United States Patent

Luebbe, Jr. et al.

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[54] METHOD OF FIXING MANIFOLD IMAGES

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[52] **U.S. Cl.** **96/1**, 96/1.3, 96/1.4

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

[58] **Field of Search** 96/1, 1.5, 1.3, 1.4

[56] **References Cited**

UNITED STATES PATENTS

2,949,848	8/1960	Mott	101/128.3
3,438,772	4/1969	Gundlach	96/1
3,446,616	5/1969	Clark	96/1.5
3,512,968	5/1970	Tulogin	96/1.2

Primary Examiner—Charles E. Van Horn

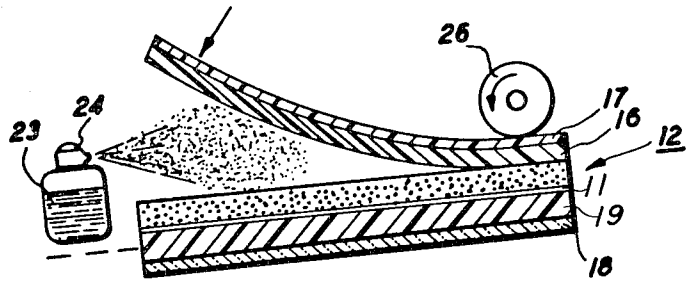
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[57] **ABSTRACT**

This invention pertains to an imaging system wherein there is employed a structure comprising a cohesively weak electrically photosensitive imaging layer sandwiched between a donor sheet and a receiver sheet. Images are produced by rendering the imaging layer cohesively weak by treatment with an activator and while subjecting the imaging layer to an electric field, it is exposed to electromagnetic radiation to which it is sensitive. With the field still applied, the sandwich is separated whereby the imaging layers fractures with the exposed portion of the imaging layer residing on one of the sheets and the unexposed portion residing on the other sheet. Images of superior quality are provided by inserting between the donor sheet and the imaging layer a solvent softenable layer which acts as a fixative for the image produced. Such images, when formed on transparent donor sheets, are particularly useful as transparencies which project a bright color image.

11 Claims, 4 Drawing Figures



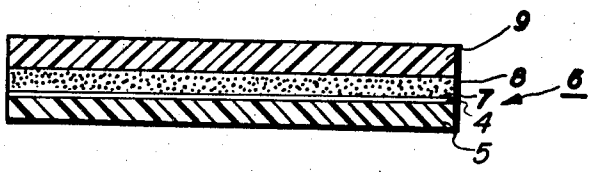


FIG. 1

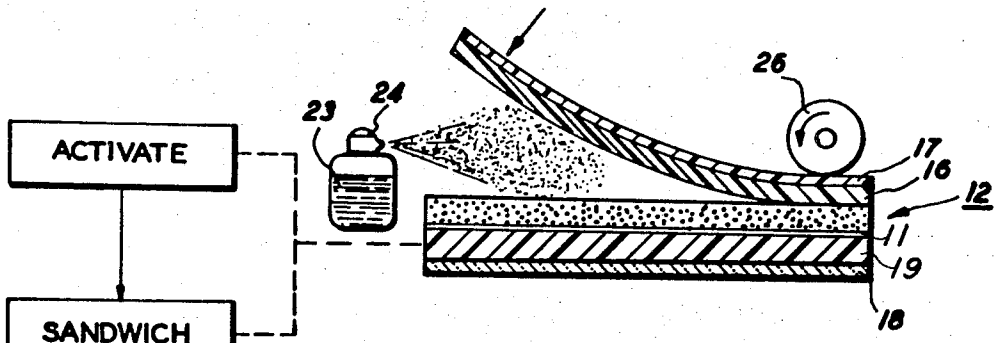


FIG. 2

FIG. 4

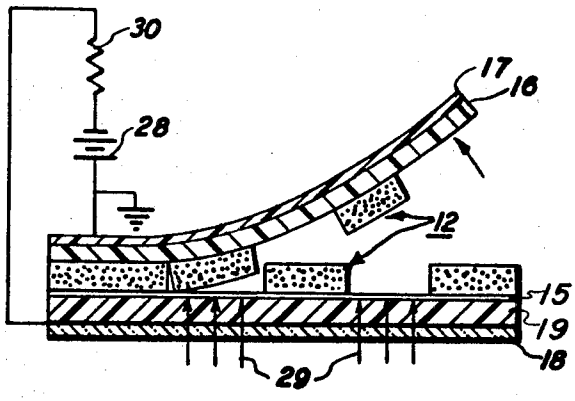


FIG. 3

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METHOD OF FIXING MANIFOLD IMAGES

BACKGROUND OF THE INVENTION

The present invention relates in general to imaging and more specifically to a method for the formation of images by layer transfer in image configuration.

There has recently been discovered an imaging technique based on layer transfer of a material from a donor sheet to a receiver sheet under the influence of an applied electric field and electromagnetic radiation. A more comprehensive discussion of imaging techniques on layer transfer may be found in copending application Ser. No. 708,380 filed Feb. 26, 1968 in the U.S. Pat. Office.

Copending application Ser. No. 708,380 describes an imaging system utilizing a manifold sandwich comprising an electrically photosensitive material between a pair of sheets. In this imaging system, an imaging layer is prepared by coating a layer of electrically photosensitive imaging material onto a substrate. In one form the imaging layer comprises a photosensitive material such as metal-free phthalocyanine dispersed in a cohesively weak insulating binder. This coated substrate is called the donor. When needed, the imaging layer is rendered cohesively weak. The process step of weakening the imaging layer is termed activation and in most cases the imaging layer is activated by contacting it with a swelling agent, solvent, or partial solvent for the imaging or by heating. After activation a receiver sheet is laid over the surface of the imaging layer. An electrical field is then applied across this manifold sandwich 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 and a negative image is produced on the other.

