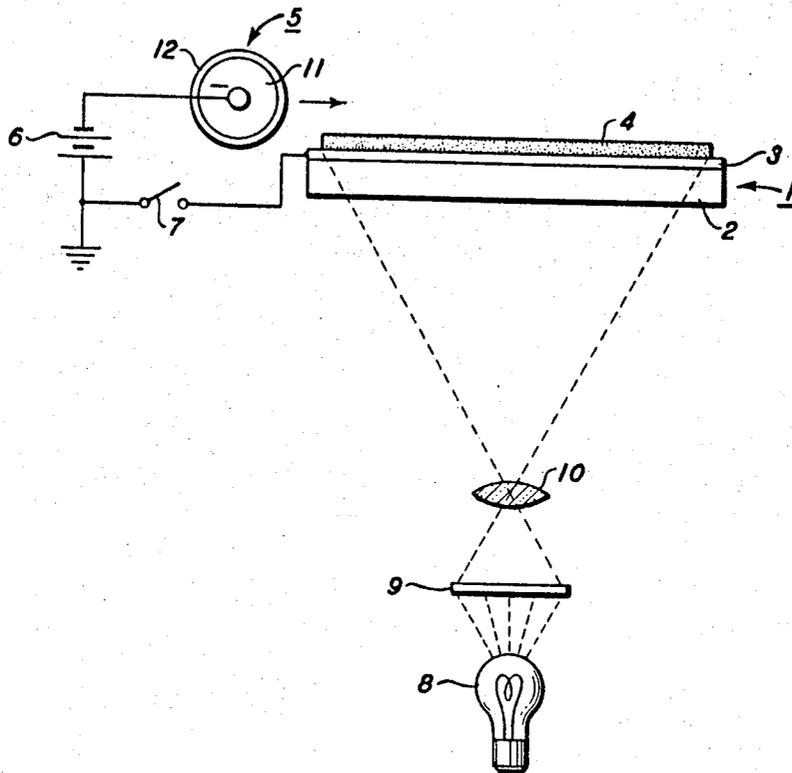


May 6, 1969

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PHOTOELECTROPHORETIC AND XEROGRAPHIC IMAGING PROCESSES
EMPLOYING TRIPHENODIOXAZINES AS THE ELECTRICALLY
PHOTOSENSITIVE COMPONENT
Filed Jan. 6, 1966

3,442,781



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PHOTOELECTROPHORETIC AND XEROGRAPHIC IMAGING PROCESSES EMPLOYING TRIPHENODIOXAZINES AS THE ELECTRICALLY PHOTOSENSITIVE COMPONENT

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Filed Jan. 6, 1966, Ser. No. 519,104
Int. Cl. B01k 5/02

U.S. Cl. 204—181

7 Claims

ABSTRACT OF THE DISCLOSURE

Triphenodioxazines are used as electrically photosensitive particles in photoelectrophoretic imaging and as photoconductors in xerographic plates.

This invention relates in general to imaging methods. More specifically, the invention concerns the use of electrically photosensitive pigments in electrophotographic imaging systems.

There has been recently developed an electrophoretic imaging system capable of producing color images which utilize photoconductive pigment particles. This process is described in detail and claimed in copending applications Serial Numbers 384,737, now U.S. Patent 3,384,565; 384,681, abandoned in favor of Ser. No. 655,023, now U.S. Patent 3,384,566, and 384,680, abandoned in favor of Ser. No. 518,041, now U.S. Patent 3,383,993, all filed July 23, 1964. In such an imaging system, various colored light absorbing particles are suspended in a non-conductive liquid carrier. The suspension is placed between electrodes, subjected to a potential difference and exposed to an image. As these steps are completed, selective particle migration takes place in image configuration, providing a visible image at one or both of the electrodes. An essential component of the system is the suspended particles which must be intensely colored pigments which are electrically photosensitive and which apparently undergo a net change in charge polarity upon exposure to activating radiation, through interaction with one of the electrodes. The images are produced in color because mixtures of two or more differently colored pigments which are each sensitive only to light of a specific wave-length or narrow range of wave-lengths are used. Pigments used in this system must have both intense pure colors and be highly photosensitive. The pigments of the prior art often lack the purity and brilliance of color, the high degree of photosensitivity and/or the preferred correlation between the peak spectral response and peak photosensitivity necessary for use in such a system.

