

Jan. 19, 1971

B. M. KYRIAKAKIS

3,556,783

COLOR MANIFOLD IMAGING PROCESS

Filed April 1, 1966

2 Sheets-Sheet 1

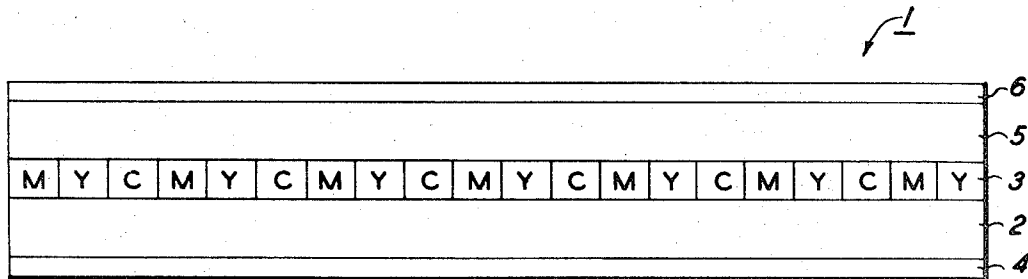


FIG. 1

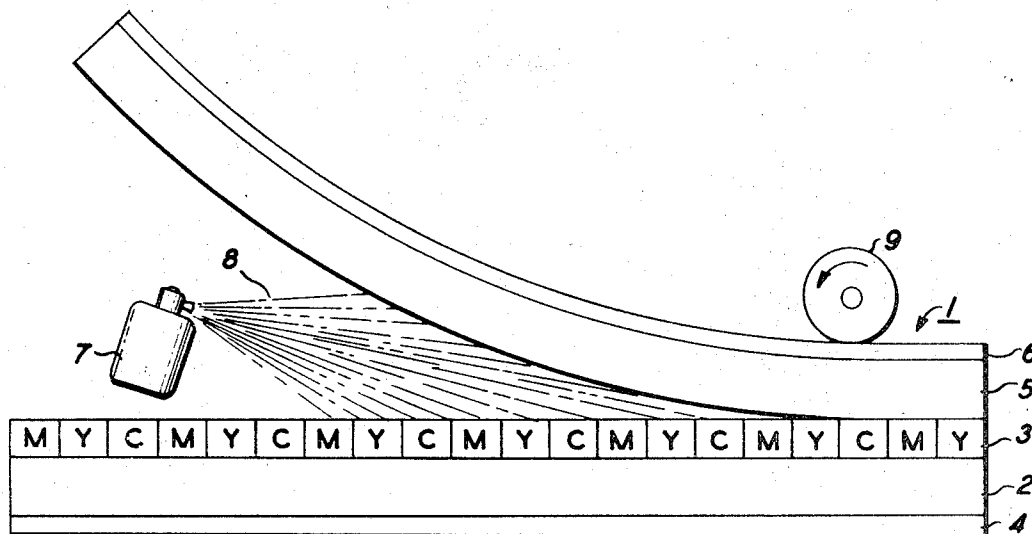


FIG. 2

INVENTOR.
BASIL M. KYRIAKAKIS
BY *John P. Dunbar*
James J. Rolabate
ATTORNEY

Jan. 19, 1971

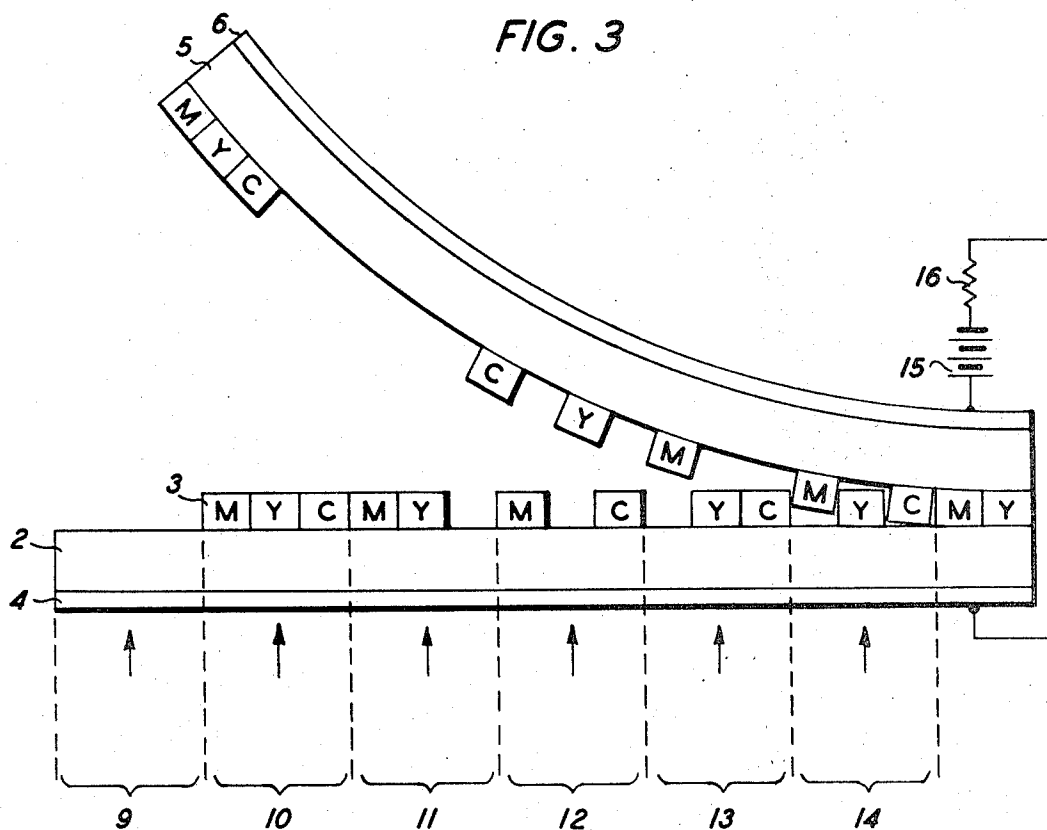
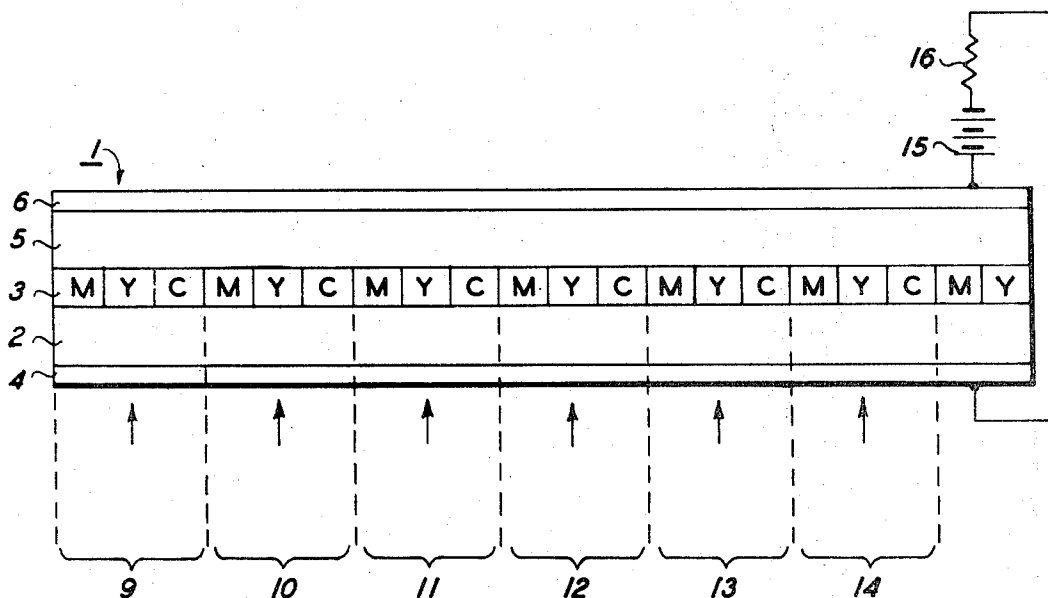
B. M. KYRIAKAKIS

3,556,783

COLOR MANIFOLD IMAGING PROCESS

Filed April 1, 1966

2 Sheets-Sheet 2



INVENTOR
BASIL M. KYRIAKAKIS

BY *John R. Blumson*
James J. Ralston
ATTORNEY

1

2

3,556,783

COLOR MANIFOLD IMAGING PROCESS

Basil M. Kyriakakis, Rochester, N.Y., assignor to Xerox Corporation, Rochester, N.Y., a corporation of New York

Filed Apr. 1, 1966, Ser. No. 539,449

Int. Cl. G03g 13/22

U.S. Cl. 96—1.2

13 Claims

ABSTRACT OF THE DISCLOSURE

A method for obtaining color separation in the manifold layer transfer imaging process wherein the cohesively weak, electrically photosensitive imaging layer comprises contiguous areas of at least two colors. The imaging layer is placed between two sheets and subjected to an electric field and electromagnetic radiation to which at least one the areas of the imaging layer is sensitive. Upon separation of the sheets the imaging layer fractures in imagewise configuration providing a full color copy of the original image on one of the sheets.

This invention relates in general to photography, and more specifically, to processes of producing multicolor photographic images.

Many methods of producing natural color images are described in the prior art. Several of these processes are in extensive commercial use. Probably the four most widely used photographic multicolor imaging processes are: (1) the diffusion transfer color process, (2) the process utilizing color separation negatives, (3) the process utilizing complementary full color negatives for producing positive prints, and (4) the reversal process giving positive full color images.