After the image is formed the image is usually fixed as by fusing the imaging material onto the substrate by means of heat. Other means of fixing the image have been employed such as by overcoating the image with a clear plastic film and then drying the film. Also images have been fixed by incorporating polymers in the activator which is sprayed onto the imaging material and subsequently fused. Usually the drying step is desirably done rapidly and thus a heating step is usually employed in fixing the image. The layer transfer imaging system described above is capable of providing images on many different substrates. Such substrates can be either opaque or transparent, paper, plastic coated paper, and even metal foil. In all cases the image must be fixed to the substrate and also provided with a durable surface so that it will not become damaged in use. Even more difficult problems occur when the images are to be employed as transparencies for purposes of projection, especially by means of an overhead projector. Not only is it difficult to firmly fix the image to the clear plastic substrates commonly used in projecting images, but also the fixative must provide a smooth, clear finish in order to provide bright color in the projected image. Since modern projection slides are generally thin transparent sheets, the images are subjected to a greater amount of flexing than other images. In addition, the color of many transparencies degrade upon aging due to the wear associated with use and handling. A particular problem found with images produced by the above described layer transfer process is the low degree of scratch resistance of the image even though such image is well fixed to the substrate. Previously images made by means of the layer transfer process required polishing by means of a buffing wheel because such images, as produced, have a rough, light scattering surface.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to provide an imaging system overcoming the above noted disadvantages.

It is another object of this invention to provide a layer transfer imaging system which provides comparatively durable images.

It is another object of this invention to provide a layer transfer imaging system which provides comparatively durable images and does not require a separate overcoating step.

Another object of this invention is to provide a method for layer transfer imaging which produces transparencies that project high quality bright color images.

The above object and others are accomplished in accordance with this invention by an imaging method utilizing a structure comprising a cohesively weak electrically photosensitive imaging layer sandwiched between a donor sheet and a receiver sheet. In accordance with this invention, a donor sheet is first coated with a solvent softenable layer upon which electrically photosensitive material of the imaging layer is coated. When the imaging layer is activated, the solvent softenable layer is softened by the activator so as to permit mixing of the softenable layer with the imaging layer. The activator is removed after imaging to provide a durable, well-fixed image on the donor sheet. By employing transparent sheets, images can be produced which are highly suitable for use as projection transparencies. Such superior images are obtained in accordance with this invention without including an additional step in the actual imaging process.

In order to produce an image by means of the layer transfer process described above, the imaging layer must be cohesively weak at the time the donor sheet and receiver sheet are separated. Many electrically photosensitive materials must be rendered cohesively weak in order that the imaging layer may fracture to provide images of acceptable quality. The means normally employed to render the imaging layer cohesively weak is termed activation. Materials employed to reduce the cohesive strength of the imaging layer are usually called an activator. Most activators are liquids which are applied to the imaging layer at some point during the imaging process. Thus, the activator may be applied either before or after exposure to electromagnetic radiation or before or after the application of the electric field. In any case the need for the activator occurs only at the time the imaging layer fractures upon separation of the two sheets. It has now been discovered that by employing a layer of material beneath the imaging layer which is softened by the activator, images of superior quality are produced. Such images are found to be well fixed to the substrate and possess hard, clear, smooth finishes making them particularly useful as color transparencies.

As stated above, the solvent softenable layer on the donor is affected by the activation step in the imaging process. The activation step may take many forms. Preferably, the activator should have a high resistivity so as to prevent electrical breakdown of the manifold sandwich. 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 fluid through a clay column or by employing any 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. The activator can be applied at any point of the process prior to separation of the donor and receiver sheets.

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 dimethyl-polysiloxanes and very high boiling point long chain aliphatic hydrocarbon oils ordinarily used as transformer oils such as Wemco-C trans-

former 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 perchloroethylene, trichloromonofluoromethane, trichlorotrifluoroethane, trichlorotrifluoroethane, ethers such as diethyl ether, diisopropyl ether, dioxane, tetraphydrofuran, ethyleneglycol monoethyl ether, aromatic and aliphatic hydrocarbons such as benzene, toluene, xylene, hexane, cyclohexane, gasoline, mineral spirits and white mineral oil, vegetable oils such as coconut oil, babussu oil, palm oil, olive oil, castor oil, peanut oil and neatsfoot oil, decane, dodecane and mixtures thereof. Sohio Odorless Solvent 3440 is preferred because it is odorless, nontoxic and has a relatively high flash point.

The solvent softenable layer can comprise any suitable material which is softened by the activator. Thus, a wide range of materials can be employed depending upon the activator used in the imaging process. For instance, some materials are softened by aliphatic hydrocarbon fractions such as kerosene while others are softened by activators such as carbon-tetrachloride and other halogenated hydrocarbons. Thus, the choice of solvent softenable material to be employed in the layer is determined by the choice of activators. Typical examples of solvent softenable material are thermoplastic resins such as polystyrene, polyethylene, polyisobutylene, polyepichlorohydrin, polypropylene; copolymers such as styrene, alphamethylstyrene, vinyl toluene, n-butylmethacrylic and ethylene-vinylacetate. A particularly preferred solvent softenable layer is a copolymer of vinyl toluene and styrene. Such copolymers contain a mol ratio of vinyl toluene to styrene in the range of from about 1 to about 10 to about 10 to 1, and preferably 1 to 1.

The solvent softenable layer need not be completely soluble in the activator employed, and it is preferred that the layer be only partially soluble, tackified or swelled by the activator. Thus, blends of materials may be employed, some of which are soluble and some of which are insoluble in the activator. For example, polymers and copolymers of varying molecular weight may be employed such that one may be more soluble in the activator than the other.

The solvent softenable material may be coated onto donor sheets by means known to the art. For example, the material may be slurried in a carrier liquid and applied by means of a doctor blade or dissolved in a solvent, coated on the substrate by means of a brush and subsequently evaporating the solvent. The solvent softenable layer is generally dried prior to receiving the imaging layer. The drying process is hastened by placing the coated substrate in an oven at a temperature in the range of from about 50° C. to about 100° C. for a period of from five to fifteen minutes. The imaging layer is coated on the donor sheet over the dried solvent softenable layer.

