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Goffe

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[54] **IMAGING SYSTEM**

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[73] Assignee: **Xerox Corporation,** Rochester, N.Y.

[22] Filed: **Dec. 31, 1969**

[21] Appl. No.: **889,457**

Related U.S. Application Data

[63] Continuation-in-part of Ser. Nos. 837,780, June 30, 1969, and Ser. No. 460,377, June 1, 1965, , and Ser. No. 483,675, Aug. 30, 1965, Pat. No. 3,656,990, and Ser. No. 695,074, Jan. 2, 1968, Pat. No. 3,542,545, said Ser. No. 837,780, is a continuation-in-part of Ser. No. 725,676, May 1, 1968, abandoned, and Ser. No. 460,377, June 1, 1965, Pat. No. 3,520,681, and Ser. No. 483,675, Aug. 30, 1965, Pat. No. 3,656,990, said Ser. No. 725,676, is a continuation-in-part of Ser. No. 460,377, June 1, 1965, Pat. No. 3,520,681, and Ser. No. 483,675, Aug. 30, 1965, Pat. No. 3,656,990, and Ser. No. 403,002, Oct. 12, 1964, abandoned, said Ser. No. 460,377, is a continuation-in-part of Ser. No. 403,002, Oct. 12, 1964, abandoned, said Ser. No. 483,675, is a continuation-in-part of Ser. No. 403,002, Oct. 12, 1964, abandoned, said Ser. No. 695,074, is a continuation-in-part of Ser. No. 520,434, Jan. 13, 1966, abandoned.

[52] **U.S. Cl.** ..... **96/1 R,** 96/1.1, 96/1.4, 117/17.5

[51] **Int. Cl.** **G03g 13/22**

[58] **Field of Search** 96/1, 1.4, 1.5; 117/17.5

[56] **References Cited**

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[57] **ABSTRACT**

An imaging system wherein an imaged migration imaging member, this member typically having a substrate, a softenable layer, and migration marking material with some of the marking material migrated toward the substrate or disrupted in an image-wise configuration, is provided and the member is electrically charged to produce an electrostatic latent image on the member.

29 Claims, 5 Drawing Figures

FIG. 1

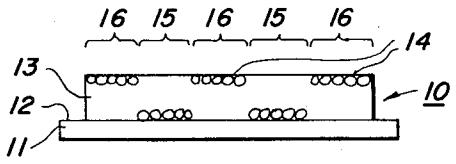


FIG. 2

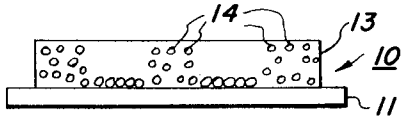


FIG. 3A

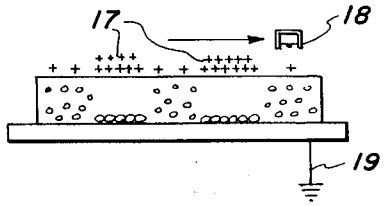
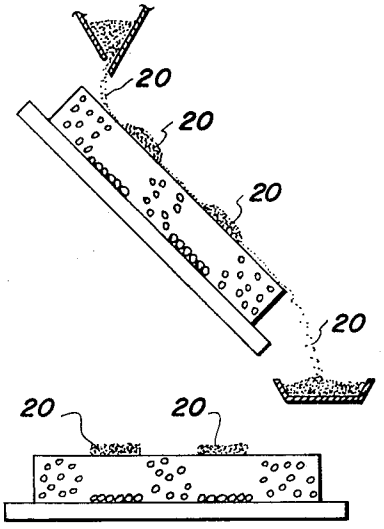


FIG. 3B

FIG. 3C



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IMAGING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of copending applications Ser. No. 837,780, filed June 30, 1969; Ser. No. 460,377, filed June 1, 1965, now U.S. Pat. No. 3,520,681; Ser. No. 483,675, filed Aug. 30, 1965, now U.S. Pat. No. 3,656,990; and Ser. No. 695,074, filed Jan. 2, 1968, now U.S. Pat. No. 3,542,545.

Application 837,780 is a continuation-in-part of my copending U.S. Patent applications (1) Ser. No. 725,676, filed May 1, 1968, now abandoned; (2) Ser. No. 460,377, filed June 1, 1965, Now U.S. Pat. No. 3,520,681, and (3) Serial No. 483,675, filed Aug. 30, 1965, now U.S. Pat. No. 3,656,990; application (1) being a continuation-in-part of (2) and (3)and application Ser. No. 403,002, filed Oct. 12, 1964 (403,002 pending when application (1) was filed but which is now abandoned); (2) and (3) both being continuations-in-part of 403,002. Application 695,074 is a continuation-in-part of application Ser. No. 520,423, filed Jan. 13, 1966, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to the production and development of electrostatic latent images on novel image support members. The image support members in the inventive system are typically produced by a migration imaging system.

Quite recently, a migration imaging system capable of producing high quality images of high density, continuous tone, and high resolution has been developed. Such migration imaging systems are disclosed in the copending applications cited above. In a typical embodiment of the new migration imaging system and imaging member comprising a substrate, a layer of softenable material and photosensitive marking material, is latently imaged by electrically charging the member and exposing the charged member to a pattern of any suitable activating electromagnetic radiation such as light. Where the photosensitive marking material was originally in the form of a fracturable layer at the upper surface of the softenable layer, the marking particles in the exposed areas of the member migrate toward the substrate when the member is developed by softening the softenable layer.