The diffusion transfer color process has been described in a number of patents, for example, U.S. 3,161,506 and British 804,971. Typically, photographic elements containing silver halide emulsion layers and layers containing diffusible dye developers are exposed to form a latent image in the silver halide layer. This is then treated with an alkaline processing composition which permeates the emulsion layers and layers containing the dyed developers which then develop the latent image to a silver image. At the same time oxidation products of the dye developers are formed in situ with the silver images. These are relatively non-diffusing in the colloid vehicle of the layers. The residual unoxidized dye developers remaining in the layers in image-wise distribution are transferred by diffusion to a superposed reception element substantially to the exclusion of the silver image and the oxidized dye developer to provide a positive dye image.

Where an element containing differentially sensitized silver halide emulsion layers is used, and subtractively colored dye developers are present in or contiguous to the respective emulsion layers, upon treatment with the processing liquid, the dye developers are oxidized and rendered non-diffusing in the developed regions of the layers and the residual dye developer images in the positive regions are transferred by diffusion and in register to the reception element to provide a multicolor reproduction.

When carefully performed, this process is capable of producing images of excellent quality. However, the development process is rather complex, utilizing various chemical developing agents, and must be performed with great care. Further, the dyes used are sensitive to adverse conditions of temperature and humidity which may produce undesirable shifts in color balance and may decrease the density of the final image.

In the process utilizing separation negatives, several negatives are made of the image to be reproduced by exposure through different suitable color filters. Then, a single silver halide emulsion layer is sequentially exposed to the properly registered separation negatives; the emulsion is developed after each exposure with a color-forming developer to form the appropriate dye-image and a silver image. The silver image is rehalogenated after each development and finally all silver and silver salts are removed from the emulsion. Such processes are described, for example, in U.S. Pats. 2,333,359; 2,433,909; and 2,471,547.

This process is capable of producing excellent color images of high density and good resolution and color balance. However, where the plural separation negatives are made sequentially in a single camera, the object photographed must be stationary throughout the period of multiple exposure. If the object to be photographed is not stationary, a complex camera holding several negatives and utilizing beam splitters to direct portions of the light to each negative must be used. Also, the development steps in producing the final color image are many and complex.

Systems utilizing single complementary negatives or reversal films are similar in that each uses a complex, multilayer emulsion containing sublayers each sensitive to light of a different color. A typical film includes a transparent base having an anti-halation layer on the rear surface and coated with three emulsions sensitive, respectively, to yellow, green, and red light. Between these selectively sensitive layers are filter layers which prevent undesired light from passing to the lower layers. A negative film produces a final image in colors complementary to those of the original. This then may be used for the printing of positive prints with a similar emulsion. Reversal films produce an image in colors corresponding to those of the original. These films, with their many thin layers, are difficult and expensive to coat. The dyes used are not entirely stable and may fade or change color with exposure to light and heat. These films tend to have a very small exposure latitude. These films, however, are capable of producing images of good color quality and high resolution and are easily exposed in a conventional camera.

Thus, it can be seen that while the photographic multicolor imaging processes generally in use today are capable of producing images of excellent quality, the processes are often cumbersome and complex in the exposure or developing processes or both, and the final images are often subject to degradation under adverse conditions of temperature and humidity. Therefore, there is a continuing need for improved photographic multicolor imaging processes and materials.

Recently, there has been developed a monochromatic imaging system utilizing a manifold set comprising a photoresponsive material between a pair of sheets. This imaging system is described in detail in copending application Ser. No. 452,641, filed May 3, 1965, now abandoned. In this imaging system, an imagable plate is prepared by coating a layer of a cohesively weak photoresponsive imaging material onto a substrate. This coated substrate is called the "donor." In preparation for the imaging operation, the imaging layer is activated, as by treating it with a swelling agent or partial solvent for the material. This step may be eliminated, of course, if the layer retains sufficient residual solvent after having been coated on the substrate from a solution or paste. The activating step serves the dual function of making the top surface of the imaging layer slightly tacky and, at the same time, weakening it structurally so that it can be fractured more easily along a sharp line which defines the image to be reproduced. Once the imaging layer is

activated, a receiving sheet is laid down over its surface. An electrical field is then applied across this manifold set while it is exposed to a pattern of light-and-shadow representative of the image to be reproduced. Upon separation of the donor substrate and receiving sheet, the imaging layer fractures along the lines defined by the pattern of light-and-shadow to which has been exposed with part of this layer being transferred to the receiving sheet while the remainder is retained on the donor sheet so that a positive image is produced on one while a negative is produced on the other. As can be seen from the above discussion, the imaging layer is structurally fracturable in response to the combined effect of an applied electric field and exposure to electromagnetic radiation to which the layer is sensitive. At least one of the donor sheet and the receiver sheet is at least partially transparent to permit exposure of the imaging material to the image to be reproduced. The imaging layer serves the dual function of imparting light sensitivity to the system while at the same time acting as colorant for the final image produced. In one form, the imaging layer comprises a photosensitive pigment, such as metal-free phthalocyanine, dispersed in a cohesively weak insulating binder.