The solvent softenable layer can be applied to the donor sheet in thicknesses ranging from about 0.5 microns to about 10 microns. The most useful thickness of the solvent softenable layer is in the range of from about 1 micron to about 3 microns.

In the manifold imaging process, the imaging layer comprises any suitable electrically photosensitive material. Typical organic materials include: quinacridones such as: 2,9-dimethyl quinacridone, 4,11-dimethyl quinacridone, 2,10-dichloro-6,13-dihydro-quinacridone, 2,9-dimethoxy-6-13-dihydro-quinacridone, 2,4,9,11-tetrachloro-quinacridone, and solid solutions of quinacridones and other compositions as described in U.S. Pat. No. 3,160,510; carboxamides such as: N-2''-pyridyl-8,13-dioxodinaphtho-(2,1-2',3')-furan-6-carboxamide, N-2''-(1'',3'',5''-triazyl-8,13-dioxodinaphtho-(2,1-2',3')-furan-6-carboxamide, anthra-(2,1)-naphtho-(2,3-d)-furan-9,14-dione-7,-(2'-methyl-phenyl) carboxamide; carboxanilides such as: 8,13-dioxodinaphtho-(2,1-2',3')-furan-6-carbox-p-methoxy-anilide, 8,13-dioxodinaphtho-(2,1-2',3') furan-6-carbox-p-methylanilide, 8,13-dioxodinaphtho-(2,1-2',3') furan-6-carbox-m-chloroanilide, 8,13-dioxodinaphtho-(2,1-2',3') furan-6-carbox-p-cyanoanilide; triazines such as: -phenanthrenylazo) phloroglucinol, 2,4-diamino-triazine, 2,4-di (1'-anthraquinonyl-amino)-6-(1''-pyrenyl)-triazine, 2,4-di (1'-anthraquinonyl-amino)-6-(1''-naphthyl)-triazine, 2,4-di (1'-naphthylamino)-6-(1'-perylenyl)-triazine, 2,4,6-tri (1',1'',1'''-pyrenyl)-triazine; benzopyrrocolines such as: 2,3-phthaloyl-7,8-benzopyrrocoline, 1-cyano-2,3-phthaloyl-7,8-benzopyrrocoline, 1-cyano-2,3-phthaloyl-5-acetamido-7,8-benzopyrrocoline; anthraquinones such as: 1,5-bis-(beta-phenylethylamino)anthraquinone, 1,5-bis-(3'-methoxypropylamino) anthraquinone, 1,5-bis (benzylamino) anthraquinone, 1,5-bis (phenylamino) anthraquinone, 1,2,5,6-di (c,c'-diphenyl)-thiazole-anthraquinone, 4-(2'-hydroxyphenylmethoxyamino) anthraquinone; azo compounds such as: 2,4,6-tris (N-ethyl-N-hydroxy-ethyl-p-aminophenylazo) phloroglucinol, 1,3,5,7-tetrahydroxy-2,4,6,8-tetra (N-methyl-N-hydroxyethyl-p-amino-phenylazo) naphthalene, 1,3,5-trihydroxy-2,4,6-tris (3'-nitro-N-methyl-N-hydroxymethyl-4'-aminophenylazo) benzene, 3-methyl-1-phenyl-4-(3'-pyrenylazo)-2-pyrazolin-5-one, 1-(3'-pyrenylazo)-2-hydroxy-3-naphthanilide, 1-(3'-pyrenylazo)-2-naphthol, 1-(3'-pyrenylazo)-2-hydroxypyrene, 1-(3'-pyrenylazo)-2-hydroxy-3-methylxanthene, 2,4,6-tris (3'-pyrenylazo) phloroglucinol, 2,4,6-tris (1'-phenanthrenylazo)phloroglucinol, 1-(2'-methoxy-5'-nitrophenylazo)-2-hydroxy-3'-nitro-3-naphthanilide; salts and lakes of compounds derived from 9-phenylxanthene, such as: phosphotongstomolybdic lake of 3,6-bis (ethylamino)-9,2'-carboxyphenyl xanthenonium chloride, barium salt of 3-2'-toluidine amino-6-2''-methyl-4''-sulphophenyl-amino-9-2'''-carboxyphphenyl xanthene; phosphomolybdic lake of 3,6-bis (ethylamino)-2,7-dimethyl-9-2'-carbethoxy-phenylx-anthenonium chloride; dioxazines such as: 2,9-dibenzoyl-6, 13-dichloro-triphenodioxazine, 2,9-diacetyl-6, 13-dichloro-triphenodioxazine, 3,10-debenzoylamino-2,9-diisopropoxy-6,13-dichloro-triphenodioxazine, 2,9-difuroyl-6,13-dichloro-tripheno-dioxazine; lakes of fluorescein dyes, such as: lead lake of 2,7-dinitro-4,5-dibromo fluorescein, lead lake of 2,4,5,7-tetrabromo fluoroescein, aluminum lake of 2,4,5,7-tetrabromo-10,11,12,13-tetrachloro fluorescein; bisazo compositions such as: N,N'-di [1-(1'-naphthylazo)-2-hydroxy-8-naphthyl] adipdiamide, N,N'-di-1-(1'-naphthylazo)-2-hydroxy, 8-naphthyl succindiamide, bis-4, 4'-(2''-hydroxy-8''-N,N'-diterephthalamide-1-naphthylazo) bephenyl, 3,3'-methoxy-4,4'-diphenyl-bis (1''-azo-2''-hydroxy-3''-naphthanilide); pyrenes such as: 1,3,6,8-tetraaminopyrene, 1-cyano-6-nitropyrene; phthalocyanines such as: beta-form metal free phthalocyanine, copper phthalocyanine, tetrachloro phthalocyanine, the X-form of metal-free phthalocyanine as described in U.S. Pat. No. 3,357,989 metal salts and lakes of azo dyes; such as: calcium lake of 6-bromo-1 (1'-sulfo-2-naphthylazo)-2-naphthol, barium salt of 6-cyano-1(1-sulfo-2-naphthylazo)-2-naphthol, calcium lake of 1-(4'-ethyl-5'-chlorobenzene-2'-sulfonic acid)-2-hydroxy-3-naphthoic acid; and mixtures thereof.

