricity.

Example 4

Three parts by weight of monoazo chromium dye Spiron Black TRH from Hodogaya Kagaku Kogyo K.K.) as a charge controlling agent and 1.2 parts by weight of the same ethylene-vinyl acetate copolymer as in the Example 1 were added to 30 parts by weight of xylene. The mixture was milled in a ball mill over a period of 50 hours to provide a dispersion of charge controlling agent.

The solution of low molecular weight styrenic copolymer and the solution of high molecular weight styrenic copolymer, both the same as in the Example 1, were mixed together in an equal weight ratio. The above mentioned dispersion of charge controlling agent was added to the resin solution, and the mixture was stirred. The mixture was then heated under reduced pressure to remove the solvent therefrom, and the resultant mass was crushed to provide a master batch.

An amount of 103 parts by weight of the master batch (composed of 100 parts by weight of binder resin and three parts by weight of charge controlling agent) was mixed with three parts by weight of the low molecular weight polypropylene and 10 parts by weight of carbon black, melt-kneaded with a twin screw extruder, and then milled with a jet mill. The resultant powder was classified to provide toner particles of 5-20 microns.

In the same manner as in the Example 1, 10000 sheets of copies were made continuously to evaluate copied images. The results are shown in the Table 1, while Fig. 3 shows the relation between the number of copied sheets and the image darkness. All of the sheets were found to have clear images without background contamination. No filming was observed on the photoconductor.

The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured in the same manner as in the Example 1. As the results are shown in Fig. 6, the toner was found to have a narrow distribution of triboelectricity.

Comparative Example 1

One part by weight of the same nigrosine dye as in the Example 1, 100 parts by weight of the same styrenebutyl methacrylate copolymer as prepared in the Example 3, 3 parts by weight of low molecular weight polypropylene, 1.5 parts by weight of carbon black and 60 parts by weight of magnetite powder, all

the same as in the Example 1, were mixed together. The mixture was then melt-kneaded with a twin screw extruder, and then milled with a jet mill. The resultant powder was classified to provide toner particles of 5-20 microns.

In the same manner as in the Example 1, 10000 sheet of copies were made continuously to evaluate copied images. The results are shown in the Table 1, while Fig. 2 shows the relation between the number of copied sheets and the image darkness. Around the last stage of 10000 sheets copying, the images were found to be remarkably contaminated and unclear.

The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured in the same manner as in the Example 1. As the results are shown in Fig. 5, the toner was found to have a wide distribution of triboelectricity.

Comparative Example 2

Three parts by weight of nigrosine dye were used, but otherwise in the same manner as in the Comparative Example 1, toner particles were prepared.

In the same manner as in the Example 1, 10000 sheet of copies were made continuously to evaluate copied images. The results are shown in the Table 1, while Fig. 2 shows the relation between the number of copied sheets and the image darkness. Around the last stage of 10000 sheet copying, the images got remarkably contaminated and unclear. Filiming was observed on the photoconductor.

The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured in the same manner as in the Example 1. As the results are shown in Fig. 5, the toner was found to have a wide distribution of triboelectricity.

Comparative Example 3

A developer was prepared by mixing 100 parts by weight of toner particles prepared in the Comparative Example 2 with one part by weight of cerium oxide.

In the same manner as in the Example 1, 10000 sheet of copies were made continuously to evaluate copied images. The results are shown in the Table 1, while Fig. 2 shows the relation between the number of copied sheets and the image darkness. The toner failed to provide copies having a stable image darknesses

The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured in the same manner as in the Example 1. As the results are shown in Fig. 5, the toner was found to have a wide distribution of triboelectricity.

Comparative Example 4

One part by weight of monoazo chromium dye (Spiron Black TRH), 100 parts by weight of styrene-acrylic acid copolymer (Himer TB-1000 available from Sanyo Kasei Kogyo K.K.), 3 parts by weight of low molecular weight polypropylene and 10 parts by weight of carbon black, both the same as in the Example 1, were mixed together. The mixture was melt-kneaded with a twin screw extruder, and then milled with a jet mill. The resultant powder was classified to provide toner particles of 5-20 microns.

An amount of 0.3 parts by weight of silica powder (Aerosil R-972 available from Nippon Aerosil K.K.) was added to and mixed with 100 parts by weight of toner particles. A developer was then prepared by mixing the toner particles with iron powder (EFV-250 available from Nippon Teppun K.K.) in a concentration of 6 % by weight.

The developer was applied to a commercial copying machine (SFT-1102-Z available from Sanyo Denki K.K.) and 10000 sheets of copies were made continuously to evaluate copied images. The results are shown in the Table 1, while Fig. 3 shows the relation between the number of copied sheets and the image darkness. Around the last stage of 10000 sheet copying, there was observed remarkable fog on the images. Also no copies were obtained with a stable image darkness.

The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured in the same manner as in the Example 1. As the results are shown in Fig. 6, the toner was found to have a wide distribution of triboelectricity.

TABLE 1

	Image Darkness		Fog on Image	Filming on Photoconductor	Reproductivity of Fine Writings
	Initial	Final ^{*)}			
Example 1	1.22	1.23	No	No	Excellent
2	1.25	1.27	No	No	Excellent
3	1.23	1.23	No	No	Excellent
Comparative Example 1	1.16	1.02	Yes	No	Bad
2	1.22	1.18	Yes	Yes	Excellent
3	1.23	1.17	Yes	No	Excellent
Example 4	1.43	1.38	No	No	Excellent
Comparative Example 4	1.33	1.43	Yes	No	Excellent

^{*)} Around 10000th sheet of copy

Example 5

An amount of 0.5 parts by weight of monoazo chromium dye (Spiron Black TRH available from Hodogaya Kagaku Kogyo K.K.) as a charge controlling agent and 0.2 parts by weight of ethylene-vinyl acetate copolymer (Soablene CH available from Nippon Gosei Kagaku Kogyo K.K.) as a dispersing agent were added to 5 parts by weight of toluene. The mixture was milled in a ball mill over a period of 50 hours to prepare a dispersion of charge controlling agent.