The system is capable of producing monochromatic images excellent density and resolution. Developing an image formed in this system is very simple since no wet chemical developing agents are required. This system, however, has been limited to monochromatic imaging since it is necessary that appreciably large portions of the imaging layer be transferred during the imaging step. If an attempt is made to uniformly mix pigment particles responding to different colors throughout the imaging material, effective strip-out becomes very difficult since particles of different colors scattered throughout the thickness of the imaging layer tend to mask each other and prevent stripping of single colors only in desired single colored areas. Thus, for example, where only yellow colored particles should be transferred, when the yellow particles and surrounding binder materials are stripped out, the binder material will carry with it magenta and cyan particles which are in the surrounding binder. Thus, color separation becomes difficult if not impossible.

It is, therefore, an object of this invention to provide a photographic multicolor imaging process overcoming the above-noted deficiencies.

It is another object of this invention to provide a photographic multicolor imaging process utilizing dry, non-chemical development.

It is another object of this invention to provide a material for producing photographic multicolor images which are not subject to degradation due to exposure to light, heat, or high humidity.

It is a further object of this invention to provide a high contrast, multicolor photographic strip-out process.

A still further object of this invention is to provide a multicolor imaging process of the lowest possible order of complexity.

Still another object of this invention is to provide a novel color imaging member in the form of a manifold set.

The above objects and others are accomplished, fundamentally, by providing a manifold imaging set in which the imaging material is coated onto the donor substrate as a plurality of small contiguous areas, different areas having at least two different colors which respond to lights of different colors whereby the manifold set will respond to color originals selectively so as to produce a full-color image corresponding to the original.

Typically, for subtractive color imaging, the areas will comprise photosensitive dyes or pigments, different areas being yellow, magenta and cyan in color. While three colors will be preferred for natural color imaging, two colors will be sufficient for many purposes, e.g., for forming printing on posters in two colors on a white or transparent background.

The contiguous areas of different colors may be coated onto the donor substrate by any suitable method. For example, the color areas may be printed by conventional multicolored printing means such as gravure rollers or by conventional color lithography. For example, three half-tone screens may be prepared, one for each of the different colored patterns so that when each plate is inked with a different color, patterns will be printed on the substrate in registration. Typical of the printing techniques which may be used are those described in "Practical Photo-Lithography" by C. M. Willy, Pittman and Sons, Ltd., London, 1952 and in "Photography and Plate Making for Photo-Lithography," I. H. Sayre, Lithographic Textbook Publishing Company, Chicago, 1944. Also, the areas could be laid down by spraying the colored material through stencils.

The individual colored areas may comprise any material having suitable color, photosensitivity, and spectral response. These areas may be either homogeneous or heterogeneous; that is, may comprise a photosensitive material dispersed in a binder or may consist entirely of the photosensitive material. Typical highly colored photosensitive materials which may be dispersed in a binder include Algol Yellow GC, 1,2,5,6-di-(C,C'-diphenyl) thiazole-anthraquinone, C.I. No. 67300, available from General Dye Stuffs; Calcium Litho Red the calcium lake of 1-(2-azonaphthalene-1'-sulfonic acid)-2-naphthol, C.I. No. 15630 available from Collway Colors; Cyan Blue GTNF, the beta form of copper phthalocyanine, C.I. No. 74160, available from Collway Colors; Diane Blue, 3,3'-methoxy - 4,4' - diphenyl-bis(1''-azohydroxy-3''-naphth-anilide, C.I. No. 21180 available from Harmon Colors; Duol Carmine, the calcium lake of 1-(4'-methylazobenzene)-2'-sulfonic acid)-2-hydroxy-3-naphthoic acid, available from E. I. du Pont de Nemours & Co.; Indofast Brilliant Scarlet Toner, 3,4,9,10-bis [N,N'(p-methoxyphenyl)-imido]-perylene, C.I. No. 71140, available from Harmon Colors; Indofast Yellow Toner, flavanthrone, C.I. No. 70600, available from Harmon Colors; Methyl Violet, a phosphotungstomolybdic lake of 4-(N,N',N''-trimethylanilino)methylene-N'',N'' - dimethylanilinium chloride, C.I. No. 42535, available from Collway Colors; Monolite Fast Blue GS, a mixture of the alpha and beta forms of metal-free phthalocyanine, available from the Arnold Hoffman Company; Naphthol Red B, 1-(2'-methoxy-5'-nitrophenylazo) - 2-hydroxy-3''-nitro-3-naphthanilide, C.I. No. 12355, available from Collway Colors; Quindo Magenta RV-6803, a substituted quinacridone, available from Harmon Colors, Vulcan Fast Red BBE Toner 35-2201, 3,3' - dimethoxy - 4,4'-biphenyl-bis(1''-phenyl-3''-methyl-4''-azo-2''-pyrazolin-5''-one), C.I. No. 21200, available from Collway Colors; Watchung Red B, 1-(4'-methyl-5'-chloroazobenzene-2'-sulfonic acid)-2-hydroxy-3-naphthoic acid, C.I. No. 15865, available from E. I. du Pont de Nemours & Company; and pigments prepared as described in copending applications Ser. Nos. 421,377; 421,280; 421,281 (each filed Dec. 28, 1964) now U.S. Pats. 3,448,029; 3,448,028 and 3,447,922 respectively, 445,179 now U.S. Pat. 3,445,277; 445,235 now U.S. Pat. 3,402,177; and 444,240, now abandoned (each filed Apr. 2, 1965). Typical photosensitive materials which may have a suitable dye incorporated to produce the desired color include 2,5 - bis(p - aminophenyl)-1,3,4-oxadiazol; 4,5-diphenylimidazolindine; N-isopropyl carbazole, triphenyl amine; triphenylpyrrol; 1,4-dicyano naphthalene; 1,2,5,6-tetraazacyclooctatetraene - (2,4,6,8); 2 - phenyl-4-alpha-naphthylideneoxazolone; 6 - hydroxy-2,3-di(p-methoxyphenyl)benzofurane; 5 - benzilidene-aminoaceneaphthene; 3-aminocarbazole and mixtures thereof. Any of the photosensitive materials described above may be sensitized, if desired, with suitable dye sensitizing agents or Lewis acids. Typical Lewis acids include 2,4,7-trinitro-9-fluorenone; 2,4,5,7-tetranitro-9-fluorenone; picric acid; 1,3,5-trinitro benzene and chloranil.