Typical inorganic compositions include cadmium sulfide, cadmium sulfoselenide, zinc oxide, zinc sulfide, sulphur selenium, mercuric sulfide, lead oxide, lead sulfide, cadmium selenide, tetanium dioxide, indium trioxide and the like.

In addition to the aforementioned organic materials other organic materials which may be employed in the imaging layer include polyvinylcarbazole; 2,4-bis (4,4'-diethyl-aminophenyl)-1,3,4-oxidazole; N-isopropylcarbazole; polyvinyl-anthracene; triphenylpyrrol; 4,5-diphenylimidazolidinone; 4,5-diphenylimidazolidinethinone; 4,5-bis-(4'-amino-phenyl)-imidazolidinone; 1,2,4,6-tetraazacyclo-octatetraene-

(2,4,6,8); 3,4-di-(4'-methoxyphenyl)-7,8-diphenyl-1,2,5,6-tetraazocyclooctatetraene-(2,4,6,8); 3,4-di(4'-phenoxy-phenyl)-7,8-diphenyl-1,2,5,6-tetraaza-cyclooctatetraene-(2,4,6,8); 3,4,7,8-tetramethoxy-1,2,5,6-tetraazo-cyclooctatetraene-(2,4,6,8); 2-mercapto-benzthiazole; 2-phenyl-4-alpha-nuphthylidene-oxazolone; 2-phenyl-4-diphenylidenepx-azolone; 2-phenyl-4-p-methoxy-benzylidene-oxazole; 6-hydroxy-2-phenyl (p-dimethyl-amino phenyl)-benzofurane; 6-hydroxy-2,3-di (p-methoxyphenyl)-benzofurane; 2,3,5,6-tetra-(p-methoxy-phenyl)-furo-(3,2f)-benzofurane; 4-dimethyl-amino-benzylidene-benzhydrazide; 4-dimethyl-aminobenzylideneiso-nicotinic acid hydrazide; turfurylidene, (2)-4'-dimethylamino-benzhydrazide; 5-benzylidene-amino-acenaphthene-3-benzylidene-amino-carbazole; (4-N,N'dimethylaminobenzylidene)-p-N,N-dimethyl aminoaniline; (2-nitro-benzylidene)-p-bromo-aniline; N,N-dimethyl-N'-(2'nitro-4-cyano-benzylidene)-p-phenylene-diamine; 2,4-diphenyl-quinazoline; 2-(4'-amino-phenyl)-4-phenyl-quinazoline; 2-phenyl-4-(4'-di-methyl-amino-phenyl)-7-methoxy-quinazoline; 1,3-diphenyl-tetra-hydroimidazole; 1,3-di (4'-chlorophenyl)-tetrahydroimidazole; 1,3-diphenyl - 2,4'-dimethylaminophenyl)-tetrahydroimidazole; 1,3-di(p-tolyl)-2-[quinolyl-(2'-)]-tetra-hydroimidazole; 3-(4' - dimethylamino-phenyl)-5-(4''-methoxy-phenyl)-6-phenyl-1,2,4-triazine; 3-pyridil-(4')-5-(4'dimethylamino-phenyl)-6-phenyl-1,2,4-triazine; 3-(4'-amino-phenyl)-5,6-di-phenyl-1,2,4-triazine; 2,5-bis [4'-amino-phenyl-(1')-]-1,3,3-triazole; 2,5-bis [4'-(N-ethyl-N-acetyl-amino)phenyl-(1')]- 1,3,4-triazole; 1,5-diphenyl-3-methyl-pyrazoline; 1,3,4,5-tetraphen-yl-pyrazoline; 1-phenyl-3-(p-methoxy styrl)-5-(p-methox-yphenyl)-pyrazoline; 1-methyl-2-(3',4'-diphydroxy-methylene-phenyl)-benzimidazole; 2,(4'-dimethylamine phenyl)-benzoxazole; 2-(4'-methoxyphenyl)-benzthiazole; 2,5-bis[p-amino-phenyl-(1)]-1,3,4-oxidiazole; 4,5-diphenyl-imidazolone; 3-amino-carbazole; copolymers and mixtures thereof.

Other materials include organic donor-acceptor (Lewis acid-Lewis base) charge-transfer complexes made up of aromatic donor resins such as phenolaldehyde resins, phenoxides, epoxies, polycarbonates, urethanes, styrene or the like complexed with electron acceptors such as 2,4,7-trinitro-9-fluorenone; 2,4,5,7-tetranitro-9-fluorenone; picric acid; 1,3,5-trinitro benzene; chloranil; 2,5-dichloro-benzoquinone; anthraquinone-2-carboxylic acid, 4-nitrophenyl; maleic anhydride; metal halides of the metals and metalloids of groups I-B and II-VIII of the periodic table including for example aluminum chloride, zinc chloride, ferric chloride, magnesium chloride, caldium iodide, strontium bromide, chromic bromide, arsenic triiodide, magnesium bromide, stannous chloride etc.; boron halides, such as boron trifluorides; ketones such as benzophenone and anisil, mineral acids such as sulfuric acid; organic carboxylic acids such as acetic acid and maleic acid, succinic acid, citroconic acid, sulphonoc acid, such as 4-toluene sulphonic acid and mixtures thereof. In addition to the charge transfer complexes, it is to be noted that many other of the above materials may be further sensitized by the charge transfer complexing technique and that many of these materials may be dye-sensitized to narrow, broaden or heighten their spectral response curves.