"Softenable" as used herein is intended to mean any material which can be rendered more permeable thereby enabling particles to migrate through its bulk. Conventionally, changing permeability is accomplished by heat or solvent softening. "Fracturable" layer or material as used herein, means any layer or material which is capable of breaking up during development, thereby permitting portions of said layer to migrate toward the substrate or to be otherwise removed. The fracturable layer may be particulate, semi-continuous, or continuous in various embodiments of the migration imaging members.

There are various other systems for forming such images, wherein non-photosensitive or inert, marking materials are arranged in the aforementioned fracturable layers, or dispersed throughout the softenable layer, as described in the aforementioned copending applications which also disclose a variety of methods which may be used to form latent images upon such migration imaging members.

Likewise, various means for developing latent images in the novel migration imaging system are known. Typical development means include solvent wash-away; solvent vapor softening, heat softening and combinations of these methods. In the solvent wash-away method, the layer of softenable material is typically substantially washed away, leaving behind an image pattern of migrated marking material on the substrate. In the heat or vapor softening modes, the softenable layer is softened to allow migration of marking material toward the substrate, and the developed imaged member comprises the substrate having migrated marking particles near the softenable layer-substrate interface, with the softenable layer and unmigrated marking materials intact on the substrate in substantially their original condition.

To this time the most successful commercial electrostatographic imaging process has been xerography. Xerography was first described in Carlson U.S. Pat. No. 2,297,691. The xerographic process is typically performed on a xerographic plate comprising a layer of photoconductive insulating material upon a conductive backing. The surface of the plate is uniformly electrically charged and then exposed to a pattern of activating electromagnetic radiation, typically a light-and-shadow image pattern. The photoconductive plate discharges in the exposed areas proportionally to the intensity of the radiation reaching said exposed areas, thereby creating an electrostatic latent image on the surface of the photoconductive layer corresponding to the image pattern projected upon the plate. The electrostatic latent image is then developed by contact with an electroscopic marking material called toner. The electrostatic latent image which has been developed by contact with toner is then referred to as the toner image or developed image. This developed image may be fixed on the xerographic plate itself, or it may be transferred to paper or other backing material, and the transferred image may be fixed on the new backing material.

In new and growing areas of technology such as migration imaging systems suitable for use in the present invention, new methods, apparatus, compositions of matter, and articles of manufacture continue to be discovered for the application of the new technology in a new mode. The present invention relates to a new and advantageous imaging system wherein electrostatic images are produced and used.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to provide a novel imaging system.

It is another object of this invention to provide a novel system for providing an electrostatic latent image.

It is yet another object of this invention to provide a new electrostatic latent image support surface.

It is another object of this invention to provide a novel electrostatographic imaging master.

It is still another object of this invention to provide a novel xerographic imaging system.

The foregoing objects and others are accomplished in accordance with this invention by providing an imaged migration imaging member and producing an electrostatic latent image thereon by electrically charging the imaged migration imaging member.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention as well as other objects and further features thereof reference is made to the following detailed disclosure of the preferred embodiments of the invention taken in conjunction with the accompanying drawings thereof, wherein:

FIG. 1 shows a partially schematic, cross-sectional view of a developed, imaged, layered configuration migration imaging member.

FIG. 2 shows a partially schematic, cross-sectional view of a developed, imaged, binder-structured migration imaging member.

FIG. 3 illustrates in partially schematic, cross-sectional view, the process steps in a preferred embodiment of the advantageous system of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the novel and advantageous imaging system of the present invention an electrostatic latent image is typically produced on an electrostatic latent imaging support surface which comprises the surface of a member already having an image therein. Although the novel image support surfaces of the present invention may be produced by any means suitable for producing the desired end product, electrostatic latent image support surfaces particularly preferred for use in the inventive system are produced by the migration imaging systems described in copending applications Ser. No. 837,780, filed June 30, 1969, and Ser. No. 837,591, filed June 30, 1969. Those two copending applications describe in great detail methods of producing developed, imaged, migration imaging members suitable for use in the advantageous system of the present invention, and all of the disclosure therein and especially the disclosure relating to such imaging processes, imaging members and the materials suitable for use in the migration imaging members used therein, which are now known to be suitable for use in the process of the present invention, is hereby expressly incorporated by reference in the present specification.

Migration developed, imaged, migration imaging members such as those produced by the aforementioned systems, are illustrated in FIGS. 1 and 2. In the imaged member 10, illustrated in FIG. 1, the member 10 comprises substrate 11 having a layer of softenable material 13 coated thereon, and the layer of softenable material 13 has a fracturable layer of migration marking material 14 contiguous the upper surface of the softenable layer 13. In the imaged member illustrated here, the migration marking material 14 in migrated areas 15 is shown near the softenable layer-substrate interface in migrated imagewise configuration. As mentioned earlier herein, such developed, imaged, migration imaging members are typically produced when latently imaged members are developed by heat or vapor softening in the migration imaging process.