Another imaging system which utilizes electrically photosensitive material is the xerographic process as described in U.S. Patent 2,297,691 to C. F. Carlson. Here, the photosensitive material must be an effective photoconductive insulator, i.e., must be capable of holding an electrostatic charge in the dark and dissipating the charge to a conductive substrate when exposed to light. In the fundamental process, a base sheet of relatively low electrical resistance such as metal, paper, etc. having a photoconductive insulating surface coated thereon, is electrostatically charged in the dark. The charged coating is then exposed to a light image. The charges leak off rapidly to the base sheet in proportion to the intensity of light to which the particular area is exposed, the charge being substantially retained in non-exposed areas, forming an electrostatic latent image. After exposure, the coating is contacted with electrostatic marking particles in the dark. These particles adhere to the areas where the electrostatic charge remains, forming a powder image corresponding

to the electrostatic latent image. Where the base sheet is relatively inexpensive, such as paper, the image may be fixed directly to the plate, as by heat or solvent fusing. Alternatively, the powder image may be transferred to a sheet of transfer material, such as paper, and fixed thereon.

Many photosensitive materials useful in the xerographic process are known in the art, e.g., vitreous selenium, sulfur, anthracene, zinc oxide, polyvinyl carbazole. While several of these different materials are in commercial use today, each has deficiencies in such areas as photographic speed, spectral response, durability, reusability and cost such that there is a continuing need for improved materials.

It is, therefore, an object of this invention to provide novel electrophotographic imaging processes which overcome the above noted deficiencies.

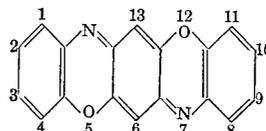
It is another object of this invention to provide novel electrophoretic imaging processes.

It is another object of this invention to provide novel xerographic imaging processes.

It is still another object of this invention to provide novel electrophoretic imaging systems capable of reproducing color images.

It is still another object of this invention to provide novel xerographic plates having maximum spectral and photosensitive responses in ranges other than those of prior plates.

The foregoing objects and others are accomplished in accordance with this invention, fundamentally, by providing novel electrophotographic imaging processes utilizing compositions having the general formula:



which may be substituted at any available site.

The compositions of the above general formula belong to the class of substituted and unsubstituted triphenodioxazines. These compounds are also known as [1,4]benzoxazino-[2,3-b]phenoxazines; 5,12-dioxo-7,14-diazapentacenes and triphenodioxazines.

Of the compositions within the above general formula, those substituted in the 6,13-positions with a halogen and in the 3,10 or 2,9 position with an alkoyl or arylol are preferred for use in electrophotographic imaging processes since they have especially pure color and are most highly photosensitive. Of these, the optimum compositions have been found to be 2,9-dibenzoyl-6,13-dichlorotriphenodioxazines and 2,9-diacetyl-6,13-dichlorotriphenodioxazine. These have been found to give the most desirable combination of color and photosensitivity in polychromatic photoelectrophoretic imaging.

Since the shade or tone of the compositions and the spectral and photosensitive responses vary slightly depending upon the substituent used, intermediate values of these variables may be obtained by mixing several of the different compositions.

The compositions within the general formula listed above, and mixtures thereof are especially useful as photosensitive pigment particles in electrophoretic imaging processes. An exemplary electrophoretic imaging system is shown in the figure.

Referring now to the figure, there is seen a transparent electrode generally designated 1 which, in this exemplary instance, is made up of a layer of optically transparent glass 2 overcoated with a thin optically transparent layer 3 of tin oxide, commercially available under the name NESA glass. This electrode will hereinafter be referred to as the "injecting electrode." Coated on the surface of injecting electrode 1 is a thin layer 4 of finely divided

