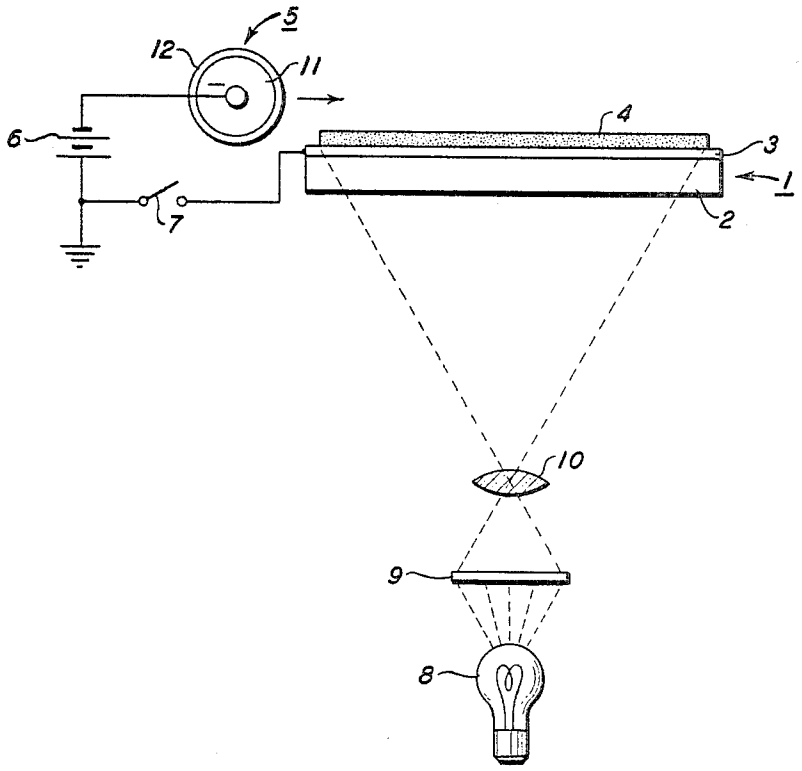
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PHOTOELECTROPHORETIC IMAGING PROCESS USING QUINACRIDONES

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PHOTOELECTROPHORETIC IMAGING PROCESS USING QUINACRIDONES

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ABSTRACT OF THE DISCLOSURE

Quinacridones as electrically photosensitive particles in photoelectrophoretic imaging.

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

There has been recently developed an electrophoretic imaging system capable of producing color images which utilizes single-component photoconductive particles. This process is described in detail and claimed in copending applications Ser. Nos. 384,680 now abandoned; 384,681 now abandoned; and 384,737 now U.S. Patent 3,384,565, all filed July 23, 1964. In such an imaging system, variously 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 electrically photosensitive and which apparently undergo a net change in charge polarity upon exposure to activating electromagnetic radiation, through interaction with one of the electrodes. In a monochromatic system, particles of a single color are used, producing a single colored image equivalent to conventional back-and-white photography. In a polychromatic system, the images are produced in natural color because mixtures of particles of two or more different colors which are each sensitive to light of a specific wave-length or narrow range of wave-lengths are used. Particles 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.

It is, therefore, an object of this invention to provide photoelectrophoretic imaging processes utilizing photosensitive pigment particles which overcome the above-noted deficiencies.

It is another object of this invention to provide highly photosensitive particles for use in electrophoretic imaging systems.

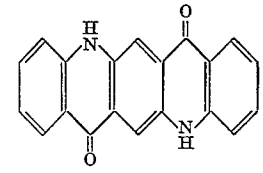
It is still another object of this invention to provide electrophoretic imaging processes capable of producing color images.

It is another object of this invention to provide photoelectrophoretic imaging processes utilizing particles having photographic speed and color qualities superior to those of known pigments.

The foregoing objects and others are accomplished in accordance with this invention, fundamentally, by providing photoelectrophoretic imaging processes utilizing quinacridone pigments.