Still another embodiment of imaged migration imaging members suitable for use in the present invention is described in copending application Ser. No. 695,074, filed Jan. 2, 1968, now U.S. Pat. No. 3,542,545. In the imaging system disclosed therein, layered configuration migration imaging members having a fracturable layer of migration marking material contiguous the surface of the softenable layer, as described previously above, are imaged by a system wherein the surface of said imaging members is imagewise deformed, and/or the fracturable layer of marking material is imagewise disrupted whereby particles of the migration marking material from the fracturable layer laterally relocate at the surface of the softenable layer, thereby changing the density of migration marking material in the imaged areas of the imaged member. In such imaged members, migration in depth in the softenable layer has not necessarily taken place. For the purpose of adequately describing imaged members having such deformed or disrupted surface layers, as well as for setting forth the best mode of providing such imaged members in the system of the present invention, the entire disclosure of copending application Ser. No. 695,074 is hereby expressly incorporated by reference. In the present application, "fracturable layer" includes layers of fracturable material wherein the migration marking material is capable of being laterally relocated or mechanically deformed as described in copending application Ser. No. 695,074, as well as fracturable layers suitable for use in the migration imaging systems previously described.

In various embodiments, the supporting substrate 11 may be either electrically insulating or electrically conductive. In other embodiments an electrically conductive substrate 11 may comprise a supporting substrate 11 having a conductive coating 12 coated onto the surface of the supporting substrate upon which the softenable layer 13 is also coated. The substrate may be opaque, translucent, or transparent, in various embodiments, including embodiments wherein the electrically conductive layer 12 coated thereon may itself be partially or substantially transparent. The fracturable layer of marking material 14 contiguous the upper surface of softenable layer 13 may be coated onto, or slightly, partially, or substantially embedded in softenable material 13 at the upper surface of the softenable layer.

Electrostatic latent image support surfaces in flat rigid plate configurations and in drum configurations are the most widely used in commercial electrostatographic processing. However, electrostatic latent image support surfaces may take any suitable form including a web, foil, laminate or the like, metallic strip, sheet, coil, cylinder, drum, endless belt, endless moebius strip, circular disk or other shape.

In FIG. 2 the migration imaging member 10 also comprises supporting substrate 11 having softenable material layer 13 coated thereon. However, here the migration marking material 14 is initially dispersed throughout softenable layer 13 in a binder-structured configuration. As in the layered configuration embodiment, the substrate may be opaque, translucent, or transparent, electrically insulating or electrically conductive.

In various embodiments of the migration imaging system discussed above, the image of marking particles which migrate toward the substrate may be either a positive image of a positive original or a negative image of a positive original, depending upon the specific materials and image parameters used in the imaging system.

As described in the incorporated disclosures, particles of the migration marking material suitable for use in the present invention are preferably of average size not greater than about 2 microns. Submicron size particles give an even more satisfactory result, with an optimum range of particle size comprising particles of average size not greater than about 0.7 microns. When the migration marking material is arranged in a fracturable layer contiguous the surface of the softenable material spaced apart from the substrate, such fracturable layers are preferably in the range of about 0.01 to about 2.0 microns in thickness, although fracturable layers of thicknesses of about 5 microns have been found to give good results in various embodiments.

Similarly, the layer of softenable material **13** may comprise any suitable softenable material as disclosed in the incorporated disclosures, and may variously be electrically photosensitive, photoconductive, photosensitively inert, substantially electrically insulating, electrically conductive, or have any other desired properties depending upon its specific use in various embodiments. The softenable layer is typically coated directly onto the substrate. However, in various embodiments, the softenable layer may have sufficient integrity to be self-supporting and may be brought into contact with a suitable substrate during the imaging process. The softenable layer may be one or more layers of any suitable thickness, with thicker layers generally requiring a greater electrostatic potential in various modes of the present migration imaging system. Such softenable layers are preferably of thicknesses in a range between about one-half micron and about 16 microns.

In FIG. **3** the process steps in a preferred embodiment of the advantageous system of the present invention are illustrated in conjunction with partially schematic, cross-sectional views of a developed, imaged, migration imaging member, (here like the one illustrated in FIG. **2**). Similarly, the developed, imaged member illustrated and described in conjunction with FIG. **1**, or any other suitable support surface, may be used in the inventive process. In FIG. **3A** the imaged migration imaging member which is used in the inventive process as a novel electrostatic latent image support surface, is shown being electrically charged **17** with corona charging device **18**, which deposits charged particles on the upper surface of the softenable layer **13** of the imaging member. It will be appreciated that where supporting substrate **11** is an electrically conductive substrate, the charging of the surface of the imaged member may be facilitated by grounding the substrate **11** as shown at **19**. Similarly, other charging methods as disclosed in the incorporated disclosures may be used to charge the support surface.