photosensitive particles dispersed in an insulating liquid carrier. The term "photosensitive," for the purposes of this application, refers to the properties of a particle which, once attracted to the injecting electrode, will migrate away from it under the influence of an applied electric field when it is exposed to actinic electromagnetic radiation. For a detailed theoretical explanation of the apparent mechanism of operation of the invention, see the above mentioned copending applications Ser. Nos. 384,737, now U.S. Patent 3,384,565; 384,681, abandoned in favor of Ser. No. 655,023, now U.S. Patent 3,384,566, and 384,680, abandoned in favor of Ser. No. 518,041, now U.S. Patent 3,383,993, the disclosures of which are incorporated herein by reference. Liquid suspension 4 may also contain a sensitizer and/or a binder for the pigment particles which is at least partially soluble in the suspending or carrier liquid as will be explained in greater detail below. Adjacent to the liquid suspension 4 is a second electrode 5, hereinafter called the "blocking electrode," which is connected to one side of the potential source 6 through a switch 7. The opposite side of potential source 6 is connected to the injecting electrode 1 so that when switch 7 is closed, an electric field is applied across the liquid suspension 4 between electrodes 1 and 5. An image projector made up of a light source 8, a transparency 9, and a lens 10 is provided to expose the dispersion 4 to a light image of the original transparency 9 to be reproduced. Electrode 5 is made in the form of a roller having a conductive central core 11 connected to the potential source 6. The core is covered with a layer of a blocking electrode material 12, which may be Baryta paper. The pigment suspension is exposed to the image to be reproduced while a potential is applied across the blocking and injecting electrodes by closing switch 7. Roller 5 is caused to roll across the top surface of injecting electrode 1 with switch 7 closed during the period of image exposure. This light exposure causes exposed pigment particles originally attracted to electrode 1 to migrate through the liquid and adhere to the surface of the blocking electrode, leaving behind a pigment image on the injecting electrode surface which is a duplicate of the original transparency 9. After exposure, the relatively volatile carrier liquid evaporates off, leaving behind the pigment image. This pigment image may then be fixed in place as, for example, by placing a lamination over its top surface or by virtue of a dissolved binder material in the carrier liquid such as paraffin wax or other suitable binder that comes out of solution as the carrier liquid evaporates. About 3% to 6% by weight of paraffin binder in the carrier has been found to produce good results. The carrier liquid itself may be paraffin wax or other suitable binder. In the alternative, the pigment image remaining on the injecting electrode may be transferred to another surface and fixed thereon. The pigment image may be transferred, for example, by the methods described in copending application, Ser. No. 459,860, filed May 28, 1965. As explained in greater detail below, this system can produce either monochromatic or polychromatic images depending upon the type and number of pigments suspended in the carrier liquid and the color of light to which this suspension is exposed in the process.

Any suitable insulating liquid may be used as the carrier for the pigment particles in the system. Typical carrier liquids are decane, dodecane, N-tetradecane, paraffin, beeswax or other thermoplastic materials, Sohio Odorless Solvent 3440 (a kerosene fraction available from Standard Oil Company of Ohio), and Isopar-G (a long chain saturated aliphatic hydrocarbon available from Humble Oil Company of New Jersey). Good quality images have been produced with voltages ranging from 300 to 5,000 volts in the apparatus of the figure.

In a monochromatic system, particles of a single composition are dispersed in the carrier liquid and exposed to a black-and-white image. A single color image results, corresponding to conventional black-and-white photog-

raphy. In a polychromatic system, the particles are selected so that those of different colors respond to different wave-lengths in the visible spectrum corresponding to their principal absorption bands. Also, the pigments should be selected so that their spectral response curves do not have substantial overlap, thus allowing for color separation and subtractive multi-color image formation. In a typical multi-color system, the particle dispersion should include cyan colored particles sensitive mainly to red light, magenta particles sensitive mainly to green light and yellow colored particles sensitive mainly to blue light. When mixed together in a carrier liquid, these particles produce a black appearing liquid. When one or more of the particles are caused to migrate from base electrode 11 toward an upper electrode, they leave behind particles which produce a color equivalent to the color of the impinging light. Thus, for example, red light exposure causes the cyan colored pigment to migrate leaving behind the magenta and yellow pigments which combine to produce red in the final image. In the same manner, blue and green colors are reproduced by removal of yellow and magenta, respectively. When white light impinges upon the mix, all pigments migrate, leaving behind the color of the white or transparent substrate. No exposure leaves behind all pigments which combine to produce a black image. This is an ideal technique of subtractive color imaging in that the particles are not only each composed of a single component but, in addition, they perform the dual functions of final image colorant and photosensitive medium.

It has been found that the compounds of the general formula given above are surprisingly effective when used in either a single or multi-color electrophoretic imaging system. Their good spectral response and high photosensitivity result in dense, brilliant images. The pigments here in disclosed have surprisingly good color separation and image density characteristics.