The term, quinacridone, applies to a series of compounds having a structure which appears to be the condensation of a quinoline residue with an acridine residue, with two carbons of the condensation product oxidized to the quinone stage.

It has now been found that quinacridones, which are well-known as pigments, have electrically photosensitive or photomigratory characteristics such as to make them especially useful in photoelectrophoretic imaging systems. The most useful quinacridones in such systems have been to be the linear-trans-quinacridones as represented by the following structural formula:



which may be substituted as desired. Linear-trans-quinacridones are available in three crystalline phases, alpha, beta, and gamma, as discussed in U.S. Patent 2,844,484. While all three crystal phases are useful in photoelectrophoretic imaging, optimum results have been, in general, obtained with the beta crystal phase.

Quinacridones suitable for use in the process of this invention may be synthesized by many conventional methods. For example, the synthesis disclosed in U.S. Patents 2,821,530; 2,821,529; and British Patent 884,044 produce useful pigments.

Of the compositions within the general class of quinacridones, those having methyl groups in the 1–4 and 8–11 positions, and unsubstituted quinacridones, and mixtures thereof are preferred for use in a photoelectrophoretic imaging process since they are simply and economically synthesized, are generally commercially available, have especially pure color, and are highly photosensitive. Of these, 2,9-dimethylquinacridone has produced optimum results. Since the shade or tone of the compositions and the spectral and photosensitive responses vary slightly upon the substituent used, intermediate values of these variables may be obtained by mixing several of the different compositions. Any other quinacridone, or mixtures thereof, may be used where suitable. Typical quinacridones include 3,10-dichloro-6,13 - dihydro - quinacridone; 2,9 - dimethoxy - 6,13-dihydro - quinacridone; 2,9 - dimethyl - 6,13 - dihydroquinacridone; 4,11 - dimethyl - 6,13 - dihydro - quinacridone; 3,4,10,11-tetrachloro quinacridone; 2,4,9,11-tetrachloro quinacridone; 2,4,9,11-tetrabromo quinacridone; 1,4,8,11-tetrafluoro quinacridone; 2,4,9,11-tetramethyl quinacridone; 2,8-dichloroquinacridone; 1,2,4,8, 9,11 - hexachloro quinacridone; 2,4,9,11 - tetramethoxy quinacridone; and mixtures thereof. In addition, angular quinacridones, such as are disclosed in U.S. Patent 2,830,990, may be used where suitable. For use in electrophoretic imaging processes, the quinacridone may have other compositions added thereto to sensitize, enhance, synergize or otherwise modify its properties. The quinacridone may, where desired, be formed into solid solutions with other compositions, such as is disclosed in U.S. Patent 3,160,510.

The use of pigments comprising quinacridones as discussed above in photoelectrophoretic imaging processes may be further understood by reference to the figure which shows an exemplary electrophoretic imaging system.

Referring now to the figure, there is seen a transparent electrode generaly designated 1 which, in this exemplary instance, is made up of a layer of optically transparent glass 2 overcoated with a thin optically trans-

parent layer 3 of tin oxide, commercialy available under the name NESA glass. This electrode will hereafter 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. 384,381, 384,680, and 384,737, 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 as 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 liquified 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. 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) and Isopar-G (a long chain saturated aliphatic hydrocarbon). Good quality images have ben 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 results, corresponding to conventional black-and-white photography. In a polychromatic system, the particles are selected so that those of different colors respond to different wavelengths 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 substractive multicolor image formation. In a typical multicolor 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 quinacridones as discussed above are surprisingly effective when used in either a single or multicolor electrophoretic imaging system. Their good spectral response and high photosensitivity result in dense, brilliant images.

Any suitable different colored photosensitive pigment particles having the desired spectral responses may be used with the magenta pigments of this invention to form a partial suspension 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–LVI 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 inches 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 47*b* are individually superimposed over the light source

in separate tests to measure the sensitivity of the suspensions to red, green and blue light respectively.