In various embodiments of the advantageous latent image support surface of the present invention, the migration marking material **14** which is typically either dispersed throughout the softenable layer **13** in a binder structured configuration, or is contiguous the upper surface of the softenable layer **13** in a layered configuration, may be any sort of material whose presence in the unmigrated areas **16** changes the charge receptivity and/or charge decay characteristics of the free surface of the softenable layer **13**. For example, in various embodiments, the marking material may be electrically photosensitive, photoconductive, photosensitively inert, magnetic, electrically conductive, electrically insulating, or any combination of materials having such characteristics are well as others, so long as the charge receptivity and/or charge decay of the imaging member structure is changed by the presence or absence of such material in various areas of the imaged member. For example, in areas where the marking material has not migrated toward the softenable layer-substrate interface, the charge receptivity and the charge decay characteristics of the softenable layer **13** and particularly the upper surface of said softenable material, will typically be changed so that there is a greater buildup of charge, i.e., greater surface potential, in those areas of the surface of the softenable layer **13** where the marking material has migrated toward the substrate. Conversely, in some embodiments in the areas where the marking material has not migrated toward the softenable layer-substrate interface, the charge receptivity and charge decay characteristics of the softenable layer will be changed so that there is a lesser build up of charge or lesser surface potential in the areas of the surface of the softenable layer where the marking material is migrated toward the substrate. This is schematically illustrated in FIG. **3A** as a greater concentration of charges in the migrated areas **15** as compared to the charge concentration on the surface in areas **16**. Positive charges **17** are shown in FIG. **3A** for purposes of illustration; however, it will be appreciated that charges of either polarity perform equally well in various embodiments of the advantageous system of the present invention.

Because the surface of the softenable layer **13** carries charges in different areas having different charge concentrations, or different surface potentials, and these areas of different surface potentials correspond to an image pattern, the surface of the charged, imaged, member is said to support an electrostatic latent image. The areas of different surface potentials which comprise the electrostatic latent image are illustrated at **15** and **16** in FIG. **3A**.

Although the migration imaged members illustrated in partially schematic views in FIGS. **1** and **2** show the migration marking material substantially completely migrated in areas **15**, in actual practice, various migrated areas **15** and unmigrated areas **16** may comprise areas wherein the migration marking material is more or less migrated than the material illustrated, and such areas having different degrees of migration have correspondingly different charge receptivity and/or charge decay characteristics which provide areas of different charge concentrations on the surface of such migration imaged members when used in the advantageous system of the present invention. In this way various half tones may be detected in the electrostatic latent images formed on the novel electrostatic latent image support surfaces of the present invention.

Any suitable charging voltage or surface potential may be used in electrically charging the advantageous electrostatic latent image supporting surface of the present invention. The only imitation on the magnitude of the charging potential is the practical one of putting a high voltage on an insulating layered structure. Lower charging potentials produce lower electric fields within the support surfaces, and such lower fields produce

lesser potential differences between the charges held in the various areas of the support surface where the migration marking material is migrated and unmigrated. Such lower charging potentials are particularly suitable in more sensitive systems using electrostatic latent images produced by the method of the present invention. However, somewhat higher charging voltages or surface potentials typically produced greater potential differences (voltage contrasts) between the various areas in the electrostatic latent image support surface. Preferred results are achieved in the present inventive system when the more charge receptive areas of said surface are charged to surface potentials which produce electrical fields within the imaging member in the range between about 60 volts per micron and about 300 volts per micron.

These preferred surface potentials have been found particularly suitable for charging the migration imaged members preferred for use in the inventive process, and the surface potentials in this range provide sufficient potential differences between areas of different potentials and the charges creating such potentials are sufficiently retained to provide excellent electrostatic latent images, suitable, for example, for development by a cascade of electroscopic xerographic toner. Where the structure of the novel electrostatic latent image support surface includes a non-conductive substrate, increasingly larger charging potentials would typically be used with substrates of increasing thickness. For example, charging potentials as high or higher than about 5,000 volts may be used satisfactorily with certain embodiments having thick insulating substrates.

Electrostatic latent images provided by the methods described herein may be used for a variety of purposes as described later herein. In various applications of such electrostatic latent images the strength of the electrical field within the latently imaged member may be as important as the surface potential across the specific area of the surface of the latently imaged member. For example, in the xerographic development of an electrostatic latent image, xerographic developing toner typically adheres to an electrostatic latent image support surface at the edges of various latent image areas having different field strengths across the thickness of the latently imaged member.

Where the marking materials in the unmigrated areas of the imaged support surface include photosensitive materials, the production of electrostatic latent images on the support surface may be enhanced by exposing the support surface to activating electromagnetic radiation, typically substantially uniformly across the imaging surface, either simultaneously with or after the charging of the support surface.

It is believed that there are at least three mechanisms operating individually and simultaneously which in part account for the formation of an electrostatic latent image when an imaged migration imaging member is electrically charged. These mechanisms include charge injection and discharge by the particles of migration marking material; charge capture by the particle of migration marking material; and, charge transfer between individual particles of migration marking material. The magnitude of each of these mechanisms and their individual effects upon the surface potentials which make up the latent image on the surface of the image support surface, are believed to depend upon the location and packing of the particles of migration marking material. Generally, particle migration in depth in the softenable material toward the substrate reduces the potential drop associated with charge transfer between individual particles because of the higher capacitance associated with the region in which the charge transfer occurs, and removes charge injecting particles from the structure surface and from the charge upon said surface, which the particles could ordinarily cause to be injected. However, particle migration away from the surface of the softenable layer can produce lower potentials in the migrated areas than in the unmigrated areas if substantially all of the migration marking particles tend to capture charge which moves from the upper surface of the structure into and through the member because of the higher capacitance between the particles in the migrated area and the substrate. Furthermore, for the layered structures, the migrated particles can be dispersed in depth throughout the softenable layer and can produce increased charge decay by particle-to-particle charge transfer in depth through the softenable layer.