Any suitable different colored photosensitive pigment particles having the desired spectral responses may be used with the pigments of this invention to form a pigment mix in a carrier liquid for color imaging. From about 2 to about 10 percent pigment by weight have been found to produce good results. The addition of small amounts (generally ranging from 0.5 to 5 mol percent) of electron donors or acceptors to the suspensions may impart significant increases in system photosensitivity.

The following examples further specifically define the present invention with respect to the use of the compositions of the general formula given above in electrophoretic imaging processes. Parts and percentages are by weight unless otherwise indicated. The examples below are intended to illustrate various preferred embodiments of the electrophoretic imaging process of the present invention.

All of the following Examples I-XVI are carried out in an apparatus of the general type illustrated in the figure with the imaging mix 4 coated on a NESA glass substrate through which exposure is made. The NESA glass surface is connected in series with a switch, a potential source, and the conductive center of a roller having a coating of Baryta paper on its surface. The roller is approximately 2½" in diameter and is moved across the plate surface at about 1.45 centimeters per second. The plate employed is roughly 3 inches square and is exposed with a light intensity of 8,000 foot-candles as measured on the uncoated NESA glass surface. Unless otherwise indicated, 7 percent by weight of the indicated pigments in each example are suspended in Sohio Odorless Solvent 3440 and the magnitude of the applied potential is 2500 volts. All pigments which have a relatively large particle size as received commercially or as made are ground in a ball mill for 48 hours to reduce their size to provide a more stable dispersion which improves the resolution of the final images. The exposure is made with a 3200° K. lamp through a 0.30 neutral density step wedge filter to

measure the sensitivity of the suspensions to white light and then Wratten filters 29, 61 and 47b are individually superimposed over the light source in separate tests to measure the sensitivity of the suspensions to red, green and blue light, respectively.

EXAMPLE I

About 7 parts of 2,9-dibenzoyl-6,13-dichloro-triphenodioxazine is suspended in about 100 parts of Sohio Odorless Solvent 3440. The mixture is coated on the NESA glass substrate and a negative potential is imposed on the roller electrode. The plate is exposed through a Wratten 29 filter and the neutral density step wedge filter, thus exposing the plate to red light. The results are tabulated in Table I below.

EXAMPLE II

A test is run as in Example I above, except that a Wratten 61 filter is used in place of the Wratten 29 filter, thus exposing the plate to green light. The results are tabulated in Table I.

EXAMPLE III

A test is run as in Example I above, except that a Wratten 47b filter is used in place of the Wratten 29 filter, thus exposing the plate to blue light. The results are tabulated in Table I.

EXAMPLE IV

A test is run as in Example I above, except that no color filter is used, thus exposing the plate to white light. The results are tabulated in Table I.

EXAMPLE V

A test is run as in Example I above, except that the roller potential is positive rather than negative. As in Example I, a Wratten 29 filter is used to expose the plate to red light. The results are tabulated in Table I.

EXAMPLE VI

A test is run as in Example V above, except that a

The Wratten 29 filter is used to expose the plate to red light. The results are tabulated in Table I.

EXAMPLE X

A test is run as in Example IX above, except that a Wratten 61 filter is used in place of the Wratten 29 filter, thus exposing the plate to green light. See Table I for results.

EXAMPLE XI

A test is run as in Example IX above, except that a Wratten 47b filter is used in place of the Wratten 29 filter, thus exposing the plate to blue light. See Table I for results.

EXAMPLE XII

A test is run as in Example IX above, except that no Wratten filter is used, thus exposing the plate to white light. See Table I for results.

EXAMPLE XIII

A test is run as in Example IX above, except that a positive rather than negative potential is imposed on the roller electrode. The plate is exposed through a Wratten 29 filter, thus exposing the plate to red light. See Table I for results.

EXAMPLE XIV

A test is run as in Example XIII above, except that a Wratten 61 filter is used in place of the Wratten 29 filter, thus exposing the plate to green light. See Table I for results.

EXAMPLE XV

A test is run as in Example XIII above, except that a Wratten 47b filter is used in place of the Wratten 29 filter, thus exposing the plate to blue light. See Table I for results.

EXAMPLE XVI

A test is run as in Example XIII above, except that no Wratten filter is used, thus exposing the image to white light. See Table I for results.