5

As stated above, the imaging layer should have relatively low cohesive strength either in the as-coated condition or after it has been suitably activated. This, of course, is true for both the homogenous system and the heterogeneous system. Low cohesive strength may, for example, be obtained by employing as a binder low molecular weight materials such as microcrystalline wax, paraffin wax, low molecular weight polyethylene and other low molecular weight polymers. Also, suitable blends of incompatible materials, such as a blend of polysiloxane resin with a polyacrylic ester resin may be used in the imaging layer. Imaging layer thicknesses of from about 0.5 to about 10 microns may be used. Within this range, the thinner layers tend to give increased resolution while the thicker layers tend to give increased density in images produced. Since it is generally desirable that the imaging layer fracture at boundaries between contiguous areas of different colors, the individual areas may be printed on the donor substrate in a very slightly spaced relationship. While this will reduce slightly resolution and color density in the images produced, it will insure proper separation of the layer during imaging.

The donor substrate sheet and the receiving sheet may alternatively comprise conductive materials or insulating materials backed with conductive materials. At least one of these sheets should be at least partially transparent so that an image may be projected onto the imaging layer through the sheet. At the time of imaging, the imaging layer should adhere reasonably equally to each of the two contacting sheets, adhering to a slightly greater extent to the donor substrate sheet. The donor substrate and the receiving sheet may consist of the same or different materials. Any suitable conductive material may be used for these sheets, such as cellophane. Alternatively, these sheets may comprise an insulating material, such as polyethylene, polyethylene terephthalate, cellulose acetate, and the like, backed by a conductive electrode material such as evaporated tin oxide. One of these sheets may consist of an opaque material, such as paper, if desired.

Where the imaging layer does not have sufficiently low cohesive strength at the time of imaging, it must be activated as described above. Typical activating fluids, as further described below, may include any material which will dissolve or swell the imaging layer, thereby reducing its cohesive strength. The activating fluid is ordinarily applied to the imaging layer immediately before the imaging operation takes place. Any suitable volatile or non-volatile activating fluid may be employed. Typical materials include kerosene, carbon tetrachloride, petroleum ether, silicone oils, such as dimethyl-polysiloxanes, long chain aliphatic hydrocarbon oils such as those ordinarily used as transformer oils, trichloroethylene, chlorobenzene, benzene, toluene, xylene, hexane, acetone, vegetable oils, or mixtures thereof.

The invention may be further understood by reference to the drawing in which an embodiment of the invention is illustrated by way of example and in which:

FIG. 1 shows schematically, a side sectional view of a photosensitive imaging member for use in the process of this invention;

FIG. 2 shows one method of activating the imaging member;

FIG. 3 shows the step of exposing the imaging member to light of different colors; and

FIG. 4 shows the process step of separating the imaging member to produce the final full color image.