Where the novel electrostatic latent image support surface of the present invention comprises a layered configuration migration imaging member imaged by disrupting the fracturable layer in imagewise configuration, it is believed that the disrupted areas produce points of greater surface injection because of clustering of particles of the migration marking material. Therefore, the disrupted areas are believed to have greater charge decay characteristics which produce lower surface potentials in the disrupted areas when such disrupted surfaces are electrically charged.

Electrostatic latent images such as the one shown on the surface of the softenable layer **13** in FIG. 3A are suitable for use in a variety of applications in imaging processes. For example, in electrostatographic copying processes, and particularly the xerographic process, the electrostatic latent image may be developed to produce a visible image by contacting the latent image support surface with an electroscopic material which adheres to the image support surface in different amounts corresponding to the different areas of charge concentration or surface potential on the electrostatic latent image support surface, or at the boundary areas between such differentially charged areas. In xerography, such electroscopic materials are typically called "toners" and may be applied to the latent image by any one of a variety of development processes. For example, the system of cascade development has found extensive commercial acceptance especially in "transfer" xerography and generally consists of gravitationally flowing developer material consisting of a two component material of the type described in Walkup et al. Pat. No. 2,638,416, over the xerographic plate bearing the latent image. The two components consist of the electroscopic toner particles and a granular material called "carrier" and which by mixing acquire triboelectric charges of opposite polarities. In development, the toner component, usually oppositely charged to the latent image is deposited on the latent electrostatic image to render that image visible. Other typical developing systems include magnetic brush development, for example see Giamo U.S. Pat. No. 2,930,351

and U.S. Pat. Nos. 2,791,949 and 3,015,305; powder cloud development, for example see Carlson U.S. Pat. No. 2,221,776 and U.S. Pat. Nos. 2,784,109; 2,725,305 and 2,918,910; skid development, for example see Mayo U.S. Pat. No. 2,895,847; the fluidized bed process described in Mott et al. U.S. Pat. No. 3,008,826; the liquid spray development system disclosed in Olson U.S. Pat. No. 3,005,726; and others.

Any suitable toner or other marking material may be used herein. Typical toners are described in Insalaco U.S. Pat. No. 3,079,342 as well as in Carlson Reissue U.S. Pat. No. 25,136; Copely U.S. Pat. No. 2,659,670, Landragin U.S. Pat. No. 2,753,308, Insalaco U.S. Pat. No. 2,891,011 and others.

In "direct" xerography, liquid development systems although not necessarily used, are often found to be preferred and are described in, for example, Gundlach U.S. Pat. Nos. 3,068,115 and 3,084,043 and Metcalfe U.S. Pat. Nos. 2,907,674; 3,001,888; 3,032,432 and 3,078,231; and Greig U.S. Pat. No. 3,053,688.

A typical liquid developer composition may comprise toner, a fixative thermoplastic resin and a carrier liquid and suitable variations thereof as known to those skilled in the art. For example, a typical liquid developer may comprise about 5 parts carbon black of particle size between about 10 and 30 milli-microns, about 40 parts of Duraplex D-65A, alkyd resin available from Rohm & Haas Co., which is mixed and pigmented in about 60 parts of xylene, the pigment dispersion then put in about 1,000 parts of kerosene carrier liquid. In liquid development systems the toner is often fused substantially to the substrate by the development process itself. Typically, toner particles may be fabricated with solvent dissolvable plastic coatings, these coatings being tackified during development to cause the toner, by their coatings, to stick and adhere tenaciously to the substrate and to adjacent surface layered toner particles; or, for example as described in Fauser et al. U.S. Pat. No. 3,311,490, the liquid carriers normally used in the liquid development systems may carry a small amount of, for example, a dissolved thermoplastic in the carrier which is deposited on the image receiving sheet, (typically the xerographic plate itself in "direct" xerography) to cause the individual toner particles to be adhesively connected to each other and to the image support surface.

In various other systems, electrostatic latent images may be suitable for use in solvent-dye transfer systems such as described in Carlson U.S. Pat. No. 2,690,394, and in processes including the reversal development system described in Sugarman U.S. Pat. No. 2,914,403.

In still other processes, the electrostatic latent image may itself be used to produce new latent images on other imaging members by processes involving induction or charge transfer. For example, such charge patterns may be transferred to other surfaces by bringing the two surfaces into very close proximity and utilizing break-down techniques as described, for example, in Carlson U.S. Pat. No. 2,982,647, and Walkup U.S. Pat. Nos. 2,825,814 and 2,937,943.

In other imaging systems such as those described for example in copending applications Ser. Nos. 646,532 and 646,533, filed June 16, 1967 now abandoned, liquid crystalline imaging materials may be used in conjunction with electrostatic latent images on support surfaces to provide visible images corresponding to the electrostatic latent images.

In still other electrostatographic systems, the electrostatic latent image may be "read-out" by suitable electronic techniques which dispense with the need of developing the electrostatic latent image into a visible image.