It is also to be understood that the electrically photosensitive particles themselves may consist of any suitable one or more of the aforementioned electrically photosensitive materials, either organic or inorganic, dispersed in, in solid solution in, or copolymerized with, any suitable insulating resin whether or not the resin itself is photosensitive. This particular type of particle may be particularly desirable to facilitate dispersion of the particle, to prevent undesirable reactions between the binder and the photosensitive material or between the photosensitive and the activator and for similar purposes. Typical resins of this type include polyethylene, polypropylene, polyamides, polymethacrylates, polyacrylates, polyvinyl chlorides, polyvinyl acetates, polystyrene, polysiloxanes, chlorinated rubbers, polyacrylonitrile, epoxies, phenolics, hydrocarbon resins and other natural resins such as resin derivatives as well as mixtures and copolymers thereof.

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. Reference is made to a book entitled "Phthalocyanine Compounds" by F. H. Moser and A. L. Thomas, published by the Reinhold Publishing Company, 1963 edition for a detailed description of phthalocyanines and their synthesis. Any suitable phthalocyanine may be used in the present invention. Phthalocyanines encompassed within this invention may be described as compositions having four isoindole groups linked by four nitrogen atoms in such a manner so as to form a conjugated chain, said compositions have the general formula $(C_8H_4N_2)_4R_n$ wherein R is selected from the group consisting of hydrogen, deuterium, lithium, sodium, potassium, copper, silver, beryllium, magnesium, calcium, zinc, cadmium barium, mercury, aluminum, gallium, indium, lanthanum, neodymium, samarium, europium, gadolinium, dypsprosium, holmium, erbium, thulium, ytterbium, lutecium, titanium, tin, hafnium, lead, silicon, germanium, thorium, vanadium, antimony, chromium, molybdenum, uranium, manganese, iron, cobalt, nickel, rhodium, palladium, osmium and platinum; and n is a value of greater than 0 and equal to or less than 2. Any other suitable phthalocyanines such as ring or aliphatically substituted metallic and/or non-metallic phthalocyanines may also be used if suitable. As above noted, any suitable phthalocyanine may be used to prepare the photoconductive layer of the present invention. Typical phthalocyanines are: aluminum phthalocyanine, aluminum polychlorophthalocyanine, antimony phthalocyanine, barium phthalocyanine, beryllium phthalocyanine, cadmium hexadecachlorophthalocyanine, cadmium phthalocyanine, calcium phthalocyanine, cerium phthalocyanine, chromium phthalocyanine, cobalt phthalocyanine, cobalt chlorophthalocyanine, copper 4-aminophthalocyanine, copper bromochlorophthalocyanine, copper 4-chlorophthalocyanine, copper 4-nitrophthalocyanine, copper phthalocyanine, copper phthalocyanine sulfonate, copper polychlorophthalocyanine, deuteriophthalocyanine, dysprosium phthalocyanine, erbium phthalocyanine, europium phthalocyanine, gadolinium phthalocyanine, gallium phthalocyanine, germanium phthalocyanine, hafnium phthalocyanine, halogen substituted phthalocyanine, holmium phthalocyanine, indium phthalocyanine, iron phthalocyanine, iron polyhalophthalocyanine, lanthanum phthalocyanine, lead phthalocyanine, lead polychlorophthalocyanine, cobalt hexaphenylphthalocyanine, copper pentaphenylphthalocyanine, lithium phthalocyanine, lutecium phthalocyanine, magnesium phthalocyanine, manganese phthalocyanine, mercury phthalocyanine, molybdenum phthalocyanine, anphthalocyanine, neodymium phthalocyanine, nickel phthalocyanine, nickel polyhalophthalocyanine, osmium phthalocyanine, palladium phthalocyanium, palladium chlorophthalocyanine, alkoxyphthalocyanine, alkylaminophthalocyanine, alkylmercaptophthalocyanine, aralkylaminophthalocyanine, aryloxyphthalocyanine, arylmercaptophthalocyanine, copper phthalocyanine piperidine, cycloalkylaminophthalocyanine, dialkylaminophthalocyanine, diaralkylaminophthalocyanine, dicycloalkylaminophthalocyanine, hexadecahydrophthalocyanine, imidomethylphthalocyanine, 1,2-naphthalocyanine, 2,3-naphthalocyanine octaazaphthalocyanine, sulfur phthalocyanine, tetraazaphthalocyanine, tetra-4-acetylaminophthalocyanine, tetrachloromethylphthalocyanine, tetradiazophthalocyanine, tetra-4,4-dimethyloctaazaphthalocyanine, tetra-4,5-diphenylenedioxide phthalocyanine, tetra-4,5-diphenyloctaazaphthalocyanine, tetra-(6-methyl-benzothiazoyl) phthalocyanine, tetra-p-methylphenylaminophthalocyanine, tetramethylphthalocyanine, tetranaphtho-triazolylphthalocyanine, tetra-4-naphthylphthalocyanine, tetra-4-nitrophthalocyanine, tetraperi-naphthlene-4,