Examples I–II

About 4 parts of quindo magenta RV6803, a 2,9-dimethyl quinacridone is suspended in about 100 parts of Sohio Odorless Solvent 3440, a kerosene fraction. In Example I, the mixture is coated on the NESA glass substrate and a negative potential is imposed on the roller electrode. Four exposure tests are made through neutral density step wedge filters and color filters as indicated above, to test the suspension for sensitivity to red, green, blue and white light. In Example II, the steps were repeated with the lower electrode at a positive potential. As can be seen in Table I below, these magenta pigments were primarily sensitive to green light, with the white light sensitivity being substantially the same as the green light sensitivity.

Examples III–IV

In these examples, a pigment suspension is prepared and tested as in Examples I–II above, with the roller electrode negative and positive respectively. Here, however, the commercial quindo magenta RV6803 is further purified by boiling in dimethyl formamide, washing with water, boiling in a 20 percent sodium hydroxide solution and then again washing with water. As can be seen from Table I, the more pure pigments has about the same photographic speed, but much improved spectral response, in that undesired response to red light is much lower.

Examples V–VI

In these examples, the pigment is suspended and tested as in Examples I–II above, with the roller electrode potential negative and positive, respectively. Here, however, the commercial quindo magenta RV6803 is suspended in a solution of diethyl carbocyanine iodide in alcohol, then ball milled for about 24 hours, filtered, and washed with alcohol before being suspended in the carrier liquid. This results, as shown in Table I, in higher sensitivity and better spectral response.

Examples VII–VIII

Again in these examples, the pigment is suspended and tested as in Examples I–II above, with the roller potential negative and positive, respectively. The commercial quindo magenta RV6803 pigment is purified by washing with a 10 percent sodium hydroxide solution, followed by a water wash. As shown in Table I, the photographic sensitivity is improved.

Examples IX–X

The pigment is suspended and tested as in Examples I–II above. Here, the commercial quindo magenta RV6803 is suspended in a solution of pyridine acetate for about 30 minutes, is filtered therefrom, and is washed with water. As shown by Table I, the pigment as so treated has a much higher photographic speed with a positive roller electrode potential than with a negative potential.

Example XI

In this example, the pigment is the same as that of Examples IX and X above. Here, however, the roller potential is positive and 1,000 volts rather than 2,500 volts. As shown by Table I, the photographic speed of the pigment at this lower roller potential is significantly higher.

Examples XII–XIII

The pigment is suspended and tested as in Examples I–II above, with the roller potential negative and positive, respectively. The commercial quindo magenta RV6803 pigment is suspended in pyridine for about 30 minutes, filtered therefrom, and washed with water. As can be seen from Table I, the photographic speed is appreciably greater where the roller electrode potential is positive.

Example XIV

The process of Examples XII–XIII is repeated with the roller electrode at a positive potential of 1,000 volts. As shown in Table I, the photographic speed of the pigment is much greater at this lower potential.

Examples XV–XVIII

In these examples, the pigment is suspended and tested as in Examples I–II above. In these four examples, the roller electrode potential is, respectively, −2500, −1000, +2500, and +1000 volts. The pigment is prepared by mixing commercial quindo magento RV6803 with p-methoxy benzylamine, filtering the pigment therefrom and washing the pigment with water. As shown by Table I, each of these examples shows good color separation and contrary to the usual result, the photographic speed is as high or higher with negative potential on the roller electrode.

Examples XIX–XXI

The pigment is suspended and tested as in Examples I–II above, with the roller electrode potential, respectively −2500, +2500 and +1000 volts. In these examples, instead of commercial pigment, the pigment is a 2,9-dimethyl quinacridone prepared by the method described in Example I of British Patent 942,797. As is seen from Table I, this pigment has good spectral response and when the roller electrode potential is positive, the photographic speed is very good.