One part by weight of styrene-acrylic acid ester copolymer (Himer TB-1000 available from Sanyo Kasei Kogyo K.K.) as a binder resin was dissolved in 10 parts by weight of toluene to prepare a resin solution.

The above mentioned dispersion was added to the resin solution, and the mixture was stirred. The mixture was then heated under reduced pressure to remove the solvent therefrom, and the resultant mass was crushed to provide a master batch.

An amount of 1.7 parts by weight of the master batch, 98.8 parts by weight of the same styrene-acrylic acid ester copolymer as above, three parts by weight of low molecular weight polypropylene (Biscol 550-P available from Sanyo Kasei Kogyo K.K.) as an antioffset agent and 10 parts by weight of carbon black (MA-8 available from Mitsubishi Kasei Kogyo K.K.) were mixed and melt-kneaded with a twin screw extruder, and then milled with a jet mill. The resultant powder was classified to provide toner particles of 5-20 microns.

An amount of 0.3 parts by weight of silica powder (Aerosil R-972 available from Nippon Aerosil K.K.) was added to 100 parts by weight of toner particles, and then the mixture was further mixed with a carrier material (iron powder EFV-250 available from Nippon Teppun K.K.) in a concentration of 6 % by weight, thereby to prepare a two-component developer.

The developer was applied to a commercial copying machine (SFT-1102-Z available from Sanyo Denki K.K.) and 10000 sheets of copies were made continuously to evaluate copied images. As the results are shown in the Table 2, images were clear and had no background contamination at the last stage of 10000 sheet copying. Further, as the relation between the number of sheets of copies and their image darkness is shown in Fig. 7, the darkness was substantially constant over continuous copying operation. No filming was observed on the photoconductor.

The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured by use of charge distribution testing machine (available from Hosokawa Micron K.K.). As the results are shown in Fig. 9, the toner was found to have a narrow distribution of triboelectricity, and contain substantially no particles reversibly charged.

Example 6

One part by weight of dye and 0.4 parts by weight of ethylene-vinyl acetate copolymer, both the same as in the Example 5, were added to 10 parts by weight of toluene. The mixture was milled in a ball mill over a period of 50 hours to prepare a dispersion of charge controlling agent.

Two parts by weight of the same styrene-acrylic acid ester copolymer as in the Example 5 were dissolved in 20 parts by weight of toluene to prepare a resin solution.

The above mentioned dispersion was added to the resin solution, and the mixture was stirred. The mixture was then heated under reduced pressure to remove the solvent therefrom, and the resultant mass was crushed to provide a master batch.

An amount of 3.4 parts by weight of the master batch, 97.6 parts by weight of the same styrene-acrylic acid ester copolymer as above, three parts by weight of low molecular weight polypropylene and 10 parts by weight of carbon black, all the same as before, were mixed and melt-kneaded with a twin screw extruder, and then milled with a jet mill. The resultant powder was classified to provide toner particles of 5-20 microns.

An amount of 0.3 parts by weight of silica powder (Aerosil R-972 available from Nippon Aerosil K.K.) was added to 100 parts by weight of toner particles, and then the mixture was further mixed with a carrier material (iron powder EFV-250 available from Nippon Teppun K.K.) in a concentration of 6 % by weight, thereby to prepare a two-component developer.

In the same manner as in the Example 5, 10000 sheet of copies were made continuously to evaluate copied images. The results are shown in the Table 2, while Fig. 7 shows the relation between the number of copied sheets and the image darkness. There were obtained clear images without background contamination at the last stage of 10000 sheet copying. Neither filming on the photoconductor nor contamination inside the copying machine with toner particles were observed.

The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured in the same manner as in the Example 1. As the results are shown in Fig. 9, the toner was found to have a narrow distribution of triboelectricity, and contain substantially no particles reversibly charged.

Example 7

One part by weight of nigrosine dye (Nigrosine Base EX available from Orient Kagaku Kogyo K.K.) as a charge controlling agent and 0.4 parts by weight of the same ethylene-vinyl acetate copolymer as in the Example 5 were added to 10 parts by weight of toluene. The mixture was milled in a ball mill over a period of 50 hours to prepare a dispersion of charge controlling agent.

Two parts by weight of the same styrene-acrylic acid ester copolymer as in the Example 5 were dissolved in 20 parts by weight of toluene to prepare a resin solution.

The above mentioned dispersion was added to the resin solution, and the mixture was stirred. The mixture was then heated under reduced pressure to remove the solvent therefrom, and the resultant mass was crushed to provide a master batch.

An amount of 3.4 parts by weight of the master batch, 97.6 parts by weight of the same styrene-acrylic acid ester copolymer as above, three parts by weight of low molecular weight polypropylene and 60 parts by weight of magnetite powder (EPT-500 available from Toda Kogyo K.K.) were mixed and melt-kneaded with a twin screw extruder, and then milled with a jet mill. The resultant powder was classified to provide toner particles of 5-20 microns.

In the same manner as in the Example 5, 10000 sheet of copies were made continuously to evaluate copied images. The results are shown in the Table 2, while Fig. 11 shows the relation between the number of copied sheets and the image darkness. There were obtained clear images without background contamination at the last stage of 10000 sheet copying. Neither filming on the photoconductor nor contamination inside the copying machine with toner particles were observed.

The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured in the same manner as in the Example 1. As the results are shown in Fig. 13, the toner was found to have a narrow distribution of triboelectricity, and contain substantially no particles reversibly charged.

Example 8

Three parts by weight of the same nigrosine dye as in the Example 7 and 1.2 parts by weight of the

same ethylene-vinyl acetate copolymer as in the Example 5 were added to 30 parts by weight of toluene. The mixture was milled in a ball mill over a period of 50 hours to prepare a dispersion of charge controlling agent.

5 Six parts by weight of the same styrene-acrylic acid ester copolymer as in the Example 5 were dissolved in 60 parts by weight of toluene to prepare a resin solution.

The above mentioned dispersion was added to the resin solution, and the mixture was stirred. The mixture was then heated under reduced pressure to remove the solvent therefrom, and the resultant mass was crushed to provide a master batch.