In other systems, deformation images may be produced in systems where electrostatic latent images are an intermediate image, for example, as in the thermoplastic deformation imaging systems described in Glenn U.S. Pat. No. 3,113,179; Corrsin U.S. Pat. No. 3,238,041; Ewing U.S. Pat. No. 3,258,336; Gundlach et al. U.S. Pat. No. 3,196,009, and others. Similarly, thin liquid interference films may be deformation imaged to produce interference color images, as described in U.S. Pat. No. 3,196,010.

Electrostatic latent images are also quite useful in the formation of migration images by the systems described in the aforementioned copending applications.

In FIG. 3B the advantageous electrostatic latent image support surface of the present invention is shown being developed by the xerographic cascade development system as described for example in Walkup U.S. Pat. No. 2,618,551. It is seen that the electroscopic marking material **20** adheres to the surface of the softenable layer in areas **15** where the surface potential or charge concentration is greater than the surface potential or charge concentration in the less charged, nonmigrated areas **16** of the novel support surface.

In FIG. 3C, the electrostatic latent image is shown fully developed having the electroscopic marking material **20** adhering to the surface in the image areas. In various processes, it may be desirable to transfer this image of electroscopic marking material to some other surface such as paper, transparencies, or any other desirable opaque, translucent, or transparent supporting base material. In yet other imaging applications, the image of electroscopic marking material on the surface of the novel electrostatic latent image support surface may be fixed directly to that surface. Similarly, the image of electroscopic marking material may be fixed to any other surface to which it is transferred as discussed above.

Because of the migration developed, imaged member which is found to be advantageous in the present invention, continues to have the image in it, it is clear that an electroscopic marking material image such as that illustrated in FIG. 3C may be transferred to another surface, and that the novel electrostatic latent image support surface may be redeveloped. The new image may also be transferred so that the novel support surface may be used any number of times, for example as an electrostatographic printing master.

Alternately, the toner image may be fixed upon the imaged migration imaging member thereby enhancing the density of the image on the member itself.

The following examples further specifically define the present invention with respect to providing a developed, imaged, migration imaging member and electrically charging the surface thereof to produce an electrostatic latent image. The parts and percentages are by weight unless otherwise indicated. The examples below are intended to illustrate various preferred embodiments of the novel electrostatographic system.

EXAMPLE I

A migration imaging member is provided by applying a softenable layer of Staybelite, an hydrogenated rosin ester available from the Hercules Powder Co., Inc., of thickness of about 4 microns on an aluminized Mylar substrate, a Mylar polyester resin available from DuPont coated with a partially transparent layer of aluminum. The migration marking material of this migration imaging member is amorphous selenium applied in a fracturable layer having migration marking particles of about 0.2 microns in diameter, said fracturable layer being vacuum evaporated onto the exposed surface of the softenable material layer, as described in copending application Ser. No. 813,345, filed Apr. 3, 1969, now abandoned. This imaging member is then positively electrostatically charged with a corona charging device to a surface potential of about +200 volts, and contact exposed through a negative photographic transparency with about 5 ergs/sq. cm. of about 4000A° light. This latently imaged member is then developed by exposure to vapors of trichloroethylene for about 10 seconds. The migration marking material migrates in depth in the softenable material toward the substrate in the areas where the charged member is exposed to light, to form an imaged member as illustrated, for example, in FIG. 1.

An electrostatic latent image is formed upon this imaged migration imaging member by positively charging the surface of this electrostatic latent image support surface with a corona charging device to a surface potential of about 300 volts in areas where the marking material has migrated. The electrostatic latent image is enhanced by exposing the charged member to room light for several seconds. The electrostatic latent image is developed by cascading over the support surface xerographic developer including carrier beads and electroscopic toner particles, colored pre-formed resin particles comprising about 60–95 percent styrene or styrene homologues as disclosed in U.S. Pat. Nos. Re/25,136 and 3,079,342, mixed with about 0.01 percent to about 4 percent finely divided zinc stearate powder such as Aero 4F, manufactured by American Cyanamide. The development toner particles in this embodiment are triboelectrically negatively charged. The electrostatic latent image produced on this imaged migration imaging member has higher surface potentials in areas where the migration marking material has migrated in depth toward the substrate. The negatively charged xerographic toner particles deposit in these areas of higher potential (the migrated particle areas) thereby producing a positive visible image corresponding to the negative photographic transparency from which the imaged migration imaging member is produced.

EXAMPLE II

A migration imaged member is provided as described in Example I. An electrostatic latent image is formed upon the imaged migration imaging member by negatively charging the surface of this electrostatic latent image support surface with an electrostatic corona charging device to a surface potential of about −300 volts. The image is enhanced by exposing the charged member to room light for several seconds. The electrostatic latent image is developed as described in Example I except that the toner particles attracted to the image are triboelectrically positively charged. The positively charged xerographic toner particles deposit in the areas of higher potential (the migrated particle areas) thereby producing a visible positive image corresponding to the negative photographic transparency from which the imaged migration imaging member is produced.