TABLE I

Example	Roller Potential	Wratten Filter	Light Color	Speed (f.c.)	Gamma	D _{max.}	D _{min.}
I.....	-2,500	29	Red.....	None	-----	-----	-----
II.....	-2,500	61	Green.....	125	2.0	1.8	0.2
III.....	-2,500	47b	Blue.....	500	-----	2.4	0.6
IV.....	-2,500	None	White.....	60	2.0	1.8	0.2
V.....	+2,500	29	Red.....	None	-----	-----	-----
VI.....	+2,500	61	Green.....	500	0.3	1.0	0.6
VII.....	+2,500	47b	Blue.....	2,000	-----	1.6	0.8
VIII.....	+2,500	None	White.....	1,000	0.3	-----	0.6
IX.....	-2,500	29	Red.....	1,000	-----	-----	0.4
X.....	-2,500	61	Green.....	300	3.0	3.0	0.1
XI.....	-2,500	47b	Blue.....	500	-----	-----	0.1
XII.....	-2,500	None	White.....	250	3.0	3.0	0.2
XIII.....	+2,500	29	Red.....	None	-----	-----	-----
XIV.....	+2,500	61	Green.....	300	1.7	7.0	0.2
XV.....	+2,500	47b	Blue.....	500	-----	-----	0.2
XVI.....	+2,500	None	White.....	300	1.7	7.0	0.2

Wratten 61 filter is used in place of the Wratten 29 filter, thus exposing the plate to green light. See Table I for results.

EXAMPLE VII

A test is run as in Example V above, except that a Wratten 47b filter is used in place of the Wratten 29 filter, thus exposing the plate to blue light. See Table I for results.

EXAMPLE VIII

A test is run as in Example V above, except that no Wratten filter is used, thus exposing the plate to white light. See Table I for results.

EXAMPLE IX

About 7 parts 2,9-diacetyl-6,13-dichloro-triphenodioxazine is suspended in about 100 parts Sohio Odorless Solvent 3440. The mixture is tested as in Example I above.

The electrophoretic sensitivity of the various pigments to red, green, blue and white light is tested according to conventional photographic methods and the results are recorded in Table I above. In the table, the first column lists the number of the test example. The second column gives the positive or negative electrical potential applied to the roller electrode in volts. The Wratten filters used in each example between the light source and the NESA plate are listed in column three. The fourth column lists the color of the light which is permitted to fall on the NESA plate. The fifth column gives the photographic speed of the photosensitive mix in foot-candles. The photographic speed is the result of a curve of optical density plotted against the logarithm of exposure in foot candles; f.c._t being 0.3 gamma toe speed and f.c._s being 0.3 gamma shoulder speed. Gamma, as listed in column 6, is a standard photographic term referring to the slope of the above mentioned curve. The maximum and mini-

mum reflection density produced are listed in Columns 7 and 8, respectively. In some instances, where the sensitivity of the particular composition to the specific light color is low, gamma and D_{\max} are not measurable. As shown by the above table, the tested pigments are sensitive, in an electrophoretic sense, to green light primarily. As can be seen, the pigments are essentially non-responsive to red and blue light, having some slight response to blue light.

In each of Examples XVII-XXI below, a suspension including equal amounts of three different colored pigments is made up by dispersing the pigments in finely divided form in Sohio Odorless Solvent 3440 so that the pigments constitute about 8% by weight of the mixture. This mixture may be referred to as a "tri-mix." The mixtures are individually tested by coating them on a NESA glass substrate and exposing them as in Example I above, except that a multicolor Kodachrome transparency is interposed between the light source and the plate instead of the neutral density and Wratten filters. Thus, a multi-colored image is projected on the plate as the roller moves across the surface of the coated NESA glass substrate. A Baryta paper blocking electrode is employed and the roller is held at a negative potential of about 2500 volts with respect to the substrate. The roller is passed over the substrate six times, being cleaned after each pass. Potential application and exposure are both continued during the entire period of the six passes by the roller. After completion of the six passes, the quality of the image left on the substrate is evaluated as to density and color separation.

EXAMPLE XVII

The pigment suspension consists of a magenta pigment, 2,9 - dibenzoyl-6,13-dichloro-triphenodioxazine; a cyan pigment, Cyan GTNF, the beta form of copper phthalocyanine, C.I. No. 74,160, available from Collway Colors Company, and as a yellow pigment, 8,13-dioxodinaphtho (2,1-b,-2',3'-d)-furan-6-carbox-m-chloroanilide, prepared by the method described in copending application Serial No. 421,377, filed December 28, 1964. This tri-mix is exposed to a multi-colored image and produces a full color image of good density and color separation.