10 An amount of 10.2 parts by weight of the master batch, 92.8 parts by weight of the same styrene-acrylic acid ester copolymer as above, three parts by weight of low molecular weight polypropylene, 1.5 parts by weight of carbon black and 60 parts by weight of magnetite powder, all the same as before, were mixed and melt-kneaded with a twin screw extruder, and then milled with a jet mill. The resultant powder was classified to provide toner particles of 5-20 microns.

15 In the same manner as in the Example 5, 10000 sheet of copies were made continuously to evaluate copied images. The results are shown in the Table 2, while Fig. 11 shows the relation between the number of copied sheets and the image darkness. There were obtained clear images without background contamination at the last stage of 10000 sheet copying. Neither filming on the photoconductor nor contamination inside the copying machine with toner particles were observed.

20 The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured in the same manner as in the Example 1. As the results are shown in Fig. 13, the toner was found to have a narrow distribution of triboelectricity, and contain substantially no particles reversibly charged.

25 Comparative Example 5

30 An amount of 0.5 parts by weight of monoazo chromium dye, 100 parts by weight of ethylene-vinyl acetate copolymer, 3 parts by weight of low molecular weight polypropylene and 10 parts by weight of carbon black were mixed and melt-kneaded with a twin screw extruder, and then milled with a jet mill. The resultant powder was classified to provide toner particles of 5-20 microns.

35 An amount of 0.3 parts by weight of silica powder (Aerosil R-972 available from Nippon Aerosil K.K.) was added to 100 parts by weight of toner particles, and then the mixture was further mixed with a carrier material (iron powder EFV-250 available from Nippon Teppun K.K.) in a concentration of 6 % by weight, thereby to prepare a two-component developer.

40 In the same manner as in the Example 5, 10000 sheets of copies were made continuously to evaluate copied images. The results are shown in the Table 2, while Fig. 8 shows the relation between the number of copied sheets and the image darkness. The developer provided toner images having varied image darkness and fog.

45 The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured in the same manner as in the Example 1. As the results are shown in Fig. 10, the toner was found to have a wide distribution of triboelectricity, and contain a significant amount of reversibly charged particles.

50 Comparative Example 6

One part by weight of monoazo chromium dye was used, and otherwise in the same manner as in the Comparative Example 5, a developer was prepared.

55 In the same manner as in the Example 5, 10000 sheets of copies were made continuously to evaluate copied images. The results are shown in the Table 2, while Fig. 8 shows the relation between the number of copied sheets and the image darkness. The developer provided toner images having varied image darkness and fog.

The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured in the same manner as in the Example 1. As the results are shown in Fig. 10, the toner was found to have a wide distribution of triboelectricity, and contain a significant amount of reversibly charged particles.

Comparative Example 7

Two parts by weight of monoazo chromium dye was used, and otherwise in the same manner as in the Comparative Example 5, a developer was prepared.

5 In the same manner as in the Example 5, 10000 sheets of copies were made continuously to evaluate copied images. The results are shown in the Table 2, while Fig. 8 shows the relation between the number of copied sheets and the image darkness. The developer provided toner images having varied image darkness and fog.

10 The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured in the same manner as in the Example 1. As the results are shown in Fig. 10, the toner was found to have a wide distribution of triboelectricity, and contain a significant amount of reversibly charged particles.

15 Comparative Example 8

One part by weight of the same nigrosine dye as in the Example 7, 100 parts by weight of ethylene-vinyl acetate copolymer, 3 parts by weight of low molecular weight polypropylene, 1.5 parts by weight of carbon black and 60 parts by weight of magnetite powder, all the same as before, were mixed and melt-kneaded with a twin screw extruder, and then milled with a jet mill. The resultant powder was classified to provide toner particles of 5-20 microns.

20 In the same manner as in the Example 5, 10000 sheets of copies were made continuously to evaluate copied images. The results are shown in the Table 2, while Fig. 12 shows the relation between the number of copied sheets and the image darkness. The developer provided toner images having varied image darkness and fog.

25 The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured in the same manner as in the Example 1. As the results are shown in Fig. 14, the toner was found to have a wide distribution of triboelectricity, and contain a significant amount of reversibly charged particles.

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Comparative Example 9

Three parts by weight of nigrosine dye was used and otherwise in the same manner as in the Comparative Example 8, a developer was prepared.

35 In the same manner as in the Example 5, 10000 sheets of copies were made continuously to evaluate copied images. The results are shown in the Table 2, while Fig. 12 shows the relation between the number of copied sheets and the image darkness. The developer provided toner images having varied image darkness and fog.

40 The toner was mixed with a carrier material in a concentration of 5 % by weight to prepare a developer and the distribution of triboelectricity of the toner was measured in the same manner as in the Example 1. As the results are shown in Fig. 14, the toner was found to have a wide distribution of triboelectricity, and contain a significant amount of reversibly charged particles.

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TABLE 2

		Image Darkness		Fog on Image	Filiming on Photoconductor	Reproductivity of Fine Writings
		Initial	Final ^{*)}			
5	Example 1	1.43	1.39	No	No	Excellent
	2	1.37	1.33	No	No	Excellent
10	Comparative Example 1	1.38	1.49	Yes	No	Bad
	2	1.33	1.43	Yes	No	Bad
	3	1.34	1.34	Yes	No	Excellent
15	Example 3	1.24	1.24	No	No	Excellent
	Example 4	1.26	1.28	No	No	Excellent
	Comparative Example 4	1.16	1.02	Yes	No	Bad
	Example 5	1.22	1.18	Yes	Yes	Bad