5-acta-azaphthalocyanine, tetra-2,3-phenyleneoxide phthalocyanine, tetral4-phenyl-octaazaphthalocyanine, tetraphenylphthalocyanine, tetraphenylphthalocyanine tetracarboxylic acid; tetraphenylphthalocyanine tetrabarium carboxylate, tetraphenylphthalocyanine tetra-calcium carboxylate, tetraphyridylphthalocyanine, tetra-4-trifluoromethyl mercaptophthalocyanine, tetra-4-trifluoromethylphthalocyanine, 4,5-trionaphtheneoctaazaphthalocyanine, platinum phthalocyanine, potassium phthalocyanine, rhodium phthalocyanine, samarium phthalocyanine, silver phthalocyanine, silicone phthalocyanine, sodium phthalocyanine, sulfonated phthalocyanine, thorium phthalocyanine, thulium phthalocyanine, tin chlorophthalocyanine, tin phthalocyanine, titanium phthalocyanine uranium phthalocyanine, vanadium phthalocyanine, ytterbium phthalocyanine, zinc chlorophthalocyanine, zinc phthalocyanine, others described in the Moser text and mixtures, dimers, trimers, oligomers, polymers, copolymers or mixtures thereof. 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 electrical field combined with the action of antinic radiation on the electrically photosensitive materials will fracture the imaging layer. Further, the layer must respond to the application of field the strength of which is below that field strength which will cause electrical breakdown or arcing across the imaging layer. 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. Other colorants such as dyes and pigments may be added to the imaging layer so as to intensify or modify the color of the final image produced when color is important. 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. 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 photoresponse 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 this binder material solely on the basis of physical properties without regard to their photosensitivity. This is also true of the two component homogeneous system in which 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 whether homogeneous or heterogeneous ranges from about 0.2 microns to about 25 microns generally about 1 micron to about 10 microns and preferably about 5 microns.

The ratio of photosensitive pigment to binder, by weight, 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 connection 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.; Paraflint 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: Capital City 1380 wax, available from Capitol City Products Co., Columbus, Ohio; Caster Wax L-2790, available from Baker Caster Oil Co.; Vitikote L-304, 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 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; Vinylacetateethylene copolymers such as: Elvax Resin 210, Elvax Resin 310, Elvax Resin 420, available from E. I. duPont 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.

Normally the imaging layer is coated onto the donor sheet or substrate which had previously been coated with the solvent softenable layer. For convenience the combination of imaging layer, solvent softenable layer and donor substrate is referred to as the donor. In those instances wherein the donor substrate is solvent softenable, the imaging layer and substrate are collectively referred to as the donor. When employing a binder in the imaging layer, the electrically photosensitive material can be fixed in the binder material by conventional means for blending conventional solids as by ball milling. After blending the ingredients of the imaging layer, the desired amount is coated onto the solvent softenable layer of the donor sheet. In a particularly preferred form of the invention, an imaging layer comprising the electrically photosensitive material dispersed in a binder is coated onto a transparent, electrically insulating donor sheet.

The imaging layer may be supplied in any color desired either by taking advantage of the natural color of the photosensitive material or binder materials in the imaging layer or by the use of additional dyes and pigments therein whether photoresponsive or not and, of course, various combinations of these photoresponsive and nonphotoresponsive colorants may be used in the imaging layer so as to produce the desired color layer.

The donor sheet and receiver sheet may comprise any suitable electrically insulating or electrically conducting material. Insulating materials are preferred since they allow the use of high strength polymeric materials. Typical insulating materials include polyethylene, polypropylene, polyethyleneterephthalate, cellulose acetate, paper, plastic coated paper, such as polyethylene coated paper, vinyl chloride-vinylidene chloride copolymers and mixtures thereof. Mylar (a polyester formed

by the condensation reaction between ethylene glycol and terephthalic acid available from E. I. duPont de Nemours & Co., Inc.) is preferred because of its durability and excellent insulative properties. Not only does the use of this type of high strength polymer provide a strong substrate for the positive and negative images formed on the donor substrate and receiver sheet but, in addition, it provides an electrical barrier between the electrodes and the imaging layer which tends to inhibit electrical breakdown of the system while subjecting the manifold sandwich to an electrical field. The donor sheet and receiver sheet may each be selected from different materials. Thus, a manifold sandwich can be prepared by employing an insulating donor sheet while a conductive material is employed as a receiver sheet.

As stated above, according to the process of this invention, the imaging layer is subjected to an electrical field. The electrical field can be applied in many ways. Generally the sandwich is placed between electrodes having different electrical potential. Also, an electrical charge can be imposed upon one or both of the donor sheet and receiver sheet before or after forming the sandwich by any one of several known methods for inducing a static electrical charge into a material. Static charges can be imposed by contacting the sheet or substrate with an electrically charged electrode. Alternatively one or both sheets may be charged using corona discharge devices such as those described in U. S. Pat. No. 2,588,699 to Carlson, U. S. Pat. No. 2,777,957 to Walkup, U. S. Pat. No. 2,885,556 to Gundlach or by using conductive rollers as described in U. S. Pat. No. 2,980,834 to Tregay et al., or by fractional means as described in U. S. Pat. No. 2,297,691 to Carlson or other suitable apparatus.

Thus, the electrical field can be provided by means known to the art for subjecting an area to an electrical field. The electrodes employed may comprise any suitable conductive material and may be flexible or rigid. Typical conductive materials include: metals such as aluminum, brass, steel, copper, nickel, zinc, etc., metallic coatings on plastic substrates, rubber rendered conductive by the inclusion of a suitable material therein, or paper rendered conductive by the inclusion of a suitable material therein or through conditioning in a humid atmosphere to insure the presence therein of sufficient water content to render the material conductive. Conductive rubber is preferred because of its flexibility. In the process of this invention wherein the imaging layer is exposed to activating electromagnetic radiation while positioned between electrodes, one of the electrodes must be at least partially transparent. The transparent conductive electrode may be made of any suitable conductive transparent material and may be flexible or rigid. Typical conductive transparent materials include cellophane, conductively coated glass, such as tin or indium oxide coated glass, aluminum coated glass, or similar coatings on plastic substrates. NESA, a tin oxide coated glass available from Pittsburgh Plate Glass Co., is preferred because it is a good conductor and is highly transparent and is readily available. In the process of this invention wherein the donor and/or receiver is composed of conductive material each may also be employed as the electrodes by which the imaging layer is subjected to an electrical field. That is either when employed as an electrode one or both of the donor sheet and receiver sheet may serve a dual function in the process of this invention.