Examples XXII–XXV

The pigment is suspended and tested as in Examples I–II above. In these four examples, the roller electrode potential is, respectively, −2500, −1000, +2500 and +1000 volts. The commercial quindo magenta RV6803 is purified by suspending it in boiling dimethyl formamide, filtering the pigment therefrom, and resuspending and refiltering six additional times. The final filtered pigment is washed with water, then washed with alcohol, and dried at about 190° C. for about 5 hours in vacuum. The dried pigment is then ball milled for about three weeks. As is seen from Table I, this highly purified pigment has excellent photographic speed.

Examples XXVI–XXVIII

The pigment is suspended and tested as in Examples I–II above. The pigment used here is Hostaperm Pink E 13–7,000, a 2,9-dimethyl quinacridone. The commercial pigment is tested without further purification. This pigment was found to exhibit excellent photographic speed and spectral response, as indicated by Table I.

Examples XXIX–XXX

The pigment is suspended and tested as in Examples I–II above. In these examples, the roller electrode is, respectively, negative and positive. The pigment used here is commercial quindo magenta RV6803, which is further purified by suspending it in boiling dimethyl formamide, filtering it therefrom, and repeating the suspending and filtering steps three times, washing the final filtered pigment with dimethyl sulfoxide, then washing the pigment with alcohol, then with water. The purified pigment is found to have especially good photographic speed when the roller electrode is at a positive potential as shown in Table I.

Examples XXXI–XXXII

The pigment is suspended and tested as in Examples I–II above. Commercial quindo magenta RV6803 is purified as in Examples XXIX–XXX above, followed by ball milling for five weeks. This improves the photographic speed where the roller electrode is at a negative potential, as shown in Table I.

Examples XXXIII–XXXIX

The pigment is suspended and tested as in Examples I–II above. Commercial quindo magenta RV6803 is ball

milled for about 6 hours in alcoholic potassium hydroxide, then boiled in quinoline at 180° C. for about 30 minutes, filtered, washed with methanol, then washed with water. The characteristics of this pigment are indicated in Table I.

Examples XXXV–XXXVI

The pigment is suspended and tested as in Examples I–II above. Here, about 10 parts commercial quindo magenta RV6803 is dyed with about 2 parts methyl violet. This pigment exhibits good photographic speed and excellent minimum density, as shown by Table I.

Examples XXXVII–XXXVIII

The pigment is suspended and tested as in Examples I–II above. Commercial quindo magenta is purified with dimethyl formamide as in Example XXIX. The resulting purified pigment is mixed with a 5 percent solution of bis-(N,N-p-methoxy phenyl)-p-phenylene diamine. The pigment is filtered from the solution, ball milled, and washed with alcohol. As shown by Table I, this pigment exhibits the relatively unusual property of having higher photographic speed when the roller electrode is at a negative potential.

Examples XXXIX–XL

The pigment is suspended and tested as in Examples I–II above. Commercial quindo magenta RV6803 is purified with dimethyl formamide as in Example XXIX above. The purified pigment is mixed with a solution of lauryl pyridinium chloride. The pigment is filtered from the solution, washed with water, and tested. The characteristics of this pigment are indicated in Table I.

Examples XLI–XLII

The pigment is suspended and tested as in Examples I–II above. Commercial quindo magenta RV6803 is dissolved in a sodium hydroxide solution in ethylene glycol monomethyl ether. The pigment is recrystallized by adding water to the solution. The recrystallized pigment is in the beta form. As shown by Table 1, this pigment has excellent photographic speed and density characteristics.

Examples XLIII–XLIV

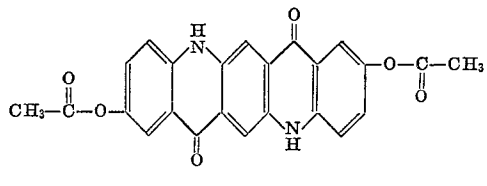
The pigment is suspended and tested as in Examples I–II above. Commercial quindo magenta RV6803 is washed with o-dichlorobenzene, then with methyl alcohol, then with acetone, then again with methyl alcohol. The thus purified pigment is tested and found to have good photographic speed and excellent density characteristics, as shown in Table I.

