United States Patent

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[54] REVERSAL ELECTROSTATIC TONER COMPOSITION

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[58] **Field of Search** 252/62.1

[56] **References Cited**

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[57] **ABSTRACT**

A liquid developer composition for reversal toning of a latent electrostatic image which comprises a tone concentrate formed of finely divided pigment particles dispersed in a mixture of a polymeric binder, a high dielectric diluent and a phospholipid charge stabilizing material which is admixed with an aliphatic carrier liquid to provide the developer composition.

9 Claims, No Drawings

REVERSAL ELECTROSTATIC TONER COMPOSITION

This invention relates to an electrostatic reproduction process, and more particularly to a developer composition for use in the preparation of an image by electrostatic and xerographic technique.

A well known electrostatic imaging process, generally referred to as the Xerox process, is described in the Carlson Patent, No. 2,297,691, wherein an element carrying a photoconductive layer is given a blanket electrostatic charge under subdued light or in the dark, such as by ion transfer from a corona discharge. Thereafter, the photoconductive layer is exposed to light modified by an image, such as by projection of a photographic image. The illuminated areas of the charged photoconductive layer, corresponding to the non-imaged areas of the original, are rendered conductive whereby the illuminated areas are discharged to leave a latent electrostatic image on the photoconductive layer corresponding to the imaged portions of the original.

The resulting electrostatic image can then be developed, as by dusting with an electroscopic powder, such as a pigmented resinous powder carrying an opposite electrostatic charge whereby the pigmented powder is electrostatically attracted to the oppositely charged latent electrostatic image, as is described in U.S. Pats. Nos. 2,618,551, 2,788,288 or 2,940,934. Development can also be achieved by a liquid developing composition of the type described in U.S. Pats. Nos. 2,877,133, 2,891,911 and 2,907,674. In either case, the powder or pigment of the powder or liquid developer adheres to the electrostatically charged latent image. The resulting developed image can be used in a variety of ways. For example, it can be fixed to form the image directly on the photoconductive layer, or it can be transferred from the photoconductive layer to a copy sheet to be fixed on the copy sheet.

In the reproduction process described above, the latent electrostatic image carries an electrostatic charge which is opposite to the electrostatic charge carried by the pigment or toner particles. However, the process can be carried out where the pigment particles carry the same charge as the electrostatic charge forming the latent electrostatic image. Thus, when the latent electrostatic image and the toner particles of the developing composition carry the same electrostatic charge, the pigment particles are repulsed from the areas of the latent electrostatic image and are deposited on the illuminated areas which have been discharged or at least have a much lower electric potential than the electrostatically charged areas of the photoconductive layer.

This method of imaging is known to those skilled in the art as reversal toning, and is useful, for example, in preparing a positive copy from a negative original (e.g. a microfilm). Reversal toners heretofore known in the art have generally lacked stability in that it has been difficult to maintain the pigment particles suspended in a carrier liquid in the case of liquid toner compositions. In addition, such toner compositions have further disadvantages in that they do not achieve permanent fixation or anchoring of the pigment particles to the copy sheet, with the result that the developed copy is susceptible to smearing, smudging and the like.

It is accordingly an object of the present invention to provide a liquid developer composition for reversal toning of a latent electrostatic image which is characterized by improved stability and a long shelf life.

It is another object of the present invention to provide a new and improved liquid developer composition for reversal toning of latent electrostatic images wherein the toner or pigment particles become permanently fixed to the copy to provide good, readable copy which is essentially smudge free.

It is yet another object of the present invention to provide a developing composition and process for using the same for reversal toning of latent electrostatic images wherein additional processing steps are not required to fix the toner or pigment particles deposited during developing of the image; in which the image becomes fixed during developing; and, in which the developer is otherwise the same as compositions heretofore employed from the standpoint of characteristics and use so as to enable application in a conventional manner without the necessity for changes in equipment, procedure and processing steps.

The concepts of the present invention reside in a liquid developing composition for reversal toning of a latent electrostatic image which comprises a toner concentrate formed of finely divided pigment or toner particles dispersed in a mixture of a polymeric binder, a high dielectric diluent and a charge stabilizing material in the form of a phospholipid, which can be admixed with a carrier liquid to provide a liquid developer composition. It has been found that reversal toning can be achieved with the foregoing developer composition to provide clear, readable copy which is essentially smudge free.