EXAMPLE III

A migration imaging member is provided by mixing migration marking material, zinc oxide particles about 1 micron in diameter, in a matrix of softenable material, a silicone resin, RS071 available from Dow Corning Corp., in a ratio of about 1 part zinc oxide particles to about 1 part binder. A binder layer of softenable material and migration marking material about 4 microns thick is coated onto an aluminum substrate. This migration imaging member is imaged by negatively charging the surface of the softenable material with an electrostatic corona charging device to a surface potential of about −300 volts, and contact exposing the charged film through a negative photographic transparency. This latently imaged migration imaging member is then developed by exposing the member to vapors of Freon 113 trichlorotrifluoroethane available from duPont, for about 20 seconds. The migration marking material particles migrate in the areas of the migration imaging member which are not exposed to light during the exposure step.

An electrostatic latent image is formed upon this imaged migration imaging member by negatively charging the surface of this electrostatic latent image support surface with a corona charging device to a surface potential of about −300 volts. The image is enhanced by exposing the charged member to room light for several seconds. The electrostatic latent image is visibly developed as described in Examples I and II. The electrostatic latent image produced on this member has higher surface potentials in the migrated particle areas. The electroscopic toner particles deposit in the lower potential areas (the unmigrated particle areas) forming a positive visible image corresponding to the negative photographic transparency from which the imaged migration imaging member is produced.

EXAMPLE IV

A migration imaging member is provided by applying a softenable layer of silicone resin, RS071, available from Dow Corning Corp., of about 2 microns in thickness, on an aluminized Mylar substrate. The migration marking material is amorphous selenium particles of diameter of about 0.2 microns which are vacuum evaporated in a fracturable layer contiguous the surface of the layer of softenable material. This migration imaging member is imaged by positively charging to a surface potential of about +200 volts, contact exposing as in Example I, and developing by exposure to vapors of Freon 113 for about 50 seconds. The migration imaging material particles migrate in areas which are exposed during the contact exposure step.

An electrostatic latent image is formed upon this imaged migration imaging member by negatively charging to a surface potential of about −300 volts and

developing as described in Examples I and II. The surface potential in the electrostatic latent image is higher in the unmigrated marking particle areas. The electroscopic toner material deposits in the lower potential areas (the migrated migration marking material areas) thereby forming a positive image corresponding to the negative photographic transparency from which the imaged migration imaging member is produced.

EXAMPLE V

An imaged migration imaging member is provided as described in Example IV. An electrostatic latent image is formed upon the imaged migration imaging member by positively charging the surface of this latent image support surface to a surface potential of about +300 volts with an electrostatic corona charging device. The image is enhanced by exposing the charged member to room light for several seconds. The electrostatic latent image is visibly developed by contacting the support surface with a liquid developing mixture comprising phthalocyanine pigment in a silicone oil of viscosity of about 0.65 centistokes, for several seconds. The surface potential in the electrostatic latent image is higher in the areas where the migration marking material is unmigrated. The phthalocyanine pigment is positively charged and deposits in the lower surface potential areas (the migrated areas) thereby forming a positive image corresponding to the negative transparency from which the imaged migration imaging member is produced.

EXAMPLE VI

A migration imaging member is provided by applying a softenable layer of a copolymer of styrene and hexyl methacrylate of thickness of about 1.5 microns on an aluminized Mylar substrate. A fracturable layer of selenium particles about 0.25 microns in diameter is vacuum evaporated onto the free surface of the softenable layer. This migration imaging member is imaged by negatively charging to a surface potential of about −100 volts, contact exposing through a negative photographic transparency, and developing by heating the latently imaged member at about 110°C. for about 20 seconds. The migration marking material migrates in the light struck areas.

An electrostatic latent image is formed upon this imaged migration imaging member by negatively electrostatically charging this latent image support surface to a surface potential of about −400 volts with a corona charging device in room light. This electrostatic latent image is visibly developed as described in Example I. The surface potential is higher in the areas where the migration marking material is unmigrated. The xerographic toner deposits in the areas of lower potential forming the visible positive image corresponding to the negative photographic transparency from which the imaged migration imaging member is produced.

EXAMPLE VII

The migration imaging member described in Example VI is electrostatically latently imaged as described in Example VI except that the negative electrostatic charging step is performed under dark room conditions. The result is the same as described in Example VI.

EXAMPLE VIII

The electrostatic latent image produced as described in Examples VI and VII is visibly developed with xerographic toner as described in Example I and said toner image is transferred to a transfer sheet of Mylar about 3 mils in thickness, and heated to fuse the toner image upon the Mylar thereby forming a positive image transparency corresponding to the negative transparency from which the imaged migration imaging member is initially produced.

EXAMPLE IX

A migration imaging member as described in Example VII is imaged by electrostatically charging to a surface potential of about −120 volts, contact exposing through a step tablet transparency having 0.3 density steps providing maximum light exposure of 1.2 f.c.s. of white light and minimum light exposure of 0.06 f.c.s. of white light. The migration imaging member is developed by heating at about 110°C. for about 20 seconds. The marking particles migrate increasingly in the areas of increasing light exposure.

An electrostatic latent image is formed upon the imaged migration imaging member by negatively electrostatically charging the surface of the imaged migration imaging member in room light. The surface potentials on various areas of the structure are measured using an electrometer as is commonly used for measuring potentials on xerographic plates. Surface potential in exposed areas receiving the maximum light exposure and where marking material migration is maximum, is about −60 volts. Surface potential in areas receiving minimum light exposure where marking material migration is minimum, is about −290 volts. This example illustrates a method of providing different areas of different surface potentials in the electrostatic latent image.