Examples XLV–XLVI

The pigment is suspended and tested as in Examples I–II above. Commercial quindo magenta RX6803 is dissolved in a solution of sodium hydroxide in ethylene glycol monomethyl ether. To this solution is added rhodamine 6 GDN, a pigment. To this solution is slowly added water, which coprecipitates the two pigments. The coprecipitant is tested and shows good photographic speed and excellent density characteristics, as shown in Table I.

Example XLVII

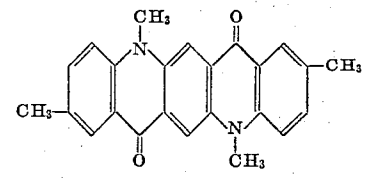
The pigment is suspended and tested as in Examples I–II above. The pigment is 2,9-diacetoxy quinacridone having the general formula:



This pigment is milled and tested as above. This pigment shows excellent photographic speed when subjected to a positive roller potential as shown in Table I.

Examples XLVIII–XLIX

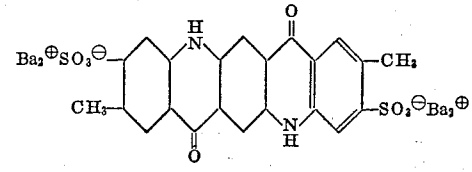
The pigment is suspended and tested as in Examples I–II above. The pigment is a 2,5,9,12-tetramethyl-quinacridone having the general formula:



This pigment is purified, milled and tested as above. This pigment has relatively low photographic speed but produces a satisfactory image with either a positive or negative roller potential, as indicated in Table I.

Example L

The pigment is suspended and tested as in Examples I–II above. The pigment is a barium salt of 2,9-dimethyl - 3,10 - disulphoquinacridone having the general formula:



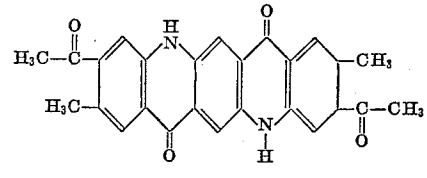
This pigment is tested as above and is found to give an image of good density when a positive potential is imposed on the roller electrode, as shown in Table I.

Example LI

The pigment is suspended and tested as in Examples I–II above. The pigment is commercial Monastral Red Y, an unsubstituted quinacridone. This pigment has excellent photographic speed and produces an image of good density as indicated in Table I.

Example LII

The pigment is suspended and tested as in Examples I–II above. The pigment is 3,10-diacetyl-2,9-dimethyl-quinacridone having the general formula:



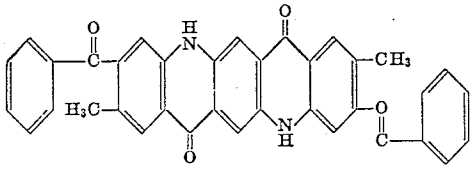
This pigment is purified, milled and tested as in Examples I–II above. This pigment is found to have low photographic speed but produces an image of satisfactory density as indicated in Table I.

Examples LIII–LIV

The pigment is suspended and tested as in Examples I–II above. The pigment is commercial Monastral Violet R. This pigment is found to have excellent photographic speed with either a negative or positive potential on the roller electrode. An image of excellent density results, as indicated in Table I.

Examples LV–LVI

The pigment is suspended and tested as in Examples I–II above. The pigment is 3,10-dibenzoyl-2,9-dimethylquinacridone having the general formula:



This pigment is purified, milled and tested as above. This pigment is found to have good photographic speed to produce good images with either a negative or positive potential on the roller electrode, as indicated in Table I.