*) Around 10000th sheet of copy

Claims

1. A method of producing a master batch for the production of toner particles used in electrophotography, which comprises:
 - (a) preparing a resin solution;
 - (b) preparing a mixture which has a dye or a pigment finely dispersed in the resin solution; and
 - (c) removing the solvent from the mixture.
2. The method as claimed in claim 1 wherein the mixture is prepared by milling a dye or a pigment in the resin solution.
3. The method as claimed in claim 1 wherein the mixture is prepared by adding a dispersion of a dye or a pigment in an organic solvent to and mixing with the resin solution.
4. A method of producing a master batch for the production of toner particles used in electrophotography, which comprises:
 - (a) dissolving a binder resin in an organic solvent to prepare a resin solution;
 - (b) milling and dispersing a dye or a pigment in the resin solution to prepare a mixture; and
 - (c) removing the solvent from the mixture.
5. The method as claimed in claim 4 wherein the master batch contains the dye or pigment in an amount of 1-40 parts by weight in relation to 100 parts by weight of resin.
6. A method of producing toner particles for use in electrophotography, which comprises:
 - (a) dissolving a binder resin in an organic solvent to prepare a resin solution;
 - (b) milling and dispersing a dye or a pigment in the resin solution to prepare a mixture;
 - (c) removing the solvent from the mixture, thereby to provide a master batch;
 - (d) adding a further amount of a second binder resin to the master batch together with an effective amount of an additive when necessary, to form a second mixture, and kneading the second mixture to a composition; and
 - (e) crushing the composition to toner particles.
7. The method as claimed in claim 6 wherein the master batch contains the dye or pigment in an amount of 1-40 parts by weight in relation to 100 parts by weight of resin.
8. A method of producing a master batch for the production of toner particles used in electrophotography, which comprises:
 - (a) dissolving a binder resin in an organic solvent to prepare a resin solution;
 - (b) milling and dispersing a dye or a pigment in an organic solvent to prepare a dispersion; and
 - (c) mixing the resin solution and the dispersion together to prepare a mixture, and removing the solvent from the mixture.
9. The method as claimed in claim 8 wherein the master batch contains the dye or pigment in an amount of

1-40 parts by weight in relation to 100 parts by weight of resin.

10. A method of producing toner particles for use in electrophotography, which comprises:

- (a) dissolving a binder resin in an organic solvent to prepare a resin solution;
- (b) milling and dispersing a dye or a pigment in an organic solvent to prepare a dispersion;
- 5 (c) mixing the resin solution and the dispersion together to prepare a mixture, and removing the solvent from the mixture, thereby to prepare a master batch;
- (d) adding a further amount of a second binder resin to the master batch together with an effective amount of an additive when necessary, to form a second mixture, and kneading the second mixture to a composition; and
- 10 (e) crushing the composition to toner particles.

11. The method as claimed in claim 10 wherein the master batch contains the dye or pigment in an amount of 1-40 parts by weight in relation to 100 parts by weight of resin.

12. A method of producing toner particles for use in electrophotography, which comprises:

- (a) dissolving a binder resin in an organic solvent to prepare a resin solution;
- 15 (b) milling and dispersing a dye or a pigment in the resin solution to prepare a mixture;
- (c) removing the solvent from the mixture, thereby to provide a master batch;
- (d) adding an additive to the master batch to form a second mixture, and kneading the second mixture to a composition; and
- (e) crushing the composition to toner particles.

20 13. The method as claimed in claim 12 wherein the master batch contains the dye or pigment in an amount of 0.5-10 parts by weight in relation to 100 parts by weight of resin.

14. A method of producing toner particles for use in electrophotography, which comprises:

- (a) dissolving a binder resin in an organic solvent to prepare a resin solution;
- (b) milling and dispersing a dye or a pigment in an organic solvent to prepare a dispersion;
- 25 (c) mixing the resin solution and the dispersion together to prepare a mixture, and removing the solvent from the mixture, thereby to prepare a master batch;
- (d) adding an additive to the master batch to form a second mixture, and kneading the second mixture to a composition; and
- (e) crushing the composition to toner particles.

30 15. The method as claimed in claim 14 wherein the master batch contains the dye or pigment in an amount of 0.5-10 parts by weight in relation to 100 parts by weight of resin.