The toner particles may be selected from a wide variety of pigment particles which carry an electrostatic charge which has the same polarity as the charge forming the latent electrostatic image. Suitable organic or inorganic materials are described in the Carlson Pat., No. 2,297,691, and include materials, such as talcum powder, aluminum bronze, carbon dust and the like depending upon the polarity of the latent electrostatic image. It is generally preferred to make use of a powdered dyestuff, such as nigrosine, or a carbon material, such as carbon black, lamp black, channel black and the like. In accordance with the practice of the present invention, the pigment or toner particles are present in the toner concentrate in an amount within the range of 1–10 percent, and in the developer composition in an amount within the range of 0.001–.010 percent by weight.

In accordance with a preferred embodiment of the present invention, the pigment particles can be incorporated in the toner concentrate in the form of a carbon black rubber base dispersion which contains pigment particles, such as carbon black, a rubber base resin component and a high-boiling solvent component. Preferred dispersions are those in which the rubber base resin component comprises at least in part a cyclized rubber base dispersion. It has been found that rubber base dispersions containing cyclized rubber resin are especially effective in the practice of the present invention in that it is believed, without limiting the invention as to theory, that the cyclized rubber resin component operates to form a thin film on the copy to thereby firmly anchor the pigment particles to the imaged portion of the copy. For this purpose, use can be made of a rubber dispersed carbon black identified as W-545, manufactured by the Chemetron Corporation. This ink dispersion contains 30 percent by weight carbon black, and about 23 percent by weight by weight cyclized rubber resin and about 47 percent by weight of a high-boiling solvent component. When the pigment particles are used in this form, it is generally desirable to employ one of the foregoing rubber base dispersion compositions in the toner concentrate in an amount within the range of 5–30 percent by weight of the toner concentrate so that the toner concentrate contains between 1–20 percent by weight carbon black, between 1–15 percent by weight rubber base resin and between 5–15 percent by weight of the solvent component. In the developer composition, the carbon black generally constitutes between 0.001–0.020 percent by weight, the cyclized rubber resin is present within the range of 0.001–0.015 percent by weight and the solvent is initially present in the range of 0.005–0.015 percent by weight.

A wide variety of polymeric binders may be used in accordance with the practice of the present invention. Best results can be achieved when the polymeric binder component is a heat reactive hydrocarbon resin, such as LX-1000 which are cyclopentadiene type resins prepared from petroleum fractions boiling between 100° and 300°C. These resins are predominantly cyclic in character, and are marketed by the Neville Corporation. Without limiting the invention as to theory, it is believed that the binder component serves to at least in part fix the pigment particles to the copy sheet on drying of the carrier by providing a thin film on the copy. The amount of the binder present in the toner concentrate and the developing composition is not critical and can be varied within

wide ranges. Best results are achieved when the toner concentrate is formulated 5–40 percent by weight of the binder, and the developing composition is formulated to include 0.005–0.040 percent by weight of the polymeric binder.

The toner concentrate of the present invention is preferably formulated to include a diluent which has a high volume resistivity, such as a volume resistivity in excess of 10^5 ohms-cm. It is believed that the diluent component serves at least in part to maintain the pigment particles dispersed throughout the toner concentrate and the developing composition when the toner concentrate is admixed with a carrier system. For this purpose, use can be made of paraffinic hydrocarbons, and more particularly paraffinic oils and/or aromatic hydrocarbons, such as xylene, toluene, benzene, etc. According to the preferred practice of the present invention, the toner concentrate is formulated to include both a paraffinic oil and an aromatic hydrocarbon. It is believed that the use of both of these materials is advantageous from the standpoint that the paraffinic oil adds to the viscosity of the toner concentrate to thereby further insure that the pigment particles will remain in dispersion, and the aromatic diluent serves as a partial solvent for the binder component. Most of the binders discussed above are relatively insoluble in aliphatic hydrocarbons and hence the aromatic diluent serves to provide an initial solution containing the aromatic hydrocarbon and the binder polymer.

The toner concentrate is preferably formulated to include 10–80 percent by weight of the diluent when one or the other of the aforementioned paraffinic hydrocarbons and aromatic hydrocarbons is used. However, when a mixture of both a paraffinic hydrocarbon and an aromatic hydrocarbon are used in accordance with the preferred practice of the invention, the paraffinic hydrocarbon is present in an amount within the range of about 5–40 percent by weight and the aromatic is present in an amount of 20–45 percent by weight of the toner concentrate. By the same token, when only a single diluent component is employed in the final developing composition, the diluent is present in an amount within the range of 0.1–0.8 percent by weight in the toner concentrate, whereas, when a mixture of paraffinic oil and aromatic hydrocarbon is employed, the developing composition contains about 0.005–0.040 percent by weight of the paraffinic hydrocarbon and 0.02–0.045 percent by weight of the aromatic hydrocarbon diluent.