EXAMPLE XVIII

The pigment suspension consists of a magenta pigment, 2,9-diacetyl-6,13-dichloro-triphenodioxazine; a cyan pigment, Cyan Blue, 3,3'-methoxy-4,4'-diphenyl-bis(1''-azo-2''-hydroxy-3''-naphthanalide), C.I. No. 21,180, available from Harmon Colors, and Algol Yellow GC, 1,2,5,6-di(C,C' - diphenyl) - thiazole - anthraquinone, C.I. No. 67,300, available from General Dye Stuff. This tri-mix is exposed to a multi-colored image and produces a full color image of good density and excellent color separation.

EXAMPLE XIX

The pigment suspension consists of a magenta pigment, 3,10 - dibenzoylamino - 2,9 - diisopropoxy-6,13-dichloro-triphenodioxazine; a cyan pigment, a polychloro-substituted copper phthalocyanine, C.I. No. 74,260, from Imperial Color and Chemical Company, and a yellow pigment Indofast Yellow Toner, flavanthrone, C.I. No. 70,600, available from Harmon Colors. This tri-mix is exposed to multi-colored image and produces a full color image of good density and color separation.

EXAMPLE XX

The pigment suspension consists of a magenta pigment, 2,9 - dibenzoyl - 6,13 - dichloro-triphenodioxazine; a cyan pigment, Monolite Fast Blue G.S., the alpha form of metal free phthalocyanine, C.I. No. 74,100, available from the Arnold Hoffman Company, and a yellow pigment, 1-cyano-2,3-(3'-nitro)-phthaloyl-7,8-benzopyrrocoline, prepared as described in copending application Serial No. 445,235, filed April 2, 1965. This tri-mix is

exposed to a multi-colored image and produces a full color image of satisfactory density and good separation.

EXAMPLE XXI

The pigment suspension consists of a magenta pigment, 2,9 - difuroyl - 6,13 - dichloro-triphenodioxazine; a cyan pigment, Cyan Blue XR, the alpha form of copper phthalocyanine, available from Collway Colors, and a yellow pigment 2,4-di-(1'-anthraquinonyl-amino)-6-(1''-pyrenyl)-s-triazine, prepared as described in copending application Serial No. 445,179, filed April 2, 1965. This tri-mix is exposed to a multi-colored image and produces a full color image of good density and color separation.

The compositions of the general formula given above are also useful in xerographic imaging systems. For use in such processes, xerographic plates may be produced by coating a relatively conductive substrate, e.g., aluminum or paper, with a dispersion of particles of the photosensitive pigment of the above general formula in a resin binder. The pigment-resin layer may also be cast as a self-supporting film. The plate formed may be both with or without an overcoating on the photoconductive layer. As a third alternative to the above noted self-supporting layer and substrate supported layer, the photosensitive pigment-resin photoconductive layer may be used in the formation of multilayer sandwich configuration adjacent a dielectric layer, similar to that shown by Golovin et al., in the publication entitled "A New Electrophotographic Process, Effected by Means at Combined Electret Layers," *Doklady Akad. Nauk SSSR* vol. 129, No. 5, pp. 1008-1011, November-December, 1959.

When it is desired to coat the pigmented resin film on a substrate, various supporting materials may be used. Suitable materials for this purpose include aluminum, steel, brass, metalized or tin oxide coated glass, semi-conductive plastics and resins, paper and other convenient materials.

Any suitable dielectric material may be used to overcoat the photoconductive layer. A typical overcoating is bichromated shellac.

Any suitable organic binder or resin may be used in combination with the pigment to prepare the photoconductive layer of this invention. In order to be useful the resin used in the present invention should be more resistive than about 10^{10} and preferably more than 10^{12} ohms per centimeter under the conditions of xerographic use. Typical resins include thermoplastics such as polyvinylchloride, polyvinylacetates, polyvinylidene chloride, polystyrene, polybutadiene, polymethacrylates, polyacrylics, polyacrylonitrile, silicone resins, chlorinated rubber, and mixtures and copolymers thereof where applicable; and thermosetting resins such as epoxy resins including halogenated epoxy and phenoxy resins, phenolics, epoxy-phenolic copolymers, epoxy urea-formaldehyde copolymers, epoxy melamine-formaldehyde copolymers and mixtures thereof where applicable. Other typical resins are epoxy esters, vinyl epoxy resins, tall-oil modified epoxies, and mixtures thereof where applicable. In addition to the above noted binder materials, any other suitable resin may be used, if desired. Also, other binders such as paraffin and mineral waxes may be used if desired.