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FIG. 1

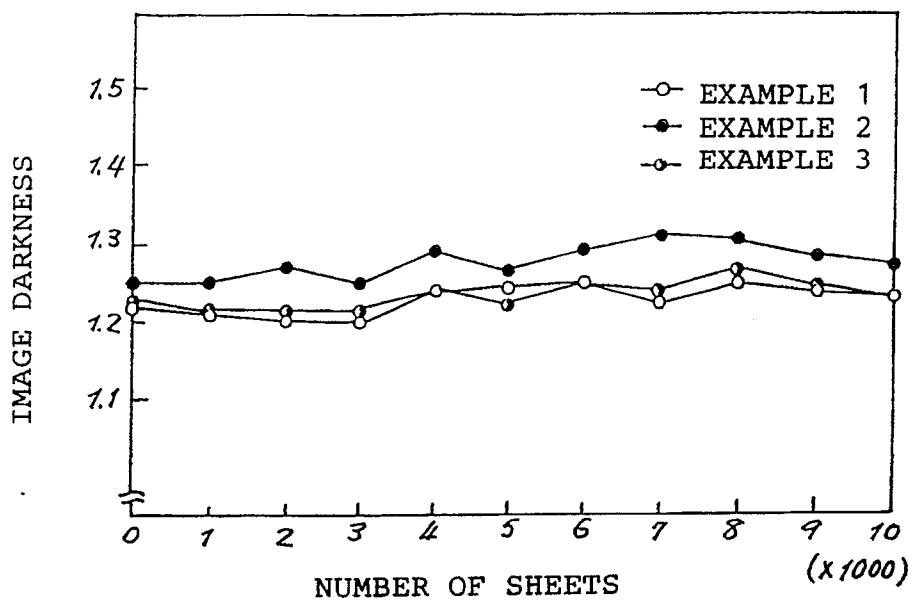


FIG. 2

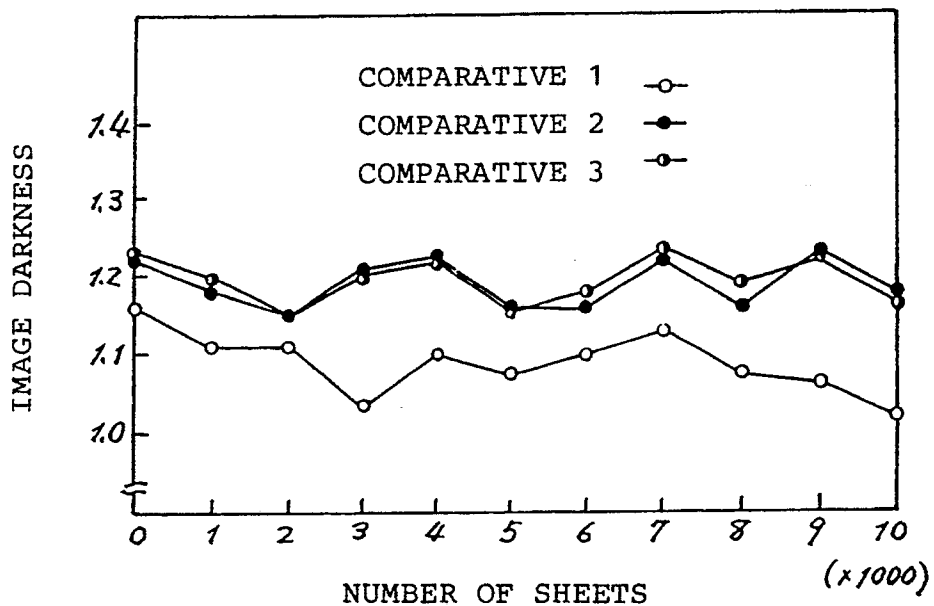


FIG. 3

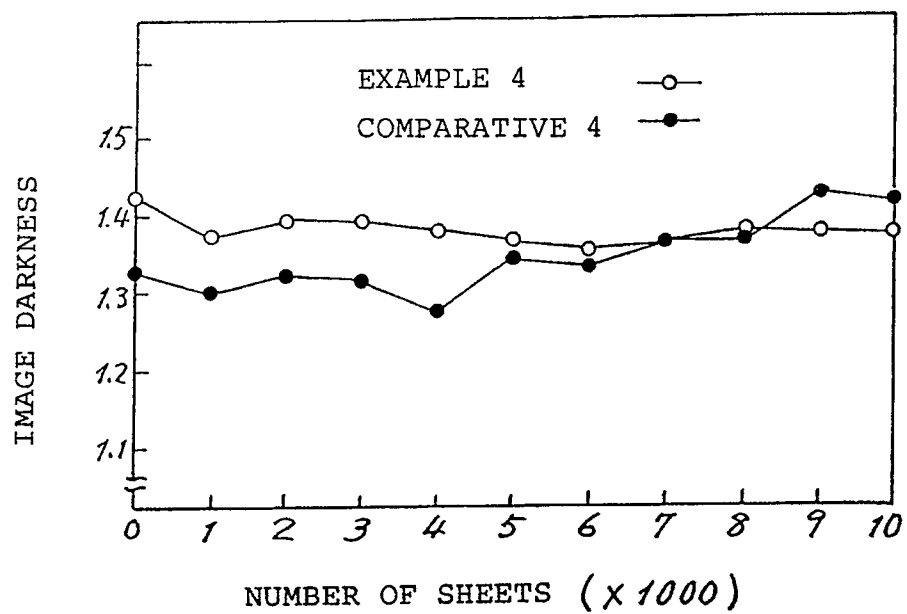


FIG. 4

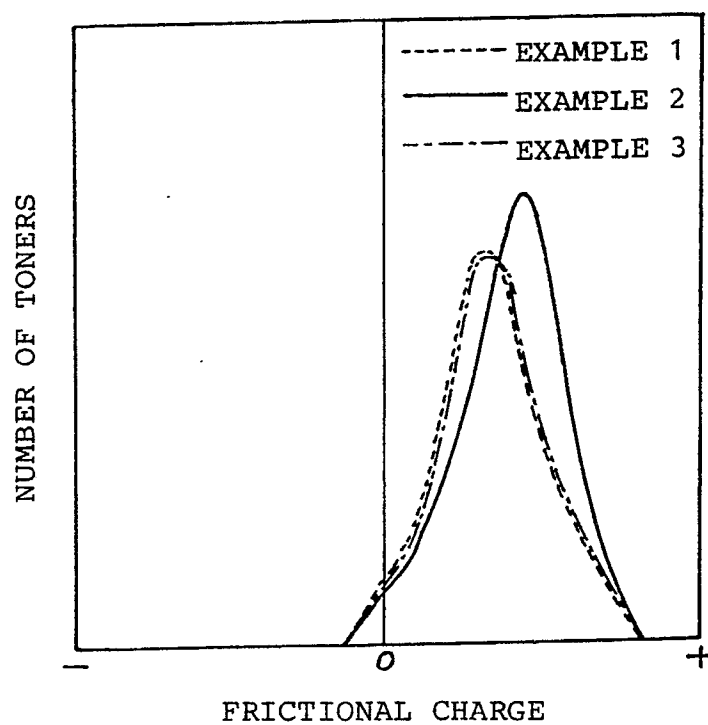


FIG. 5

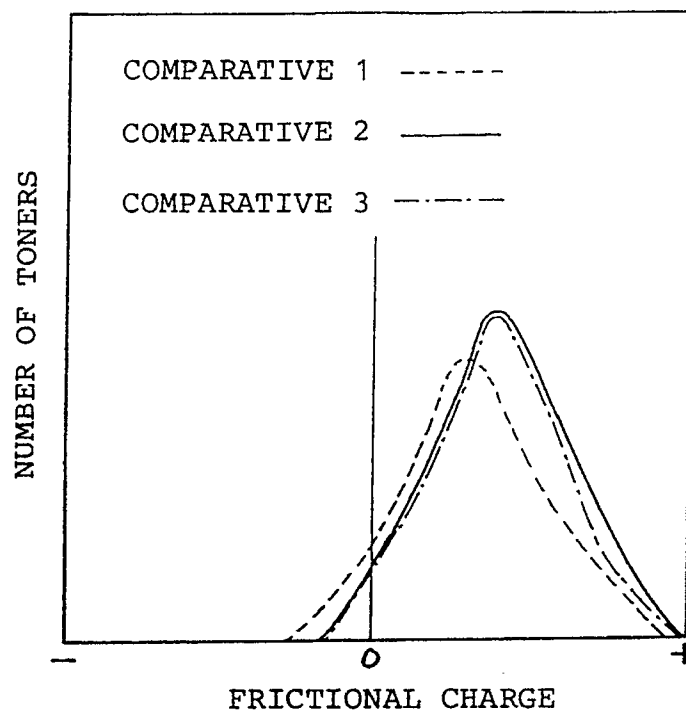


FIG. 6

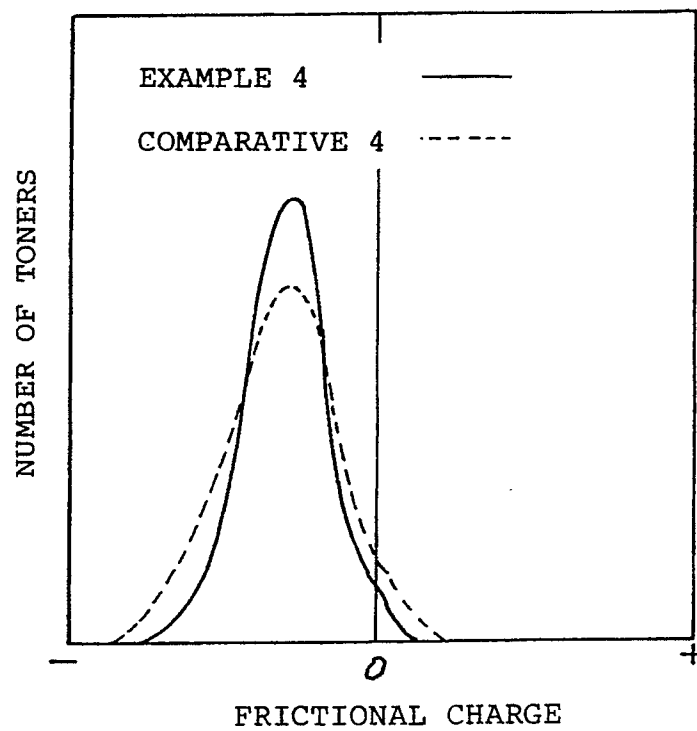


FIG. 7

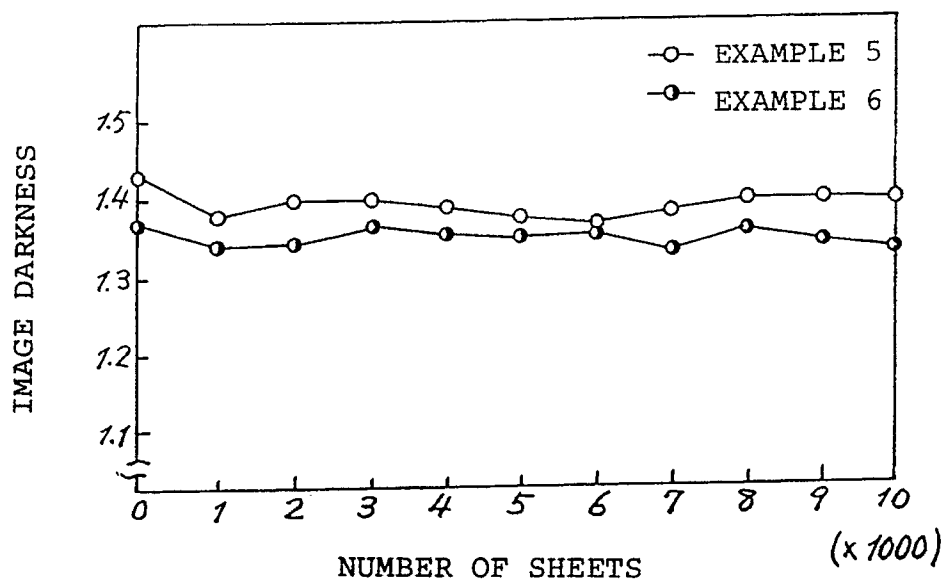


FIG. 8

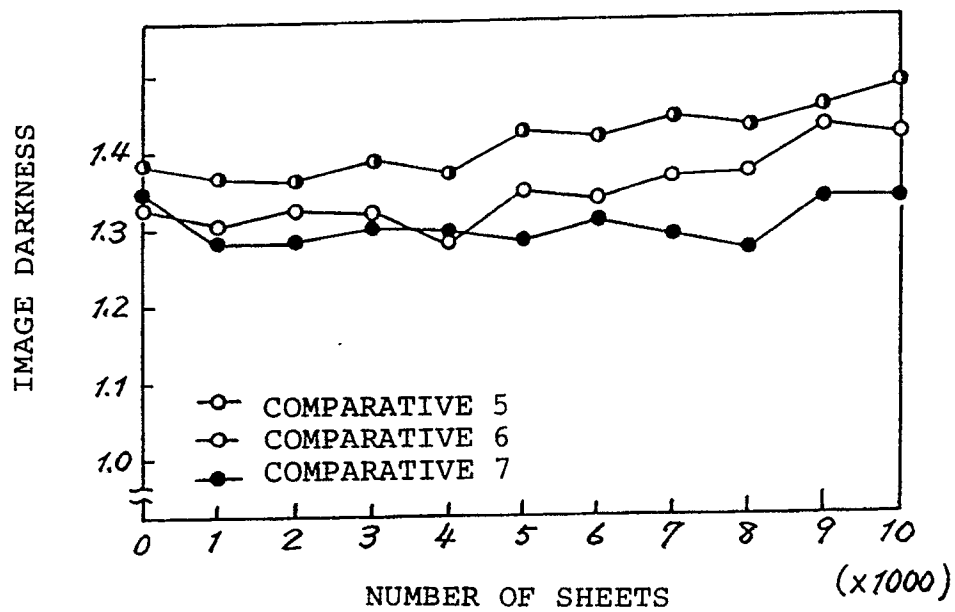