Examples LVII–LVIII

The pigment is suspended and tested as in Examples I–II above. The pigment is Monastral Scarlet. This pigment is believed to be a solid solution of unsubstituted quinacridone and 4.11-dichloroquinacridone. The pigment is purified, milled and tested as above. This pigment is found to have good photographic speed to produce good images with either a negative or positive potential on the roller electrode, as indicated in Table I.

TABLE I

Example	Applied Potential (v.)	Photographic Speed (fo.) Red	Green	Blue	White	Gamma	D—max.	D—min.
I	−2,500	-------	800	-------	800	1.6	1.5	0.22
II	+2,500	1,500	125	500	125	3.9	1.7	0.11
III	−2,500	12,500	500	2,000	450	1.1	1.5	0.28
IV	+2,500	7,200	200	1,600	180	5.0	2.4	0.08
V	−2,500	-------	200	1,800	180	3.0	1.3	0.08
VI	+2,500	-------	150	1,300	120	3.5	1.5	0.08
VII	−2,500	-------	500	2,000	450	1.0	1.7	0.24
VIII	+2,500	-------	125	300	125	6.0	2.7	0.2
IX	−2,500	-------	1,200	-------	1,200	0.2	0.9	0.2
X	+2,500	2,000	125	1,000	125	5.0	2.1	0.12
XI	+1,000	-------	60	1,000	60	2.2	2.0	0.16
XII	−2,500	-------	1,500	-------	1,500	0.4	1.5	0.3
XIII	+2,500	-------	125	800	100	5.0	1.8	0.12
XIV	+1,000	-------	50	400	40	3.2	1.8	0.13
XV	−2,500	-------	500	3,500	225	2.0	1.2	0.09
XVI	−1,000	-------	250	1,000	200	2.0	1.0	0.1
XVII	+2,500	-------	1,000	-------	750	2.7	1.5	0.05
XVIII	+1,000	-------	250	1,500	250	5.0	1.5	0.03
XIX	−2,500	-------	2,000	4,000	2,000	0.3	0.7	0.2
XX	+2,500	-------	125	800	125	4.0	1.7	0.2
XXI	+1,000	-------	25	100	25	5.7	1.8	0.3
XXII	−2,500	-------	225	1,000	225	2.0	2.2	0.4
XXIII	−1,000	-------	250	1,000	250	1.3	1.9	0.32
XXIV	+2,500	-------	125	400	125	1.3	1.3	0.1
XXV	+1,000	-------	60	-------	60	0.4	0.75	0.08
XXVI	−2,500	-------	125	2,000	125	3.0	1.8	0.3
XXVII	+2,500	-------	45	250	40	7.0	2.4	0.12
XXVIII	+1,000	-------	30	250	20	3.5	1.6	0.09
XXIX	−2,500	-------	500	4,000	500	0.9	1.7	0.4
XXX	+2,500	-------	30	200	20	3.0	1.7	0.14
XXXI	−2,500	-------	250	2,000	200	1.6	1.7	0.45
XXXII	+2,500	-------	50	240	20	6.0	2.0	0.2
XXXIII	−2,500	-------	1,000	4,000	800	2.3	1.6	0.3
XXXIV	+2,500	-------	250	1,000	200	6.0	2.0	0.15
XXXV	−2,500	-------	250	2,000	250	1.5	1.2	0.15
XXXVI	+2,500	-------	125	2,000	125	2.5	1.4	0.07
XXXVII	−2,500	-------	250	2,000	250	4.5	2.0	0.3
XXXVIII	+2,500	-------	300	2,000	250	2.1	1.8	0.2
XXXIX	−2,500	-------	1,000	-------	1,000	0.4	1.0	0.3
XL	+2,500	-------	250	1,500	250	6.0	2.3	0.2
XLI	−2,500	-------	250	2,000	125	0.9	1.5	0.2
XLII	+2,500	-------	60	500	40	3.0	1.9	0.1
XLIII	−2,500	-------	500	-------	500	3.9	1.8	0.16
XLIV	+2,500	3,000	200	1,800	160	4.0	2.0	0.1
XLV	−2,500	-------	250	1,000	200	6.0	3.0	0.2
XLVI	+2,500	-------	200	800	125	6.0	2.2	0.05
XLVII	+2,500	-------	250	1,000	125	1.1	1.0	0.15
XLVIII	−2,500	-------	1,000	-------	1,000	-------	1.2	0.6
XLIX	+2,500	-------	1,000	-------	1,000	0.4	0.6	0.3
L	+2,500	-------	2,000	-------	900	4.0	1.3	0.3
LI	−2,500	-------	500	2,000	250	2.0	1.6	0.7
LII	+2,500	-------	2,000	-------	2,000	0.4	0.8	0.3
LIII	−2,500	-------	250	2,000	125	0.9	0.8	0.3
LIV	+2,500	-------	250	1,000	125	4.0	1.8	0.1
LV	−2,500	-------	2,000	8,000	2,000	0.8	1.8	0.3
LVI	+2,500	-------	1,200	-------	1,800	0.9	1.5	0.5
LVII	−2,500	-------	400	1,000	500	1.6	1.5	0.30
LVIII	+2,500	-------	500	1,000	500	2.1	1.2	0.20