Referring now to FIG. 1, there is seen a color manifold set generally designated 1 made up of several components. Donor substrate 2 has coated on one surface thereof a layer of imaging material 3 made up of a plurality of differently colored areas. For subtractive polychromatic image formation, these areas are colored magenta, yellow, and cyan. In FIG. 1 these areas are indicated by "M" for magenta, "Y" for yellow, and "C" for cyan. These

6

areas may, for example be formed as contiguous dots or as contiguous lines. These areas may have a diameter ranging, for example, from 0.5 micron to about 50 microns. Obviously, the smaller colored dots or narrower colored lines will result in higher resolution in the final image. Therefore, it is preferred that these areas be as small as possible, limited only by the printing or stenciling process used to coat them on substrate 2. As shown in FIG. 1, substrate 2 has a conductive backing 4. This conductive backing is necessary where donor substrate 2 is insulating and may be eliminated where donor substrate 2 is relatively conductive, such as cellophane. In contact with the upper surface of imaging material 3 is a receiving sheet 5. Where receiving sheet 5 is insulating, it will have, as shown in FIG. 1, a conductive backing layer 6. This conductive backing layer 6 may be eliminated where layer 5 is conductive.

One method of activating imaging material 3 is shown in FIG. 2. Where it is desirable to lower the cohesive strength of layer 3 so as to prove fracturing during imaging, receiving sheet 5 is removed from the surface of imaging material 3. A solvent or swelling agent is applied to the surface of imaging material 3 and receiving sheet 5 is replaced. A spray means 7 is shown in FIG. 2 for applying activating fluid 8 to the exposed surface of imaging material 3. Alternatively, the activating fluid 8 may be applied by any suitable technique, such as with a brush, with a smooth or rough surface roller, by flow coating, by vapor condensation or the like. After activating fluid 8 has been applied, the manifold set is closed by roller 9 which also acts to squeeze out excess activating fluid from the set. This activating step is, of course, unnecessary where the layer 3 is already sufficiently frangible for imaging. This may be the case, for example, where in printing the contiguous colored areas, only a very weak bond was obtained between adjoining areas. Also, sufficient solvent may have remained in imaging material 3 after coating to give the desired frangible characteristics.

When the manifold set has been prepared for imaging, it is exposed to a full color image, as by projection, through one of the covering sheets 2 and 5. While the imaging layer may be exposed through either of the covering sheets 2 and 5, for highest color fidelity and greatest photosensitivity it is preferred that exposure be made through the donor sheet, substrate 2. FIG. 3 shows, schematically, the exposure of groups of colored areas to light of different colors. Area 9 is exposed to white light, area 10 is not exposed, area 11 is exposed to red light, area 12 is exposed to blue light, area 13 is exposed to green light and area 14 is exposed to yellow light. During the exposure operation, a potential is imposed across imaging material 3 between electrodes formed by conductive layers 4 and 6 by means of potential source 15 acting through resistor 16. The polarity of the potential imposed on the donor-substrate may be either positive or negative. However, for some materials there is a preferred polarity orientation. Preferred field strengths are in the range of about 1,500 to 2,000 volts per mil across the manifold set. Thus, using two mil Mylar sheets for both donor substrate and receiver sheet, the preferred applied voltage is about 6,000 to 8,000 volts across the electrodes outside these Mylar sheets. However, satisfactory images are also produced with voltage of from about 2,000 to about 10,000 volts. The potential may be imposed either before or after the receiving sheet 5 is brought into contact with imaging material 3. Where potential is imposed before assembly of the manifold set, it is desirable that a resistor 16 having a resistance on the order of 5,000 to 20,000 megohms be included in the circuit. This resistor prevents air gap breakdown between the imaging material 3 and receiving sheet 5 as they are brought together or separated.

After exposure, the manifold set is separated as shown in FIG. 4, producing a visible multicolored image. As shown in FIG. 4, with subtractive color formation, the

positive image conforming to the original is ordinarily formed on the donor substrate. Ordinarily, the electric field is maintained across the imaging material during the separating step. As shown in FIG. 4, white light exposure in area 9 results in transfer of the magenta, yellow, and cyan areas to the receiving sheet 5, leaving a white or transparent area on donor substrate 2. Where no light strikes the imaging material as in area 10, all of the material remains on the donor substrate, combining to form a block-appearing area. Where red light strikes the imaging material as in area 11, the cyan material transfers leaving behind the magenta and yellow areas which combine to appear red to the eye. Where blue light strikes the imaging material as in area 12, the yellow material transfers, leaving behind magenta and cyan which combine to appear blue to the eye. Where green light strikes the imaging material as in area 13, the magenta material transfers leaving behind yellow and cyan which combine to appear green to the eye. Where yellow light strikes the imaging material as in area 14, the magenta and cyan materials transfer leaving behind only yellow. Thus, it can be seen that this is a simple and economical method of producing full color copies.

The following examples will further specifically define the color imaging process of the present invention. Parts and percentages are by weight unless otherwise indicated. The examples below are intended to illustrate various preferred embodiments of the present invention.

EXAMPLE I

The material for the imaging layer is prepared as follows: About 5 parts of Sunoco 1290, a micro-crystalline wax with a melting point of about 180° F. is dissolved in about 100 parts of reagent grade petroleum ether heated to about 50° C. and quenched by immersing the container in cold water to form small wax crystals. About 5 parts of Monolite Fast Blue GS, a mixture of alpha and beta forms of metal-free phthalocyanine, available from the Arnold Hoffman Co. is placed in a ball mill jar with wax paste. The jar is then half filled with clean porcelain balls and the formulation is ball milled in darkness for about 3 hours at about 70 revolutions per minute. After milling, about 20 parts of Sohio Odorless Solvent 3440, a kerosene fraction available from Standard Oil of Ohio, is added to the paste. A second sample is then prepared as above except that the pigment is Algol Yellow GC, 1,2,5,6-di(C,C'-diphenyl)-thiazole-anthraquinone, C.I. No. 67300, available from General Dyestuffs. A third sample is then prepared as above except that the pigment is Watchung Red B, 1-(4'-methyl-5'-chloroazobenzene-2'-sulfonic acid)-2-hydroxy-3-naphthoic acid, C.I. No. 15865, available from E. I. du Pont de Nemours & Co. A continuous pattern of cyan, yellow and magenta dots are then printed onto a 2-mil Mylar sheet by conventional 3-color lithographic printing means. The resulting colored areas are substantially in contact with each other but with little or no overlap. Each area has a diameter of about 5 microns and a thickness of about 3 microns. The thus produced coated donor sheet is then placed on the tin oxide surface of a NESA glass plate with the coating facing away from the tin oxide. A receiver sheet, also of 2-mil-thick Mylar, is then placed on the coated surface of the donor. Then, a sheet of black, electrically conductive paper is placed over the receiver sheet to form the complete color manifold set. The receiver sheet is then lifted up and the imaging layer is activated with one quick brush stroke of a wide camel's hair brush saturated with petroleum ether. The receiver sheet is then replaced on the imaging layer and a roller is rolled slowly once over the closed color manifold set with light pressure to squeeze out excess petroleum ether. The negative terminal of an 8,000 volt DC power supply is then connected to the NESA coating in the series with a 5,500 megohm resistor and the positive terminal is connected to the black opaque electrode and grounded. While the voltage is applied, an

image is projected upward through the NESA glass through a "Kodachrome" transparency using a Wollensak 19 millimeter, f4.5 enlarger lens with illumination of approximately 0.01 foot-candle applied for about 5 seconds for a total incident energy of about 0.05 foot-candle-seconds. After exposure, the receiver sheet is peeled from the set with the potential source still connected. A full color image conforming to the original of good quality is observed on the donor sheet.

EXAMPLE II

A second color manifold set is prepared and imaged as in Example I with the following modifications: Here, the three pigments are a cyan, Diane Blue, 3,3'-methoxy-4-4'-diphenyl-bis (1''-azo-2''-hydroxy-3''naphthanilide), C.I. No. 21180, available from Harmon Colors; a magenta, Locarno Red X-1686, 1-(4'-methyl-5'-chloroazobenzene-2'-sulfonic acid)-2-hydroxy-3-naphthoic acid, C.I. No. 15865, available from American Cyanamid Co.; and a yellow, Indofast Yellow Toner, flavanthrone, C.I. No. 70600, available from Harmon Colors. Also, instead of the micro crystalline wax, the binder here is Epolene C-12, a low molecular weight polyethylene having an approximate molecular weight of 3,700, a ring and ball softening point of about 92° C., an acid number of about 0.5 and a density at 25° C. of about 0.893, available from Eastman Chemical Products Company. When the color manifold set prepared from these materials as in Example I, is imaged as in Example I, a full color image conforming to the original of excellent quality results.

EXAMPLE III

A color manifold imaging set is prepared as follows: A pattern of alternating contiguous date is formed by printing from three color separation originals onto a Mylar film. The dots are cyan, magenta and yellow in color. This film is then used as an original to prepare color manifold sheets. The manifold sheets are prepared by the photoelectrophoretic imaging method described in copending application Ser. No. 384,681, filed July 23, 1964, now abandoned. An imaging mix is prepared by mixing about 7 parts Algol Yellow GC, about 7 parts Monolite Fast Blue GS, about 7 parts Watchung Red B, and about 50 parts Sunoco 1290 in about 100 parts Sohio Odorless Solvent 3440. A color image is formed by the process described in the above-cited application, using the printed film described above as the original. The resulting image is transferred to a Mylar sheet. This image comprises magenta, yellow and cyan dots in a wax matrix, and conforms to the original. A receiver sheet of 2 mil Mylar is placed over the image to form a color manifold set. Additional color manifold sets may be quickly and conveniently prepared from the printed film original. This color manifold set is imaged as in Example I. A full color image conforming to the original results.