The pigments may be incorporated in the dissolved or melted binder resin by any suitable means such as strong shear agitation, preferably with simultaneous grinding. These include ball milling, roller milling, sand milling, ultrasonic agitation, high-speed blending and any desirable combination of these methods. Any suitable range of pigment-resin ratios may be used.

The pigment-resin-solvent slurry (or the pigment-resin melt) may be applied to the conductive substrate by any of the well known painting or coating methods, including spraying, flow coating, knife coating, electro-coating, Mayer bar drawdown, dip coating, reverse foil coating, etc. Spraying in an electric field may be preferred for the smoothest finish and dip coating for convenience in the

laboratory. The setting drying and/or curing steps for these plates are generally similar to those recommended for films of the particular binder used for other painting applications. For example, pigment-epoxy plates may be cured by adding a cross-linking agent and stoving according to approximately the same schedule as other baking enamels made with the same resins and similar pigments for painting applications.

The thickness of the photoconductive films may be varied from about 1 to about 100 microns, depending on their required individual purpose. Self-supporting films, for example, cannot usually be manufactured in thicknesses thinner than about 10 microns, and they are easiest to handle and use in the 15 to 75 micron range. Coatings, on the other hand, are preferably formed in the 5 to 30 micron range. For certain compositions and purposes, it is desirable to provide an overcoating; this should usually not exceed the thickness of the photoconductive coating, and preferably not above one-quarter of the latter. Any suitable overcoating material may be used, such as bichromated shellac.

The invention as it pertains to xerographic imaging processes will be further described with reference to the following examples, which describe in detail various preferred embodiments of the present invention. Parts, ratios and percentages are by weight unless otherwise stated.

Xerographic plates for use as in the following examples are prepared as follows: Mixtures using specific pigments and resin binders are prepared by ball milling the pigment or a solution of a resinous binder and one or more solvents until the pigment is well dispersed. This is done by adding the desired parts of the pigment to the desired parts of resin solution in a suitable mixing vessel. A quantity of one-eighth steel balls are added and the vessel is rotated for approximately one-half hour in order to obtain a homogeneous dispersion. The cooled slurry is applied onto an aluminum substrate with a wire drawdown rod and force dried in an oven for about 3 minutes at about 100° C. The coated sheets are dark rested for about 1 hour and then tested.

In the following examples, plates are tested as follows. The plate is charged negative by corona discharge to about 400 volts and exposed to a light and shadow image. The plate is cascade developed by the method described by Walkup in U.S. Patent 2,618,551. The powder image produced on the plate corresponds to the projected image. The developed image may be then either fused to the plate or may be electrostatically transferred to a receiving sheet and there fused. Where the image is transferred, the plate may be then cleaned of residual toner and may be reused as by the above described process.

EXAMPLE XXII

The xerographic plate is prepared by initially mixing about 2 parts of Lucite 2042, an ethylmethacrylate polymer available from E. I. duPont de Nemours and Co., about 18 parts benzene, and about 1 part of 2,9-dibenzoyl-6,13-dichloro-triphenodioxazine. This mixture is coated onto an aluminum substrate to a thickness of about 8 microns and cured. The plate is then charged, exposed for about 45 seconds to a light and shadow image using a Simmons Omega D3 enlarger equipped with a tungsten light source operating at 2950° K. color temperature (illumination level incident on the plate is 2.8 foot-candles as measured with a Weston Illumination Meter Model No. 756) and developed as above described. The image produced is heat fused directly onto the plate.

EXAMPLE XXIII

The xerographic plate is prepared by initially mixing a binder and a solvent as in Example XXII above with about 1 part of 2,9-dimethoxy-6,13-dichlorotriphenodioxazine. This mixture is coated on an aluminum substrate to a thickness of about 8 microns and cured. The plate is charged, exposed for about 45 seconds to a light

and shadow image using a Simmons Omega D3 enlarger equipped with a tungsten light source operating at 2950° K. color temperature (illumination level incident on the plate is 2.8 foot-candles as measured with a Weston Illumination Meter Model No. 756) and developed.