As shown by the above examples and Table I, quinacridones, in general, are suitable for use in electrophoretic imaging processes. Since their photographic speed, density characteristics and color characteristics vary, a mixture of the particular pigments may be preferred for specific uses. As can be seen from the examples, some characteristics of the pigments may be improved by particular purification processes, recrystallization processes and dye sensitization.

Although specific components and proportions have been described in the above examples, other suitable materials, as listed above, may be used with similar results. In addition, other materials may be added to the pigment compositions to synergize, enhance, or otherwise modify their properties. The pigment compositions of this invention may be dye sensitized, if desired, or may be mixed with other photosensitive materials, 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 comprising subjecting a layer of a suspension to an applied electric field between at least a pair of electrodes, at least one of which is partially transparent, and simultaneously exposing said suspension to an image through said 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, said particles of one color comprising a quinacridone.

2. The method of claim 1 wherein said quinacridone is an unsubstituted quinacridone.

3. The method of claim 1 wherein said quinacridone is 2,9-dimethyl quinacridone.

4. The method of claim 1 wherein said quinacridone is 3,10-dimethyl quinacridone.

5. The method of claim 1 wherein said quinacridone is 4,11-dimethyl quinacridone.

6. The method of claim 1 wherein said quinacridone is 4,11-dichloro quinacridone.

7. The method of electrophoretic imaging comprising subjecting a layer of a suspension to an applied electric field between at least a pair of electrodes, at least one of which is a blocking electrode, and simultaneously exposing said suspension to an image 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, said particles of one color comprising a quinacridone.

8. The method of claim 7 wherein said quinacridone is 2,9-dimethyl quinacridone.

9. The method of electrophoretic imaging comprising subjecting a layer of a suspension to an applied electric field between a pair of electrodes, at least one of which is at least partially transparent, said suspension comprising a plurality of finely divided 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 band substantially coincides with its principal photosensitive response, simultaneously exposing said suspension to a light image through said partially transparent electrode and then separating said electrodes whereby a pigment image is

formed on the surface of at least one of said electrodes, the particles of one color comprising a quinacridone.

10. The method of claim 9 wherein said quinacridone is 2,9-dimethyl quinacridone.

11. The method of electrophoretic imaging comprising subjecting a layer of a suspension to an applied electric field between a pair of electrodes, at least one of which is a blocking electrode, said suspension comprising a plurality of finely divided 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 band substantially coincides with its principal photosensitive response, simultaneously exposing said suspension to a light image and then separating said electrodes, whereby a pigment image is formed on the surface of at least one of said electrodes, the particles of one color comprising a quinacridone.

12. The method of claim 11 wherein said quinacridone is 2,9-dimethyl quinacridone.

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