The strength of the electrical field applied across the manifold sandwich depends on the structure of the manifold sandwich and the materials used. For example, if highly insulating receiver and donor substrate materials are used, a much higher field may be applied than if relatively conductive donor and receiver sheets are used. The field strength required may be, however, easily determined. If too large a potential is applied, electrical breakdown of the manifold sandwich will occur allowing arcing between the electrodes. If too little potential is applied, the imaging layer will not fracture in imagewise configuration. By way of example, if a 3 mil Mylar receiver sheet and a 2 mil Mylar donor sheet are used, potentials as high as 20,000 volts may be applied between the electrodes. The preferred field strengths across the manifold sandwich are, however, in the range of from about 1,000 volts per mil to about 7,000 volts per mil of electrically insulating material. Since relatively high potentials are utilized, it is desirable to insert a resistor in the circuit to limit the flow of current. Resistors on the order of from about 1 megohm to about 20,000 megohms are conventionally used.

Initially, whether the positive image is formed on the donor sheet or the receiver sheet depends on the imaging layer materials used and/or the polarity of the applied field. It has been found in general, however, if the donor side electrode is held at a positive potential in respect to the receiver side electrode, that the positive image is formed on the donor sheet and a negative image is formed on the receiving sheet. That is, the illuminated portions of the imaging layer adhere to the receiver sheet and the non-illuminated areas of the imaging layer adhere to the donor sheet. It has also been found, in general, that when the imaging layer is coated onto a donor sheet, the best quality images are produced by exposing through the 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 of this invention. The electrically photosensitive material is chosen so as to be responsive to the wavelength of the electromagnetic radiation used. 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 a material to a peak or to broaden it to make it more panchromatic in its response.

The imaging layer can be exposed to electromagnetic radiation at any point in the process prior to field modification including prior to forming the manifold sandwich. Alternatively, the process of this invention can include the steps (1) exposing the imaging layer to actinic electromagnetic radiation (2) placing the receiver on the imaging layer forming a manifold sandwich (3) subjecting the sandwich to an electrical field (4) modifying the field and (5) separating the sandwich. For example, one embodiment of the process of this invention are the steps of (1) imposing an electrical charge on the donor as by corona discharge (2) exposing the imaging layer to electromagnetic radiation to which it is sensitive (3) forming the manifold sandwich of the donor (4) modifying the field and (5) separating the sandwich.

In addition, the activation step can be included at any point in the process prior to the separation of the sandwich. The sequence of steps of the process of this invention including the optional activation step can be further varied by those skilled in the art without departing from the scope of this invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages of this invention will become apparent upon consideration of the detailed disclosure of the invention, especially when taken in conjunction with the accompanying drawings wherein:

FIG. **1** is a side sectional view of a photosensitive imaging member for use in this invention;

FIG. **2** is a side sectional view diagrammatically illustrating the activation step and the formation of the manifold sandwich;

FIG. **3** is a side sectional view diagrammatically illustrating the final two process steps of this invention, including imagewise exposure and sandwich separation while under an electric field;

FIG. **4** is a process flow diagram of the method steps of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. **1**, imaging layer **6** comprising photosensitive particles **7** dispersed in binder **8** is deposited on

insulating donor sheet 5. Donor sheet 5 has been previously prepared by having coated thereon a solvent softenable layer 4, which adheres tightly to donor sheet 5 and is preferably transparent to electromagnetic radiation to which imaging layer 6 is sensitive. The image receiving portion of the manifold imaging member comprises insulating receiver sheet 9. Although shown in the attached drawing as insulating, receiver sheet 9 may be either electrically conductive or insulating. In addition, either or both sheets 5 and 9 may be transparent so as to permit exposure of imaging layer 6. The embodiment of the invention shown in FIG 1 is preferred because it allows for the use of high strength insulating polymeric materials as donor sheet 5 and receiver sheet 9.

Referring now to FIG. 2 which diagrammatically illustrates the activation step and the formation of the manifold imaging member or sandwich, FIG. 2 shows the activator fluid 23 being sprayed onto the imaging layer 12 of the manifold imaging member from container 24. Alternatively, the activator may be applied by any suitable techniques such as with a brush, with a smooth or rough surface roller, by flow coating or the like. The activator serves to swell or otherwise weaken and thereby lower the cohesive strength of imaging layer 12. In addition, the activator after permeating imaging layer 12 softens or partially dissolves or swells the solvent softenable layer 11. Electrode 17 and receiver sheet 16 are then lowered onto imaging layer 12 and optional roller 26 is rolled across the surface of electrode 17 to remove any excess activator fluid which may be present. The use of roller 26 may be omitted and in those instances wherein the solvent softenable layer 11 is soluble in the activator employed. Electrodes 17 and 18 may be separate members or they may be integral parts of the donor sheet and receiver sheet. Thus, transparent conductive cellophane may be employed both as an electrode and as a donor or receiver sheet in the imaging member of this invention.

Referring now to FIG. 3 the imaging member is charged by connecting electrodes 17 and 18 to potential source 28 and resistor 30. The imaging member is then exposed to electromagnetic radiation 29 in image configuration. Receiver sheet 16 and donor sheet 19 are then separated. Upon separation imaging layer 12 fractures along the edges of exposed areas and at the surface where it adhered to substrate solvent softenable layer 15 on donor sheet 19. Accordingly, when separation is completed exposed portions of imaging layer 12 are retained on one of the layer 16 and 19 while unexposed portions are retained on the other layer. Although FIG. 3 shows a positive image being formed on donor sheet, it is possible to form a negative image on the donor sheet. Alternatively, solvent softenable layer 15 may be coated on the receiver sheet 16 and form subbing layer under the portions of the imaging layer 12 which is transferred to receiver sheet 16. Thus, the object of this invention can be accomplished by coating either the receiver sheet or donor sheet with a solvent softenable layer. After sandwich separation as shown in FIG. 3, the image is desirably fixed to the substrate by mild heating which evaporates the activator leaving a well fixed, smooth, scratch resistant image.