FIG. 9

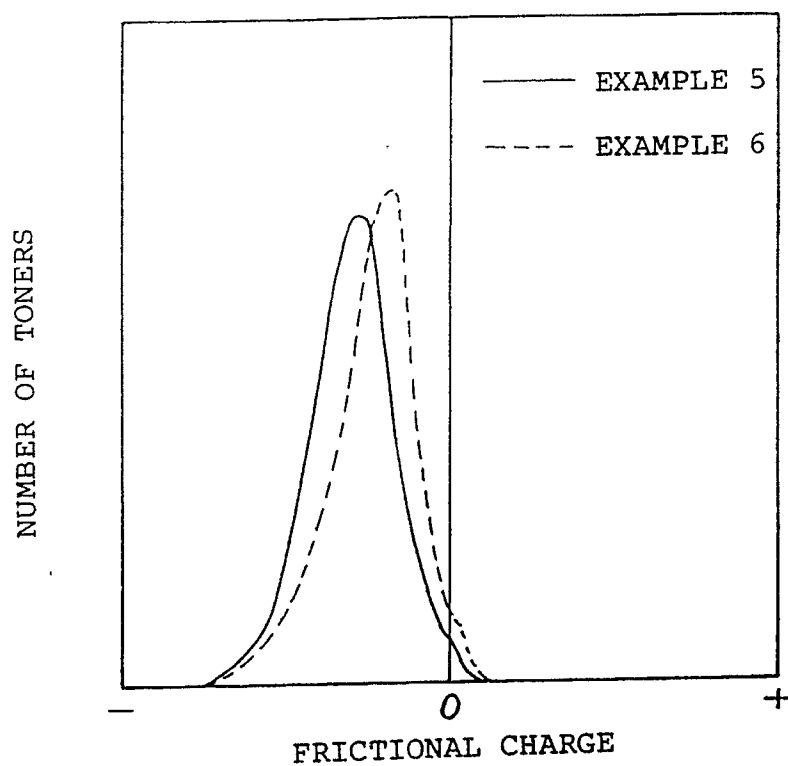


FIG. 10

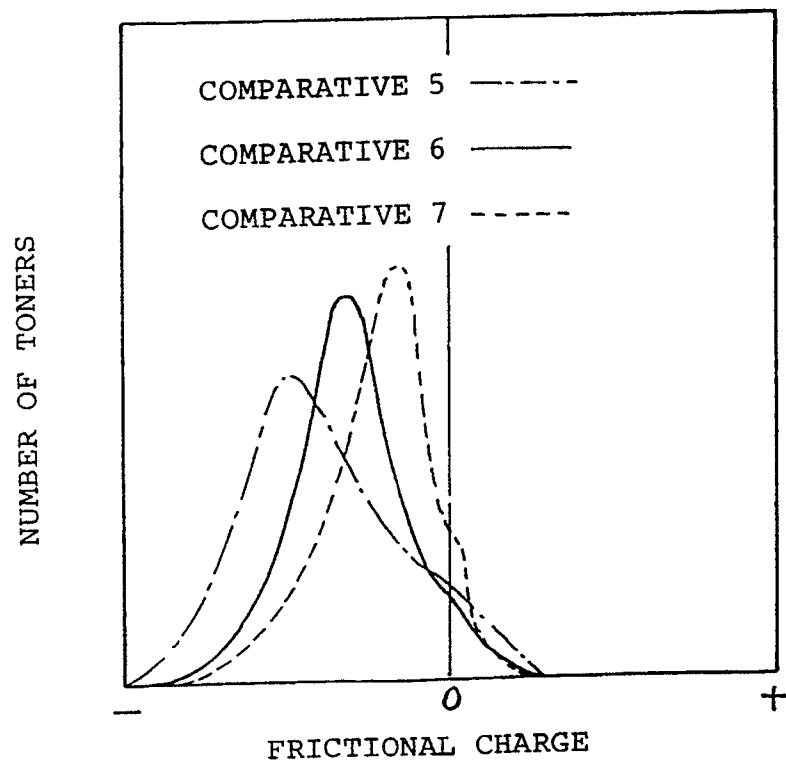


FIG. 11

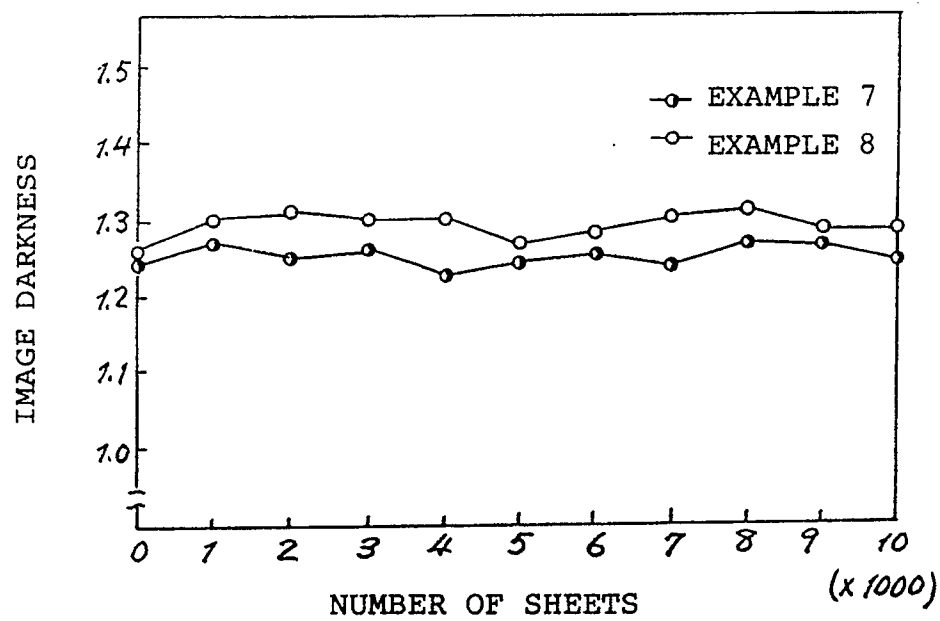


FIG. 12

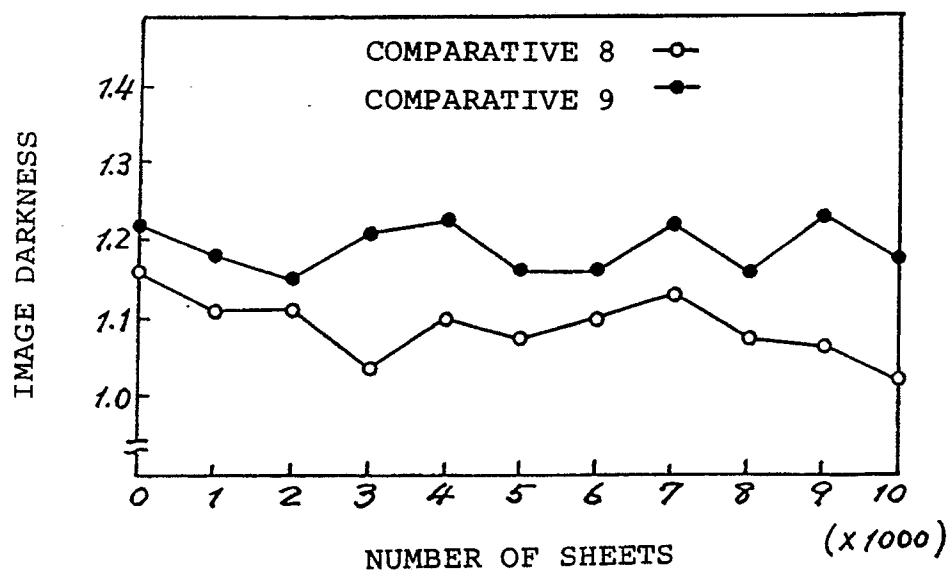


FIG. 13

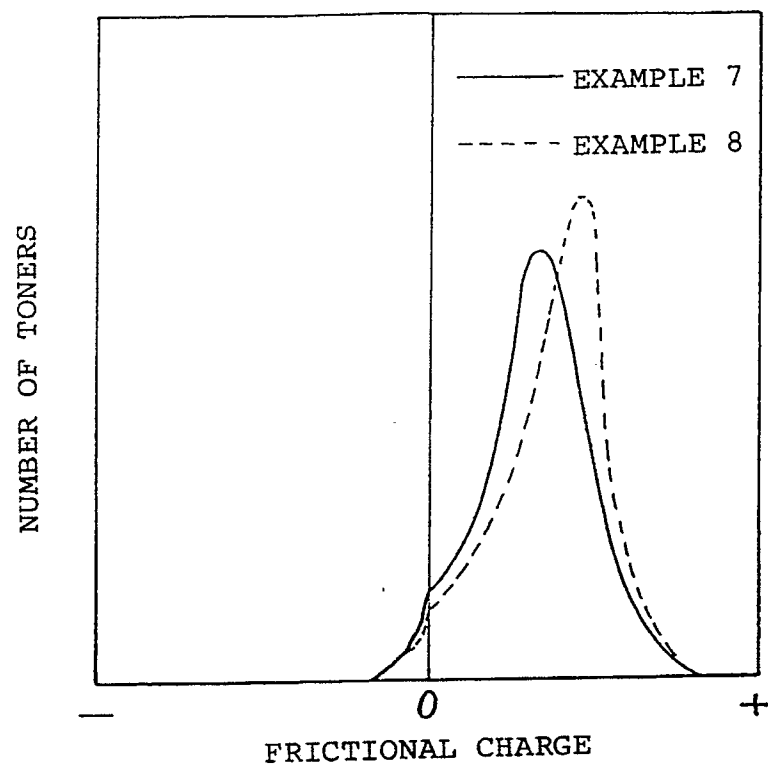
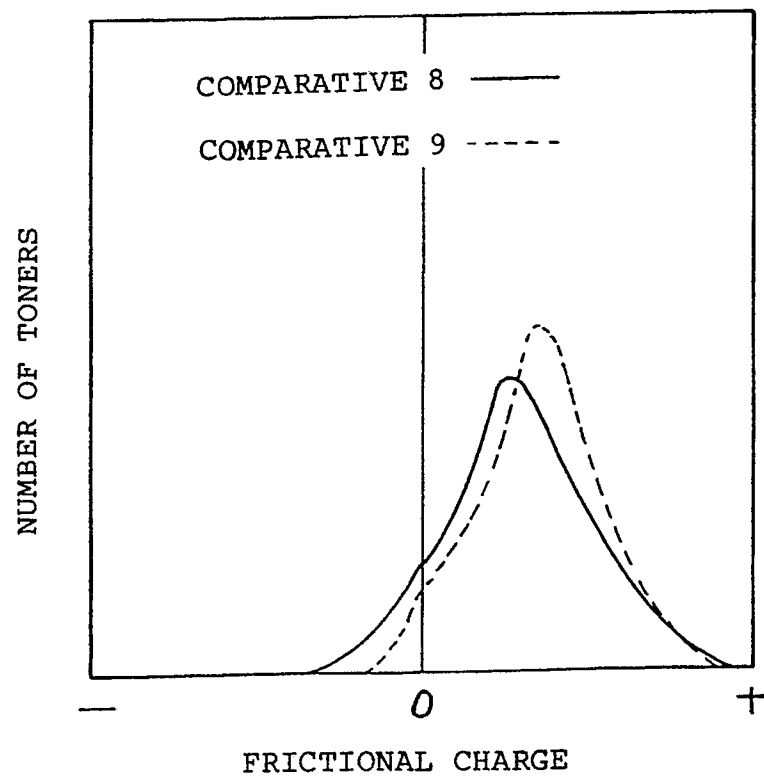


FIG. 14





European
Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 11 5131

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X,A	EP-A-0 298 173 (MITSUI TOATSU CHEMICALS INC.) * page 3, lines 11 - 57; claims 1-10 **examples * - - -	1,3,4-15	G 03 G 9/08
X	GB-A-2 005 692 (APECO CO.) * claims 1-18 * - - -	1-4	
A	DE-A-1 522 628 (B. F. W. VON GRABE) * claims 1-4 * - - -	1	
D,X	PATENT ABSTRACTS OF JAPAN vol. 10, no. 358 (P-522)(2415) 02 December 1986, & JP-A-61 156054 (FUJITSU LTD.) 15 July 1986, * the whole document * - - -	1-3	
A	DE-A-2 908 565 (MINOLTA CAMERA K.K.) * claims 1-8 * - - - - -	4-15	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			G 03 G
The present search report has been drawn up for all claims			
Place of search		Date of completion of search	Examiner
The Hague		28 November 90	BATTISTIG M.L.A.
CATEGORY OF CITED DOCUMENTS E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons &: member of the same patent family, corresponding document X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention			