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MANIFOLD IMAGING PROCESS

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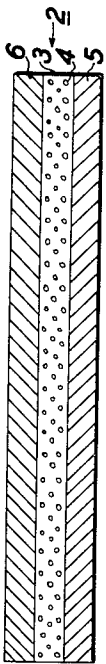


FIG. 1

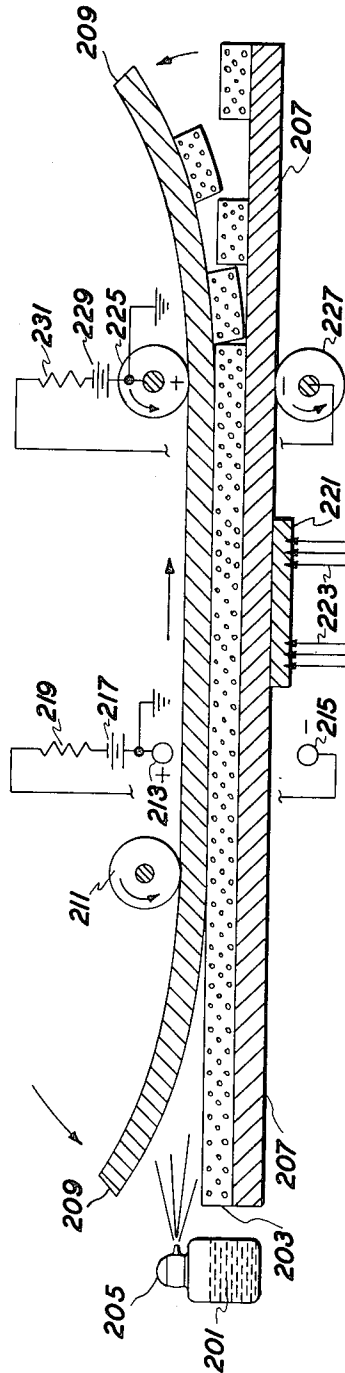


FIG. 2

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MANIFOLD IMAGING PROCESS

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10 Claims

ABSTRACT OF THE DISCLOSURE

An improved imaging process wherein a cohesively weak electrically photosensitive imaging layer is sandwiched between a donor sheet and a receiver sheet. The imaging layer is subjected to an electric charge provided at least in part by a static charge on one of the sheets and the imaging layer is exposed to a pattern of electromagnetic radiation to which the imaging layer is sensitive. Subsequently, the charge bearing sheet or sheets are electrically charged a second time. While under an electrical charge the sandwich is separated whereby the imaging layer fractures in imagewise configuration.

BACKGROUND OF THE INVENTION

This invention relates in general to an improved imaging process and more specifically to a process for the formation of images by layers transfer in imagewise configuration.

An imaging process has recently been developed wherein an imaging layer sandwiched between two sheets is fractured in imagewise configuration by the combined effects of electromagnetic radiation and an electric field. This imaging process is commonly termed the manifold imaging process and utilizes a manifold sandwich comprising an electrically photosensitive material positioned between a pair of sheets. In this imaging system, an imaging layer is prepared conventionally by coating a layer of electrically photosensitive imaging material onto a substrate. In one form the imaging layer comprises an electrically photosensitive material such as metal-free phthalocyanine dispersed in a cohesively weak binder. This coated substrate is called a donor. The other sheet is commonly termed a receiver. An electric field is applied across this manifold sandwich conventionally while it is exposed to a pattern of light and shadow representative of the image to be reproduced. Upon separation of the donor substrate or sheet and receiver sheet, the imaging layer fractures along the lines defined by the pattern of light and shadow to which the imaging layer has been exposed. Part of the imaging layer is transferred to one of the sheets while the remainder is retained on the other sheet so that a positive image, that is, a duplicate of the original is produced on one sheet while a negative image is produced on the other. The separation of the donor sheet and receiver sheet takes place under an electrical field.

The quality of images obtained by means of the manifold imaging process have been found to vary considerably without apparent explanation since measurable variables appear to have been held constant. That is, identical manifold sandwiches have been exposed to the same amount of light under the same apparent electrical field conditions but on different occasions the images thus produced have varied in quality. In addition, there are many different types of materials employed as donor and receiver sheets in the manifold process. Paper, thermoplastic materials, metal or plastic coated paper sheets are exemplary of these materials, but such differences do not explain the variation in image quality.

It has now been found that the field across the manifold sandwich, in some instances, decays for various rea-

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sons subsequent to imagewise exposure of the imaging layer and prior to sandwich separation. It has further been discovered that the quality of the image produced by the manifold process is adversely affected by such charge decay. The many mechanical conditions under which the manifold process can be operated and the many different materials useful in the process, renders difficult the solution to the problem of charge decay. For example, atmospheric conditions affect the conductivity of many materials employed in the process since their electrical conductivity varies with atmospheric humidity. Charge leakage across the manifold sandwich may occur for many other reasons such as machine cleanliness, etc. Thus, there is a need for a process which provides a remedy for charge decay across the manifold sandwich subsequent to imagewise exposure of the imaging layer but prior to sandwich separation.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to provide an imaging process which will overcome the above noted disadvantages.

Another object of this invention is to provide an improved manifold imaging process.

Another object of this invention is to provide a process for producing improved images.

Now, therefore, in accordance with the present invention an imaging layer is exposed to electromagnetic radiation to which it is sensitive while subjected to an electric field. The imaging layer is sandwiched between a donor sheet and a receiver sheet and fractured in imagewise configuration upon separation of the sandwich. Prior to separating the manifold sandwich but subsequent to the exposure step, the electric field is increased or intensified to restore the electrical field to the strength employed during exposure of the imaging layer or above that strength. The exposure can take place either before or after the manifold sandwich is formed but, of course, if the exposure step takes place after sandwich formation then at least one of the donor and receiver sheets must be transparent to the electromagnetic radiation employed.

In the manifold imaging process, an electric field is provided by many different means such as placing the imaging layer sandwiched between the donor and receiver sheets between a pair of electrodes and applying a potential between the electrodes. The electric field can also be provided by employing an electrically insulating material in at least one of the sheets and producing a static charge in the insulating sheet. When only one electrically insulating sheet is employed, the field is created by employing one electrode on the opposite side of the manifold sandwich from the conductive sheet which is grounded. The static charge can be created by means such as friction charging, corona charging or by passing the electrically insulating layer between a pair of electrically conductive rollers which are under a potential. Thus, the static charge is developed by providing an electrical charge bearing member and an electrically insulating layer and positioning the charge bearing member in electrical communication with the electrically insulating layer. The electric field can be increased or intensified by the same or different means employed to initially impose the electric field. Thus, a pair of electrodes can be placed under greater potential difference subsequent to the exposure step than they were under prior to the exposure step. In addition, when the electric field is imposed by means of a static charge on at least one of the donor and receiver sheets, the manifold sandwich is positioned in electrical communication with a charge bearing member after the exposure step to increase the static charge in the sheet.

After increasing or intensifying the electrical field, the manifold sandwich is separated whereupon the imaging layer fractures along the lines defined by the pattern of light and shadow of electromagnetic radiation to which the imaging layer has been exposed. Part of the imaging layer is transferred to one of the sheets while the remainder is retained on the other sheet so that a positive image that is a duplicate is produced on one sheet while a negative image is produced on the other.

The electric field, at the time the imaging layer is exposed, and the manifold sandwich is separated desirably in the range of from about 2,000 to 10,000 volts per mil across the imaging layer. Preferably, the electric field is in the range of from about 3,000 to about 7,000 volts per mil. To attain such electric field, a potential of from 5,000 to about 20,000 volts can be employed. Higher voltages can be employed but are not desirable.

The process of this invention has been found to be particularly useful in the manifold imaging process wherein the electric field is provided by a static charge in at least one of the donor and receiver sheets which are electrically insulating. Either or both of the electrically insulating sheets can be placed in electrical communication with a charge bearing member both before and after the exposure step of the imaging process. Said charge bearing members can be devices such as the corona discharge device described in U.S. Patent No. 2,588,699 to Carlson, U.S. Patent 2,777,957 to Walkup, and U.S. Patent 2,885,556 to Gundlach. Conductive wires can also be employed as can frictional means as described in U.S. Patent 2,297,691 to Carlson. Although other suitable apparatus can be employed as the charge bearing member in the process of this invention, a preferred embodiment is a conductive roller or a pair of rollers as described in U.S. Patent No. 2,980,834 to Tregay et al.

As stated above, the electric field across the imaging layer during the exposure and separation steps is desirably in the range of from about 2,000 to about 10,000 volts per mil. In the process of this invention wherein the electric field is supplied by means of a static charge in at least one of the donor and receiver sheets, a loss of voltage due to leakage is experienced during the time between the exposure step and the sandwich separation step. This loss of voltage results in images of inferior quality. The process of this invention is advantageously employed to provide the voltage required to produce high quality images by increasing the electric field across the imaging layer prior to the separation step and thereby restore the field loss due to leakage. Thus, the process of this invention increases the electric field across the imaging layer either to an amount equal to that maintained during the exposure step or an amount in excess of that maintained during the exposure step.

In the process of this invention the electrodes employed may consist of any suitable conductive material. Typical conductive electrode materials include aluminum brass, stainless steel, copper, nickel, zinc and mixtures thereof. Aluminum is preferred because it is readily available and it is a good conductor. Also, when one of the donor and receiver sheets is electrically conductive, the sheet may be employed as the electrode. Thus one of the sheets can be employed in a dual function, i.e. as an electrode and as part of the sandwich.

The electrically insulating receiver or donor sheet may consist of any suitable insulating material. Typical insulating materials include polyethylene, polypropylene, polyethylene terephthalate, cellulose acetate, paper, plastic coated paper such as polyethylene coated paper and mixtures thereof. Mylar, a polyester formed by the condensation reaction between ethylene glycol and terephthalic acid, available from the E. I. du Pont de Nemours & Company, Inc., is preferred because of its physical strength and its insulation qualities. Conductive materials such as aluminized paper, metal foil, cellophane and conductively coated glass may be employed.

In the manifold imaging process, the imaging layer contains any suitable electrically photosensitive material. Such electrically photosensitive material can be coated on an electrically insulating sheet or a conductive sheet to form a donor for use in the manifold imaging process. Typical organic electrically photosensitive materials include: quinacridones such as: 2,9-dimethyl quinacridone, 4,11-dimethyl quinacridone, solid solutions of quinacridones and other compositions as described in U.S. Pat. 3,160,510; carboxamides such as N-2''-(1'',3'',5''-triazyl - 8, - 13 - dioxo dinaphtho - (2,2'',3)furan-6-carboxamide; anthraquinones such as 1,5-bis(benzyl-amino) anthraquinone; phthalocyanines such as beta form metal-free phthalocyanine, copper phthalocyanine, tetra chloro cyanine, the x-form of metal-free phthalocyanine as described in U. S. Pat. 3,357,989; metal salts and lakes of azo dyes such as calcium lakes of 6 - bromo - 1 (1' - sulfo - 2 - naphthylazo) - 2 - naphthol barium salt of 6 - cyano - 1 - (1' - sulfo - 2 - naphthylazo)-2-naphthyl and mixtures thereof.

Typical inorganic electrically photosensitive materials include cadmium sulfide, calcium sulfoselenide, zinc oxide, zinc sulfide, sulphur selenium, mercuric sulfide, lead oxide, lead sulfide, cadmium selenide, titanium dioxide, indium trioxide and the like.

In addition to the aforementioned organic and inorganic materials which may be employed in the imaging layer other such materials may be used as described in U.S. Patent application Ser. No. 708,380 filed Feb. 26, 1968.

The x-form phthalocyanine is preferred because of its excellent photosensitivity although any suitable phthalocyanine may be used to prepare the imaging layer of this invention. The phthalocyanine used may be in any suitable crystal form. It may be substituted or unsubstituted both in the ring and straight chain portions. References made to a book entitled "Phthalocyanine Compounds" by F. H. Moser and A. L. Thomas, published by the Reinhold Publishing Co., 1963 edition for a detailed description of phthalocyanine and their synthesis. A particularly preferred x-phthalocyanine is described in U.S. patent application Ser. No. 708,380 referred to above.

The basic physical property desired in the imaging layer is that it be frangible as prepared or after having been suitably activated. That is the layer must be sufficiently weak structurally so that the application of electric field combined with the action of electromagnetic radiation on the electrically photosensitive material will fracture the imaging layer. Further, the layer must respond to the application of the field the strength of which is below that field strength which will cause electrical breakdown or arcing across the imaging layer. Thus, the imaging layer must be cohesively weak at the time the manifold sandwich is separated so that the imaging layer will fracture along the lines of light and shadow of the electrical magnetic radiation to which the imaging layer has been exposed. Another term for "cohesively weak," therefore, would be "field fracturable."

The imaging layer serves as the photoresponsive element of the system as well as the colorant for the final image produced. Preferably, the imaging layer is selected so as to have a high level of response while at the same time being intensely colored so that a high contrast image can be formed by the high gamma system of this invention. The imaging layer may be homogeneous comprising, for example, a solid solution of two or more pigments with one or more pigments being electrically photosensitive. The imaging layer may also be heterogeneous comprising, for example, pigment particles dispersed in a binder.

One technique for achieving low cohesive strength in the imaging layer is to employ relatively weak, low molecular weight materials therein. Thus, for example, in a single component homogeneous imaging layer, a monomeric compound or a low molecular weight polymer complexed with a Lewis acid to impart a high level of photo-

response to the layer may be employed. Similarly, when a homogeneous layer utilizing two or more components in solid solution is selected to make up the imaging layer, either one or both of the components of the solid solution may be a low molecular weight material so that the layer has the desired low level of cohesive strength. This approach may also be taken in connection with the heterogeneous imaging layer. Although the binder material in the heterogeneous system may in itself be photosensitive, it does not necessarily have this property. Materials may be selected for use as the binder material solely on the basis of physical properties without regard to their photosensitivity. This is also true of the two component homogeneous system where photoinsensitive materials with the desired physical properties can be used. Any other technique for achieving low cohesive strength in the imaging layer may also be employed. For example, suitable blends of incompatible materials such as a blend of a polysiloxane resin with a polyacrylic ester resin may be used either as the binder layer in a heterogeneous system or in conjunction with a "homogeneous" system in which the photoresponsive material may be either one of the incompatible components (complexed with a Lewis acid) or a separate and additional component of the layer. The thickness of the imaging layer preferably ranges from about 0.2 micron to about 10 microns generally about 0.5 micron to about 5 microns and preferably about 1 micron.

The ratio of photosensitive pigment to binder by volume in the heterogeneous system may range from about 10 to 1 to about 1 to 10 respectively, but it has generally been found that properties in the range of from about 1 to 4 to about 2 to 1 respectively, produce the best results and, accordingly, this constitutes a preferred range.

The binder material in the heterogeneous imaging layer or the material used in conjunction with the pigment materials in the homogeneous layer, where applicable, may comprise any suitable cohesively weak insulating material or materials which can be rendered cohesively weak. Typical materials include: microcrystalline waxes such as: Sunoco 1290, Sunoco 5825, Sunoco 985, all available from Sun Oil Co.; Paraffint RG, available from the Moore and Munger Company; paraffin waxes such as: Sunoco 5512, Sunoco 3425, available from Sun Oil Co.; Sohio Parowax, available from Standard Oil of Ohio; waxes made from hydrogenated oils such as: Capitol City 1380 wax, available from Capitol City Products Co., Columbus, Ohio; Caster Wax L-2790, available from Baker Caster Oil Co.; Vitikote L-340, available from Duro Commodities; polyethylenes such as: Eastman Epolene N-11, Eastman Epolene C-12, available from Eastman Chemical Products Co.; Polyethylene DYJT, Polyethylene DYLT, Polyethylene DYNF, Polyethylene DYDT, all available from Union Carbide Corp.; Marlex TR 822, Marlex 1478, available from Phillips Petroleum Co.; Epolene C-13, Epolene C-10, available from Eastman Chemical Products Co.; Polyethylene AC8, Polyethylene AC612, Polyethylene AC324, available from Allied Chemicals; modified styrenes such as: Piccotex 75, Piccotex 100, Piccotex 120, available from Pennsylvania Industrial Chemical; Vinylacetate-ethylene copolymers such as: Elvax Resin 210, Elvax Resin 310, Elvax Resin 420, available from E. I. du Pont de Nemours & Co., Inc.; Vistanex MH, Vistanex L-80, available from Enjay Chemical Co.; vinyl chloride vinyl acetate copolymers such as: Vinylite VYLF, available from Union Carbide Corp.; styrene-vinyl toluene copolymers; polypropylenes; and mixtures thereof. The use of an insulating binder is preferred because it allows the use of a larger range of electrically photosensitive pigments.

A mixture of microcrystalline wax and polyethylene is preferred because it is cohesively weak and an insulator.

Where the imaging layer is not sufficiently cohesively weak to allow imagewise fracture, it is desirable to include an activation step in the process of this invention. The

activation step may take many forms such as heating the imaging layer thus softening it or applying a substance to the surface of the imaging layer or including a substance in the imaging layer which substance lowers the cohesive strength of layer or aids in lowering the cohesive strength. The substance so employed is termed an "activator." Preferably, the activator should have a high resistivity so as to prevent electrical breakdown of the manifold set. Accordingly, it will generally be found to be desirable to purify commercial grades of activators so as to remove impurities which might impart a higher level of conductivity. This may be accomplished by running the fluids through a clay column or by employing any other suitable purification technique. Generally speaking, the activator may consist of any suitable material having the aforementioned properties. For purposes of this specification and the appended claims, the term activator shall be understood to include not only materials which are conventionally termed solvents but also those which are partial solvents, swelling agents or softening agents for the imaging layer. Heat may also be employed as an activator when applied so as to soften the imaging layer.

It is generally preferable that the activator have a relatively low boiling point so that fixing of the resulting image can be accomplished upon evaporation of the activator. If desired, fixing of the image can be accomplished more quickly with mild heating at most. It is to be understood, however, that the invention is not limited to the use of these relatively volatile activators. In fact, very high boiling point non-volatile activators including silicone oils such as dimethylpolysiloxanes and very high boiling point long chain aliphatic hydrocarbon oils ordinarily used as transformer oils such as Wemco-C transformer oil, available from Westinghouse Electric Co., have also been successfully utilized in the imaging process. Although these less volatile activators do not dry off by evaporation, image fixing can be accomplished contacting the final image with an absorbent sheet such as paper which absorbs the activator fluid. In short, any suitable volatile or non-volatile activator may be employed. Typical activators include Sohio Odorless Solvent 3440, an aliphatic (kerosene) hydrocarbon fraction, available from Standard Oil Co. of Ohio, carbon tetrachloride, petroleum ether, Freon 214 (tetrafluorotetrachloropropane), other halogenated hydrocarbons such as chloroform, methylene chloride, trichloroethylene, perchloroethylene, chlorobenzene, trichloromonofluoromethane, tetrachlorodifluoroethane, trichlorotrifluoroethane, amides such as formamide, dimethyl formamide, ethers such as diethyl ether, di-iodopropyl ether, dioxane, tetrahydrofuran, ethyleneglycol monoethyl ether, aromatic and aliphatic hydrocarbons such as benzene, toluene, xylene, hexane, cyclohexane, gasoline, mineral spirits, and white mineral oil, and vegetable oils such as coconut oil, babu-su oil, palm oil, olive oil, castor oil, peanut oil and neats-foot oil, decane, dodecane and mixtures thereof. Sohio Odorless Solvent 3440 is preferred because it is an excellent insulator and evaporates readily.

Although the imaging layers may be prepared as self-supporting films, normally these layers are coated onto a sheet referred to as the donor sheet or substrate. For convenience the combination of imaging layer and donor sheet is referred to as the donor. The electrically photosensitive pigment and electrically photoinsensitive pigment are usually blended or mixed together directly in the homogeneous system. When employing a binder the pigments can be either mixed separately in binder material by conventional means for blending solids as by ball milling or both pigments may be added directly to a binder material and dispersed as for example by ball milling or by heating the binder to a temperature above its melting point and dispersing the pigments in the fluid binder material by simple mixing. After blending the ingredients of the imaging layer, the desired amount is coated on a substrate. In a particularly preferred form

of the invention an imaging layer comprising the electrically photosensitive pigment and the electrically photosensitive pigment dispersed in a binder is coated onto a transparent, electrically insulating donor sheet.

A visible light source, an ultraviolet light source or any other suitable source of electromagnetic radiation may be used to expose the imaging layer in the manifold imaging process. The electrically photosensitive material is chosen so as to be responsive to the wave length of the electromagnetic radiation employed. It is to be noted that different electrically photosensitive materials have different spectral responses and that the spectral response of many electrically photosensitive materials may be modified by dye sensitization so as to either increase or narrow the spectral response of the material to a peak or to broaden it to make it more panchromatic in its response.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages of this improved imaging process will become apparent upon consideration of the detailed disclosure of the invention especially when taken in conjunction with the accompanying drawing wherein:

FIG. 1 is a side sectional view of a manifold sandwich for use in the method of this invention.

FIG. 2 is a side sectional view diagrammatically illustrating the process steps of the manifold imaging process embodying the process of this invention.

Referring now to FIG. 1, imaging layer 2 comprising electrically photosensitive material 4 dispersed in a binder 3 is deposited on the surface of donor sheet 5. Receiver sheet 6 rests upon imaging layer 2 to complete the manifold sandwich.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A commercial metal-free phthalocyanine is first purified by *o*-dichlorobenzene extraction to remove organic impurities. Since this extraction step yields the less sensitive beta crystalline form, the desired α -form is obtained by dissolving about 100 grams of beta in approximately 600 cc. of sulfuric acid, precipitating it by pouring the solution into about 3000 cc. of ice water and washing with water to neutrality. The thus purified α -form phthalocyanine is then salt milled for 6 days and desalted by slurring in distilled water, vacuum filtered followed by water washing, and finally methanol washing until the initial filtrate is clear. After vacuum drying to remove residual methanol, the α -form phthalocyanine thus produced is used to prepare the imaging layer according to the following procedure: about 5 grams of the α -form phthalocyanine is added to about 5 grams of Algol Yellow GC, 1,2,4,6-di-(*C,C'*-diphenyl) triazoleanthraquinone, C. I. No. 67300, available from General Dyestuffs and about 2.8 grams of purified 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., which is purified as follows: approximately 240 grams of the Watchung Red B is slurried in about 2400 milliliters of Sohio Solvent 3440, a mixture of kerosene fractions available from the Standard Oil Company of Ohio. The slurry is then heated to a temperature of about 65° C. and held there for about ½ hours. The slurry is then filtered through a glass sintered filter. The solids are then reslurried with petroleum ether (90 to 120° C.) available from Matheson, Coleman and Bell Division of the Matheson Company, East Rutherford, N.J. and filtered through a glass sintered filter. The solids are then dried in an oven at about 50° C.

About eight grams of Sunoco Microcrystalline Wax Grade 5852 having an ASTM-127 melting point of 151° F. and about two grams Parafint R.G., a low molecular weight paraffinic material, available from the Moore & Munger Company, New York city, and about 320 mil-

liliters of petroleum ether (90 to 120° C.) and about 40 milliliters of Sohio Odorless Solvent 3440 are placed with the pigments in a glass jar containing ½ inch flint pebbles. The mixture is then milled by revolving the glass jar at about 70 r.p.m. for about 16 hours. The mixture is then heated for approximately two hours at about 45° C. and allowed to cool to room temperature. The mixture is then ready for coating on the donor substrate. The paste-like mixture is then coated in subdued green light on 2 mil Mylar (a polyester formed by the condensation reaction between ethylene glycol and terephthalic acid available from E. I. du Pont de Nemours & Co., Inc.) with a No. 36 wire-wound drawdown rod to produce a coating thickness when dried of approximately 7½ microns. The coating on the two mil Mylar sheet is then dried in the dark.

Referring now to FIG. 2 there is shown the optional activation step in the manifold imaging process employing a donor sheet having an imaging layer coated thereon prepared as described above. Although the activator 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, FIG. 2 shows the activator fluid 201 being sprayed onto imaging layer 203 from container 205. Following the deposition of the activator fluid, the imaging layer is sandwiched between donor sheet 207 and receiver sheet 209. In certain instances the activation step of the manifold process may be omitted. Thus, for example, a manifold sandwich may be supplied wherein imaging layer 203 is initially fabricated to have a low cohesive strength so that activation may be omitted and receiver sheet 209 may be placed on the surface of imaging layer 203 directly. It is generally preferable, however, to include an activation step in the process.

In the preferred embodiment, after receiver sheet 209 has been placed on imaging layer 203, the sandwich is passed by roller 211 and an electrical field is applied across the manifold sandwich through electrodes 213 and 215 which are connected to potential source 217 and resistor 219. Although FIG. 2 shows the manifold sandwich not coming in contact with either electrode 213 or 215 since the receiver sheet and donor sheet are preferably insulating materials, they may contact one or both electrodes during the charging operation. Preferably the sandwich will contact one electrode to serve as a guide.

Alternatively, the charging electrode may be a corona discharge device, a roller, roller 211 may be conductive, for example, and be used to charge the receiver sheet in place of electrode 213. A sharp edge or a friction charging device such as a fur covered roller may also be used.

The sign of the charge as shown on electrodes 213 and 215 may be reversed, electrode 213 being negative and electrode 215 being made the positive electrode. The charge bearing manifold set then moves on to transparent plate 221 where it is exposed to light image 223. Light image 223 may be light projected through a transparency or light information projected from an opaque subject. In a continuous operation the light image preferably is projected through a slit in such a manner that there is little or no relative movement between the projected light image and the manifold sandwich. The manifold sandwich then passes through rollers 225 and 227 which are electrically conductive and connected to potential source 229 and resistor 231. Conductive rollers 225 and 227 increase or intensify the electrical field across the imaging layer. The conductive rollers are thus charge bearing members which are placed in electrical communication with the manifold sandwich. Alternatively, the conductive rollers may be replaced by corona discharge, conductive rod or other charge bearing means by which the electrical field across the imaging layer may be intensified or increased.

After the electric field has been intensified by passing the manifold sandwich between roller electrodes 225 and

227, the manifold sandwich is stripped apart by separating the donor sheet and the receiver sheet. Upon separation of the donor and receiver sheets, imaging layer 203 fractures along the edges of the exposed areas and at the surface where it had adhered to donor sheet 207. Accordingly, once separation is complete exposed portions of imaging layer 203 are retained on one of sheets 207 and 209 while unexposed portions are retained on the other sheet which provide a positive image on one sheet and a negative image on the other sheet.