EXAMPLE X

An imaging member is provided by applying a softenable layer of Staybelite, an hydrogenated rosin ester available from Hercules Powder Co., Inc., of thickness of about 2 microns on an aluminized Mylar substrate. A fracturable layer of selenium particles about 0.2 microns in diameter is vacuum evaporated onto the free surface of the softenable layer. This imaging member is imaged by the disruption imaging technique described in copending application Ser. No. 695,074, filed Jan. 2, 1968, now U.S. Pat. No. 3,542,545 by positively charging the surface of the member, exposing the charged member through a positive photographic transparency, and heat developing at about 80°C. for several seconds. The particulate fracturable layer disrupts in the unexposed areas.

The imaged member described above is electrostatically latently imaged by electrostatically negatively charging the imaged member to about −400 volts. The image is enhanced by exposing the member to room light for several seconds. The latently imaged member is then visibly developed with negatively charged xerographic toner as described in Example I. The disrupted areas of the imaged member have a lower surface potential than the remaining areas, and the xerographic toner deposits in the disrupted areas thereby producing a positive image corresponding to the positive trans-

parency from which the imaged member is originally produced.

Although specific components are proportions have been stated in the above description of the preferred embodiments of the novel electrostatographic system for producing electrostatic latent images, other suitable materials and variations in the various steps in the system as listed herein, may be used with satisfactory results and various degrees of quality. In addition, other materials and steps may be added to those used herein and variations may be made in the process to synergize, enhance, or otherwise modify the properties of or increase the uses for the invention.

It will be understood that various other changes in the details, materials, steps, arrangements of parts and uses which have been herein described and illustrated in order to explain the nature of the invention, will occur to and may be made by those skilled in the art, upon a reading of this disclosure, and such changes are intended to be included within the principle and scope of this invention.

What is claimed is:

1. An imaging process comprising

providing an image support surface comprising a substrate, a layer of softenable material which is sufficiently electrically insulating to retain an electrostatic latent image on one surface thereof, and migration marking material, some of said marking material migrated in an imagewise configuration,

electrically charging the support surface by substantially uniformly providing electrical charges across said surface whereby an electrostatic latent image correspond to or complementary to said imagewise configuration is produced on said support surface.

2. The process of claim 1 wherein the unmigrated migration marking material comprises a fracturable layer of marking material contiguous the free surface of the softenable layer, and said migrated marking material is disrupted and laterally relocated in the image areas.

3. The process of claim 1 wherein said migrated marking material is migrated in depth in said softenable layer toward the substrate.

4. The process of claim 1 wherein the unmigrated migration marking material comprises a fracturable layer of marking material contiguous the free surface of the softenable layer.

5. The process of claim 4 wherein said fracturable layer is of a thickness in the range between about 0.01 micron and about 2 microns.

6. The process of claim 4 wherein said migration marking material comprises selenium.

7. The process of claim 6 wherein said migration marking material comprises amorphous selenium.

8. The process of claim 1 wherein the unmigrated marking material is dispersed throughout the softenable layer in the unmigrated areas.

9. The process of claim 8 wherein said migration marking material comprises phthalocyanine.

10. The process of claim 1 wherein said softenable layer is of a thickness in the range between about one-half micron and about 16 microns.

11. The process of claim 1 wherein said substrate is electrically conductive.

12. The process of claim 1 wherein said substrate is substantially electrically insulating.

13. The process of claim 1 wherein said migration marking material comprises particles of average size not greater than about 1 micron.

14. The process of claim 1 wherein said migration marking material comprises particles of average size not greater than about 0.7 microns.

15. The process of claim 1 wherein said migration marking material is electrically photosensitively inert material.

16. The process of claim 1 wherein said migration marking material is electrically photosensitive material.

17. The process of claim 16 wherein said marking material is photoconductive material.

18. The process comprising the steps of claim 1 wherein said migration marking material is electrically photosensitive material,

and uniformly exposing the support surface to a source of activating electromagnetic radiation whereby an electrostatic latent image is produced on said support surface.

19. The process of claim 18 wherein the charge and expose steps are performed simultaneously.

20. The process comprising the steps of claim 18 and developing the electrostatic latent image to produce a palpable image.

21. The process comprising the steps of claim 18 and developing electrostatic latent image to produce a visible image.

22. The process of claim 21 wherein the developed visible image is produced by contacting the electrostatic latent image with electroscopic marking material.

23. The process of claim 22 wherein the developed electroscopic image is fixed to the electrostatic latent image support surface.

24. A process comprising the steps of claim 22 and transferring the developed image comprising electroscopic marking material to a second image support surface.

25. The process of claim 24 wherein the developed and transferred electroscopic marking material image is fixed to the second support surface.

26. The imaging process comprising repeating the steps of claim 24 a plurality of times whereby a plurality of electroscopic marking material images are transferred to a plurality of other image support surfaces.

27. The process of claim 26 wherein the transferred images are fixed to the other support surfaces.

28. The process comprising the steps of claim 1 and developing the electrostatic latent image to produce a palpable image.

29. The process comprising the steps of claim 1 and developing electrostatic latent image to produce a visible image.

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