The developing composition of the present invention is also formulated to include a charge stabilizing material to negatively charge the toner particles and to aid in the prevention of dissipation of the electrostatic charge forming the latent image during development of the latent image. For this purpose use can be made of various phospholipids, although it has been found that best results are usually obtained with lecithin.

As used herein, the term "lecithin" in intended to mean and refer to the alpha and beta isomers of phosphatidyl cholines and mixtures thereof, as well as mixtures of one or more of the phosphatidyl cholines with one or more of phosphatidyl ethanolamines, phosphatidyl L-serines and/or phosphatidyl inositols. Various lecithins are commercially available, and include mixtures of the foregoing materials. One such material which has been found to be particularly suitable in the preferred practice of the present invention, is Lecithin 5F-UB which is marketed by the Central Soya Company. The phospholipid charge stabilizing material is generally present in the toner concentrate in an amount within the range of 1–10 percent by weight, and in an amount within the range of 0.001–0.010 percent by weight of the developer composition when the toner concentrate is admixed with a compatible carrier system.

The compatible carrier system for use in admixture with the toner concentrate described above to provide the liquid developing composition generally comprises an aliphatic solvent which will not attack the binder component present in the photoconductive coating. Aliphatic solvents used for this purpose preferably have a high volume resistivity in excess of 10^{10} ohms-cm so as to avoid dissipation of the charge in the electrostatic image, and at the same time serve to avoid attack on the binder component on the photoconductive coating as indicated above. Aliphatic solvents marketed by the Humble Oil and Refining Company have been found to be useful for this purpose and include Isopar H with a flash point of 123° F., and Isopar G with a flash point of 104° F. Both of these solvents have a KB value of about 27, and a low odor level.

Both the carrier and the toner concentrate are completely compatible one with the other in any desirable ratio to provide the liquid developing composition whereby the toner concentrate in the liquid developing composition can easily be increased or varied to raise the color concentration by the addition of toner concentrate, or to lower the concentration by the addition of the carrier in order to maintain the optimum toner concentration. Such additions of concentrate and carrier can be effected without noticeable change in the viscosity of the developer liquid to provide high loading in the developer.

As a result, as the toner content is thereby dispersed during use of the developing composition by high speed development of latent electrostatic images, the optimum concentration of the pigment particles in the liquid developer composition can be maintained by measured or substantially continuous additions of concentrate. By the same token, loss of diluent by reason of slow or low rate of development can be compensated for without an undesirable increase in the concentration of toner by additions of the carrier liquid.

Accordingly, the ratio of toner concentrate to carrier liquid used in forming a developing composition can be varied within wide ranges. It has been found, however, that best results can be achieved when the toner concentrate is added to the carrier liquid in an amount corresponding to between 0.5–10 parts per volume of toner concentrate to between 1,000 parts per volume of the aliphatic carrier.

Having described the principal concepts of the present invention, reference is now made to the following examples, which are provided by way of illustration, and not by way of limitation, of specific embodiments of the invention.

EXAMPLE 1

A toner concentrate is prepared by admixing 30 g. of a hydrocarbon resin (LX-1000) with 30 g. of a paraffinic oil (Stanoline 11 from Standard Oil Co.) and 60 g. of xylene, and placing the resulting solution in a blender. Thereafter, 8.0 g. of carbon black and 5 g. of lecithin (Lecithin 5F-UB from Central Soya Co.) are added, and the mixture is blended for about 10 minutes to provide the following toner concentrate:

Resinous binder (LX–1000)	30.0 parts by wt.
Paraffin oil	30.0 parts by wt.
Xylene	60.0 parts by wt.
Carbon black	8.0 parts by wt.
Lecithin	5.0 parts by wt.

The liquid developer composition can be formed from the foregoing toner concentrate by admixing the toner concentrate with an aliphatic solvent (e.g. Isopar G) in a ratio of about 0.5 to 10 parts by volume of concentrate per 1,000 parts by volume of aliphatic solvent to provide a developer composition containing between 0.001 to 0.010 percent by weight pigment particles.