Alternatively, the process can also be practiced wherein only one of sheets 207 and 209 are initially charged and the electric field can be intensified by contacting the charged sheet with a charge bearing member subsequent to the exposure step and prior to separation of the manifold sandwich.

Example I

An electrically photosensitive imaging material is prepared from three different photosensitive materials as follows: A red pigment available as Iragazine Red 2 BLT available from Geigy Chemical Company is purified by solvent extraction and a yellow pigment available as Algol Yellow GC a concentrated powder available from General Aniline and Film Corporation is purified by recrystallization from sulfuric acid. About 2.5 parts of *x*-phthalocyanine, 1.2 parts of purified Algol Yellow, 2.8 parts of the purified Iragazine Red and about 45 parts of naphtha are combined and placed in a ball mill and milled for a period of four hours.

A binder material is prepared by combining about three parts of Polyethylene DYLTL available from Union Carbide Corporation, about 1.5 parts of Paraffint R-2 microcrystalline wax available from Moore and Munger Company, about 0.5 part of vinylacetate-ethylene copolymer available from E. I. du Pont de Nemours & Co., Inc. as Elvax 420 and 2.5 parts of a modified styrene available from Pennsylvania Industrial Chemical Company as Piccotex 75 and about .1 part of polyethylene available from Union Carbide Corporation as Polyethylene DYDT in about 20 ml. of Sohio Odorless Solvent 3440, a kerosene fraction available from The Standard Oil Company. The mixture is heated with stirring until all the solid materials are dissolved. Preferably, prior to combining the material, they are purified by dissolving them individually in an organic solvent, precipitating them and washing them with a low molecular weight organic alcohol. The above described mixture, when in clear solution, is cooled to form a paste which is then mixed with the milled photosensitive materials overnight. The photosensitive imaging materials combined with the binder paste is milled in a ball mill for sixteen hours, heated to 65° C. and held at that temperature for two hours. After cooling the resulting paste is coated on a 3 mil Mylar sheet with a knife blade set at a gap of 4.4 mils to obtain a coating thickness of approximately 1.4 mils after drying. The coated Mylar is then placed upon the tin oxide surface of a NESAs glass plate with the uncoated surface of the Mylar facing the tin oxide. The imaging layer containing the photosensitive material is activated by applying thereto Freon 214 by means of a brush saturated with the Freon. A receiver sheet of 2 mil thick Mylar is placed over the activated imaging layer and the excess activator removed by applying light pressure on the receiver sheet. A potential of 5,000 volts per mil is applied between the NESAs glass and a black electrically conductive paper which is laid over the receiver sheet with the NESAs glass being made positive. With the voltage applied, a pattern of a white incandescent light image is projected upward through the NESAs glass through a lens having a setting of *f*-22 for one second providing an illumination of approximately 0.2 foot-candle seconds. After exposure with the potential still applied, the manifold sandwich is separated yielding

descent light image is projected upward through the NESAs glass through a lens having a setting of *f*-22 for one second providing an illumination of approximately 0.2 foot-candle seconds. After exposure with the potential still applied, the manifold sandwich is separated yielding

a pair of good quality images having low background of a resolution of 10 line pairs per mm. (lp./mm.).

Example II

The procedure of Example I is repeated except that prior to separating the sandwich but after imagewise exposure of the imaging layer the applied potential across the sandwich is reduced to 3,000 volts. Upon separation of the sandwich at the lower voltage, a pair of poor-quality images are provided having high background to the extent that a determination of resolution is prevented.

Example III

The procedure of Example I is repeated except that prior to sandwich separation but after imagewise exposure of the imaging layer the electric field across the manifold sandwich is reduced to 3,000 volts per mil and raised to 5,000 volts per mil. Upon sandwich separation a pair of good-quality images are provided having low background and a resolution of 10 lp./mm.

Example IV

An imaging layer comprising electrically photosensitive material dispersed in a binder is first prepared. About 100 parts of Naphthol Red B [1-(2'-methoxy-5'-nitrophenylazo) - 2 - hydroxy - 3'''' - nitro-3-naphthanilide, C. I. No. 12355] available from American Cyanamid Company is dissolved in reagent grade ethylenediamine. The solution is filtered immediately through coarse filter paper and the filtrate mixed with an equal volume of reagent grade isopropanol. The Naphthol Red B precipitates in the alcohol and is removed by means of a centrifuge. After separating the ethylenediamine and alcohol, the electrically photosensitive material is washed and filtered with successive amounts of isopropanol, a 2:1 volume mixture of isopropanol and de-ionized water followed by five washings with de-ionized water until the filtrate is neutral. Finally, the material is washed with dimethylformamide and methanol in succession until the filtrates have a pale yellow color. The Naphthol Red B is then dried at 40° C. under vacuum. The dried pigment is milled for four hours in a ball mill with 16 parts of DC naphtha.