EXAMPLE XXIV

The xerographic plate is prepared by initially mixing about 3 parts of Lucite 2042 with about 100 parts benzene and about 10 parts of 3,10-dibenzoylamino-2,9-diethoxy-6,13-diacylaminotriphenodioxazine. This mixture is coated onto an aluminum substrate to a thickness of about 8 microns and cured. The plate is then charged, exposed for about 45 seconds to a light and shadow image using a Simmons Omega D3 enlarger equipped with a tungsten light source operating at 2950° K. color temperature (illumination level incident on the plate is 2.8 foot-candles as measured with a Weston Illumination Meter Model No. 756) and developed. The image is heat fused onto the plate surface.

EXAMPLE XXV

The xerographic plate is prepared by initially mixing about 10 parts Lucite 2042, with about 90 parts benzene and about 2 parts 3,10-dibenzoylamino-2,9-diisopropoxy-6,13-dichloro-triphenodioxazine. This mixture is coated onto an aluminum substrate to a thickness of about 10 microns and cured. The plate is then charged, exposed through a film positive for about 30 seconds to a high intensity, long wave, ultraviolet lamp (1680 microwatts/cm.² of 3660 a.u. radiation at a distance of 18 inches) and developed. The powder image developed on the plate is electrostatically transferred to a receiving sheet by the method described by Schaffert in U.S. Patent 2,576,047 and heat fused. The image on the receiving sheet corresponds to the contact exposed original. The plate is wiped clean of any residual toner and is reused as in the above described manner. The image on the receiving sheet corresponds to the original.

EXAMPLE XXVI

The xerographic plate is prepared by initially mixing about 10 parts Lucite 2042, with about 90 parts benzene and about 2 parts triphenodioxazine. The mixture is coated onto an aluminum substrate to a thickness of about 10 microns and cured. The plate is then charged, contact exposed through a film positive for about 30 seconds to a high intensity, long wave, ultraviolet lamp (1680 microwatts/cm.² of 3660 a.u. radiation at a distance of 18 inches) and developed. The image developed on the plate is electrostatically transferred to a receiving sheet and heat fused. The image on the receiving sheet corresponds to the contact exposed original. The plate is wiped clean of any residual toner and is reused as in the above described manner.

Although specific components and proportions have been described in the above examples relating to electrophoretic, and xerographic imaging systems, other suitable materials, as listed above, may be used with similar results. In addition, other materials may be added to the pigment compositions or to the pigment-resin compositions to synergize, enhance or otherwise modify their properties. The pigment compositions and/or the pigment-resin compositions of this invention may be dye sensitized, if desired, or may be mixed or otherwise combined with other photoconductors, both organic and inorganic.

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

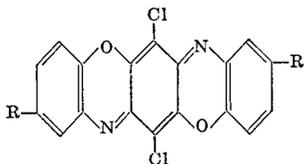
What is claimed is:

1. The method of electrophoretic imaging which comprises: (a) subjecting a layer of a particulate suspension to an applied electric field between at least two electrodes,

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at least one of which is partially transparent; and, (b) simultaneously exposing said suspension to an image through said partially transparent electrode with activating electromagnetic radiation whereby a pigment image made up of particles is formed on at least one of said electrodes, said suspension comprising a plurality of finely divided particles of at least one color, at least some of said particles comprising a photosensitive pigment selected from the group consisting of substituted and unsubstituted triphenodioxazines.

2. The method of claim 1 wherein said photosensitive pigment has the general formula:



wherein R is selected from the group consisting of alkoyl and aryloyl radicals.

3. The method of claim 1 wherein said photosensitive pigment is 2,9-dibenzoyl-6,13-dichloro-triphenodioxazine.

4. The method of claim 1 wherein said photosensitive pigment is 2,9-diacetyl-6,13-dichlorotriphenodioxazine.

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5. The method of claim 1 wherein said suspension comprises particles of at least two different colors in an insulating carrier liquid, the particles of each color comprising a photosensitive pigment whose principal light absorption bands substantially coincides with its principal photosensitive response.

6. The method of claim 1 wherein at least one of said electrodes is a blocking electrode.

7. The process for forming a latent xerographic image on a photoconductive layer comprising a photoconductive pigment in an organic binder, which comprises electrostatically charging said layer and exposing said layer to a pattern of activating electromagnetic radiation; said photoconductive pigment comprising a composition selected from the group consisting of substituted and unsubstituted triphenodioxazines.

References Cited

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U.S. Cl. X.R.

25 96—1, 1.2, 1.5, 1.6