EXAMPLE 2

A toner concentrate is prepared by mixing 5.0 g. of a heat reactive hydrocarbon resin (LX-1000), 24.0 g. of paraffin oil (Stanoline 11) and 42.0 g. of xylene. The resulting solution is stirred, and placed in a blender. Thereafter, 5.0 g. of lecithin (Lecithin 5F-UB) and 24.0 g. of a rubber based dispersion (Chemetron W545) having the following composition are added:

Carbon black	30% by weight
Cyclized rubber resin	23% by weight
Solvent	47% by weight

The resulting mixture is blended for about 10 minutes to insure a complete dispersion of the pigment particles. The resulting toner concentrate has the following composition.

Resin(LX-1000)	5% by weight
Paraffin oil	24% by weight
Xylene	42% by weight
Carbon black	7.2% by weight
Resin	5.5% by weight
Solvent	11.3% by weight
Lecithin	5.0% by weight

EXAMPLE 3

A liquid developing composition for reversal toning is prepared by admixing the toner concentrate of Example 2 with an aliphatic solvent to provide the following composition.

Toner concentrate	3.2 cc.
Aliphatic solvent (Isopar G)	1000.0 cc.

In use, the copy sheet containing the latent electrostatic image is wetted with the liquid developing composition by immersion of the sheet in a bath of the developing composition or a flow-coating of the composition over the copy surface of the application of the liquid developing composition onto the surface of the copy sheet by a roller coater. The copy sheet which is wet with developing composition is then advanced through squeeze rollers in order to remove the excess liquid. The toner particles, which carry an electrostatic charge which carries the same polarity as the charge forming the electrostatic image, are repulsed by the latent electrostatic image and are deposited on the discharged portions of the imaged copy sheet for visual development of the image on the copy by reverse toning. After development, the copy is allowed to dry by evaporation of the liquid with or without the application of heat. The aliphatic solvent evaporates from the sheet to thereby reduce the binder to a tackified or adhesive stage whereby the deposited toner particles become bonded to the coating so as to be permanently fixed on the copy sheet upon complete drying of the copy sheet.

It will be apparent that I have provided a new and improved liquid developing composition for reversal toning of latent electrostatic images which is capable of providing good readably copy which is essentially smudge free. The developing composition of the present invention enjoys a stabilizer which is far superior to reversal toning compositions heretofore known.

It will be understood that various changes may be made in the details of formulation, procedure and use without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. A toner composition for reversal toning of a latent electrostatic image wherein the toner is attracted to the background area and repelled by the latent electrostatic image, comprising pigment particles, a binder in the form of a heat reactive cyclopentadiene hydrocarbon resin, a charge stabilizer in the form of a phospholipid, and an organic diluent having a volume resistivity in excess of 10^5 ohm-cm.

2. A composition as defined in claim 1 wherein the composition is in the form of a concentrate for admixture with additional amounts of diluent and contains 5–40 percent by weight of the binder, 1–10 percent by weight of the pigment particles, 1–10 percent by weight of the phospholipid and 10–80 percent by weight of the diluent.

3. A composition as defined in claim 1 wherein said pigment particles are provided in the form of a dispersed rubber ink whereby said composition also contains a cyclized rubber resin.

4. A composition as defined in claim 1 wherein said pigment particles are carbon black.

5. A composition as defined in claim 1 wherein said diluent is selected from the group consisting of paraffinic hydrocarbons, aromatic hydrocarbons and mixtures thereof.

6. A composition as defined in claim 1 wherein said diluent is a mixture of a paraffinic hydrocarbon oil and an aromatic hydrocarbon.

7. A composition as defined in claim 1 wherein said phospholipid is lecithin.

8. A composition as defined in claim 1 wherein said phospholipid is selected from the group consisting of phosphatidyl cholines and mixtures of phosphatidyl cholines with one or more materials selected from the group consisting of phosphatidyl ethanolamines, phosphatidyl L-serines and phosphatidyl inositols.

9. A toner composition for reversal toning of a latent electrostatic image wherein the toner is attracted to the background areas and repelled by the image areas of the latent electrostatic image, comprising 0.001–0.01 percent by weight of pigment particles, 0.005–0.04 percent by weight of a binder in the form of a heat reactive cyclopentadiene hydrocarbon resin, 0.001–0.01 percent by weight of a charge stabilizer in the form of a phospholipid, with the balance of the composition being an organic diluent having a volume resistivity in excess of 10^5 ohm-cm.

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