A binder material is prepared according to the procedure of Example I into which is incorporated about 3 parts of the purified Naphthol Red B in the same manner as described in Example I for blending the photosensitive material with the binder material. The resulting imaging material is then coated on 3 mil Mylar with a doctor knife set at a gap of 4.4 mils to produce a donor. The donor is dried at a temperature of about 115° F.

The donor is then placed on the tin oxide surface of an NESAs glass plate with the imaging layer facing away from the tin oxide. The imaging layer is activated by applying Sohio Odorless Solvent 3440 by means of a brush and a manifold sandwich is formed by placing a thin sheet of aluminum foil over the activated donor as a receiver. A black paper electrode is laid over the receiver sheet and a potential of 5,000 volts per mil is applied between the black paper electrode and NESAs glass plate. With the potential still connected, the sandwich is separated yielding a pair of good quality images having low background and a resolution of about 16 lp./mm.

Example V

The procedure of Example IV is repeated except that subsequent to imagewise exposure of the imaging layer the field across the manifold sandwich is reduced to 3,000 volts per mil. Upon separation of the sandwich at the lower voltage, a pair of poor-quality images having high background, a resolution of 14 lp./mm. are obtained.

Example VI

The procedure of Example IV is repeated except that the electric field across the imaging layer is reduced to 3,000 volts per mil subsequent to imagewise exposure of

the imaging layer and then raised to 5,000 volts per mil immediately prior to sandwich separation. Upon sandwich separation a pair of high-quality images are obtained which have low background and a resolution of 20 lp./mm.

In accordance with the above examples, therefore, the process of this invention is capable of producing images of improved quality by subjecting the manifold sandwich to a field of at least the same value during the sandwich separation step as was employed during the imagewise exposure of the imaging layer. Surprisingly, as shown by Example VI, images of improved resolution are obtained by restoring the field to the imaging value. That is, the resolution of the images produced in accordance with Example VI exceed that of Example III wherein the field remains constant during the steps of imagewise exposure and sandwich separation.

Although specific components and proportions have been stated above, other typical materials as listed above if suitable may be used with similar results. In addition, other materials may be added to the mixture to synergize, enhance, or otherwise modify the properties of the imaging layer. For example, various dyes, spectral sensitizers or electrical sensitizers such as Lewis acid 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. In an imaging process which comprises providing an electrically photosensitive imaging layer sandwiched between a donor sheet and a receiver sheet, at least one of said sheets comprising an electrically insulating layer, said imaging layer being structurally fracturable in response to the combined effects of an applied electric field and exposure to electromagnetic radiation to which said layer is sensitive, subjecting said sandwich to a first electrical potential supplied by a static electrical charge in at least one of said sheets, exposing said imaging layer to electromagnetic radiation to which it is sensitive and separating said sandwich while under an electrical potential whereby said imaging layer fractures in imagewise configuration, the improvement which comprises subjecting said sandwich to a second electrical potential by electrostatically charging to the same polarity and at least the same potential as before exposure said charged insulating sheets subsequent to said exposure and prior to said separation, said second electrical potential being applied to said charged sheets immediately after said first electrical potential application and said exposure steps and said separation being

carried out immediately after said second electrical potential application step.

2. The method of claim 1 further including the step of rendering said imaging layer structurally fracturable in response to the combined effects of an applied electrical field and exposure to electromagnetic radiation to which said layer is sensitive by applying an activating amount of an activator to said layer.

3. The method of claim 1 wherein the electric charge is provided by passing said manifold sandwich between two oppositely charged electrodes in spaced relationship.

4. The method of claim 3 wherein said electrodes are conductive rollers.

5. The method of claim 3 wherein said electrodes are conductive rods.

6. The method of claim 1 wherein the electric charge is provided by passing said manifold sandwich through the ionization area of at least one corona discharge device.

7. The method of claim 1 wherein said imaging layer comprises an electrically photosensitive material dispersed in a binder.

8. The method of claim 3 wherein said imaging layer comprises an electrically photosensitive material dispersed in a binder.

9. The method of claim 2 wherein said imaging layer comprises an electrically photosensitive material dispersed in a binder.

10. The method of claim 1 wherein the electric field is supplied by static charges in at least one of the donor and receiver sheets.

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