EXAMPLE IV

A color manifold set is prepared as in Example I, except that the matrix material is Epolene C-12 in place of the Sunoco 1290 and the cyan, magenta and yellow pigments are the x-form of metal-free phthalocyanine, prepared as described in copending application, Ser. No. 505,723 filed Oct. 29, 1965, now U.S. Pat. 3,357,989; 2-(4'-toluazo)-4-isopropoxy-1-naphthol, prepared as described in copending application Ser. No. 445,240, filed Apr. 2, 1965, now U.S. Pat. 3,384,632, and N-2''-pyridyl-8,13-dioxodinaaphtho-(1,2,2',3')-furan-6-carboxamide; respectively. An image is formed as in Example I, except that the exposure is for about 15 seconds, producing a total incident energy of about 0.15 foot-candle-second. A full color image conforming to the original results.

Although specific components and proportions have been described in the above examples relating to color manifold imaging systems and materials, other suitable materials as listed above, may be used with some more

9

results. In addition, other materials may be added to the imaging layer, donor sheet and receiving sheet to synergize, enhance, or otherwise modify their properties. For example, various dyes, spectral sensitizers or electrical sensitizers such as Lewis acids may be added to the several layers.

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. A method of color imaging comprising:

(a) providing an electrically photosensitive imaging layer sandwiched between a donor sheet and a receiving sheet, said imaging layer being structurally fracturable in response to the combined effect of an applied electric field and exposure to electromagnetic radiation to which said layer is sensitive and comprising contiguous areas of at least two different electrically photosensitive materials of different colors, each of said areas being responsive to lights of different colors;

(b) exposing said imaging layer to a pattern of electromagnetic radiation to which at least one of said areas is sensitive while applying an electric field across said imaging layer; and

(c) during the application of said field separating said receiving sheet from said donor sheet whereby said image layer fractures in imagewise configuration forming a multi-color image conforming to the original on at least one of said sheets.

2. The method of claim 1 wherein the said imaging layer is rendered structurally fracturable in response to the combined effect of an applied electrical field and exposure to electromagnetic radiation to which said layer is sensitive by the application thereto of an activator fluid selected from the group consisting of solvents, partial solvents and swelling agents for said imaging layer before said sandwich is assembled.

3. The method of claim 1 wherein said imaging layer comprises electrically photosensitive pigment particles dispersed in a binder.

4. The method of claim 3 wherein the imaging layer is rendered structurally fracturable in response to the combined effect of an applied electric field and exposure to electromagnetic radiation to which said layer is sensitive by the application of an activator thereto prior to the separation of the sandwich said activator selected from the group consisting of solvents, partial solvents and swelling agents for said layer.

5. The method of claim 4 wherein said imaging layer is made up of contiguous areas having cyan, magenta and yellow colors.

6. The method of claim 1 wherein said donor sheet is at least partially transparent and said imaging layer is exposed through said donor sheet.

8. The method of claim 7 wherein said contiguous areas comprise dots of cyan, magenta and yellow colors.

10

7. A method of color imaging comprising the steps of:
(a) providing an electrically photosensitive imaging layer coated on a donor sheet, said imaging layer comprising contiguous areas of at least two different electrically photosensitive materials of different colors, each of said areas being responsive to lights of different colors;

(b) applying an activator to said imaging layer to render said layer structurally fracturable, said activator selected from the group consisting of solvents, partial solvents and swelling agents for said layers;

(c) placing a receiving sheet over said imaging layer;

(d) exposing said imaging layer to a multicolor light image to which at least one of said areas is sensitive while simultaneously applying an electric field across said imaging layer; and,

(e) separating said receiving sheet from said donor sheet during the application of said field whereby said imaging layer fractures in imagewise configuration forming a multicolor image conforming to the original on at least one of said sheets.

9. The method of claim 7 wherein said donor sheet is at least partially transparent and said imaging layer is exposed through said donor sheet.

10. The method of claim 7 wherein the imaging layer comprises an electrically photosensitive material dispersed in a binder.

11. A color imaging member comprising an electrically photosensitive imaging layer said layer being structurally fracturable in response to the combined effect of an applied electric field and exposure to electromagnetic radiation to which said layer is sensitive and made up of contiguous areas of at least two different electrically photosensitive materials of different colors, each of said areas being responsive to lights of different colors, coated on a donor sheet and a receiving sheet in contact with said imaging layer with a least one of said donor and receiving sheets being substantially transparent to electromagnetic radiation to which at least one of said areas is sensitive.

12. The color imaging member of claim 11 wherein said imaging layer has a stronger initial degree of adhesion for said donor sheet than for said receiving sheet.

13. The color imaging member of claim 11 wherein said contiguous areas comprise dots having magenta, cyan and yellow colors.

References Cited

UNITED STATES PATENTS

2,940,847	6/1960	Kaprelian	96—1
3,212,887	10/1965	Miller et al.	96—1
3,316,088	4/1967	Schaffert	96—1.5

GEORGE F. LESMES, Primary Examiner

J. C. COOPER, Assistant Examiner

U.S. Cl. X.R.

96—1, 1.3, 1.4, 1.5, 27