Activation of the imaging layer may take place by employing yet another layer in the imaging member. There can be employed a thermosolvent which upon heating becomes a liquid and acts as an activator to the imaging layer and the solvent softenable layer. Such thermosolvents are described in copending application Ser. No. 675,989 filed Oct. 17, 1967, now abandoned, which is incorporated herein by reference.

The following examples further specifically illustrate the present invention. The examples below are intended to illustrate various preferred embodiments of the improved imaging method. The parts and percentages are by weight unless otherwise indicated.

EXAMPLES I–IX

A donor sheet consisting of 2 mil polyester film sold under the trade name of Mylar by the E. I. duPont de Nemours & Co., Inc. is first coated with a layer of solvent softenable material. The solvent softenable material is prepared by slurrying in toluene 10 percent by weight of the material. The slurry is then hand coated with a No. 12 wire-wound drawdown rod onto the Mylar. The coating is dried in an oven at a temperature of about 70° to about 90° C. for periods of from five to fifteen minutes. The coated Mylar is then overcoated with an imaging layer comprising an electrically photosensitive material dispersed in a binder. The binder material is prepared by dissolving in hot petroleum ether eight parts of polyethylene AC-8 available from Allied Chemical Company, one part of Vistanex L-80 and one part of Vistanex MH both of which are vinyl acetate-ethylene copolymers available from the EnJay Chemical Company and 100 mil of petroleum ether (90°–120° C.). The hot solution is poured into 1 liter of isopropyalcohol with agitation and left standing overnight. The suspension is then filtered, reslurried in 1 liter of isopropyl-alcohol, filtered again to a damp cake containing about 20 percent solids. A suspension of an electrically photosensitive material is prepared by first purifying a commercial, metal-free phthalocyanine. The commercial material is first purified by acetone extraction to remove organic impurities. Since this extraction step yields the less sensitive beta crystalline form, the alpha form is obtained by dissolving 100 parts of the beta form in 600 cc. of sulfuric acid, precipitating by pouring the solution to about 3 liters of ice water and washing with water to neutrality. The thus purified phthalocyanine is then salt milled for six days and desalted by slurrying in distilled water, vacuum filtered, water washed and methanol washed until the initial filtrate is clear. After vacuum drying to remove residual methanol, the X-form phthalocyanine is dispersed in a binder solution prepared as described above. About two parts of the above described phthalocyanine is slurried in 100 mil of isopropanyl. About 10 mil of this dispersion is mixed with about two parts of the binder material and additional 5 mil of isopropanol. This paste mixture is then coated on the donor prepared as described above using a No. 12 wire-wound drawdown rod, and the donor is oven dried at 75° C. for 5 minutes. The donor is taped to a transparent electrode with the imaging layer side up. The transparent electrode is a tin oxide-coated glass available from the Pittsburgh Plate Glass Company under the trade name NESA. The imaging layer is covered with a sheet of aluminized styrene wet on the non-aluminized side with an activator which in this case is a kerosene fraction sold under the trade name of Sohio Odorless Solvent 3440 available from The Standard Oil Company. The imaging member comprising the aluminized styrene, the imaging layer and the coated donor sheet is rolled flat with a soft rubber roller and an electric potential is applied between the aluminized side of the styrene sheet and the NESA glass electrode from a 10KV direct current power supply with the NESA glass made the positive pole. The imaging layer is exposed to an imagewise pattern of light from a white incandescent light source for a period of about two seconds through the NESA glass and the transparent donor sheet. With the voltage still applied, the receiver sheet is separated from the donor sheet. The image on the donor sheet is heated by hot air for a few seconds providing a clear, smooth surface that is well fixed. In Table I below there is listed solvent softenable materials which are employed in the above described example. The procedure for each Example I–IX is repeated except for the solvent softenable layer which is listed in Table I for each example. There is also shown in Table I the solubility of the solvent softenable material in the Sohio Odorless Solvent employed as the activator in the manifold imaging process described above.

TABLE I

Example	Type	Solvent Softenable Layer: Physical Property	Trade Name	Manufacturer	Solubility
I	Ethylene-vinyl acetate copolymer.	Ring and ball softening point—99° C.	Nevex 100	Neville Chem. Co.	Soluble.
II	Polystyrene	Ring and ball point 75° C mol. wt. 400.	Piccolastic A-75	Pennsylvania Industrial Chem. Corp.	Do.
III	Alphamethyl-styrene-vinyltoluene copolymer.	Ring and ball softening point—120° C.	Piccotex 120	Same	Partially soluble.
IV	Polymerized rosin and glycerin reaction product.	Ring and ball softening point—105° C.-110° C.	VBR 4000	Nelio Corp.	Soluble.
V	Alphamethyl-styrene-styrene copolymer (mol. ratio 67/33).	Nalge softening point 55° C.-70° C. intrinsic visc. .029 in toluene at 25° C.			Do.
VI	Vinyltoluene n-butyl methacrylate copolymer (60/40 wt. percent).	Melt index—17			Partially soluble.
VII	Vinyltoluene n-butyl methacrylate copolymer (62/37 wt. percent).	Melt index—61			Do.
VIII	33⅓% vinylidene-acrylic terpolymer.	Melting point—100° C	Alphaprene A-100	Reichhold Chem. Inc.	Soluble.
	66⅔% alphamethyl styrene vinyltoluene copolymer.	Ring and ball softening point—75° C.	Piccotex 75	Pennsylvania Industrial Chem. Corp.	Insoluble.
IX	97.1% alphamethyl styrene vinyltoluene copolymer.		Piccotex 120	Same	Partially soluble.
	2.1% polyisobutylene	Mol. wt. 64,000-81,000 (Staudiger) Intrinsic Visc. (dl/g) 2.04-2.57.	Vistanex MM L80	EnJay Chem. Company	Insoluble.

EXAMPLE X

Example III is repeated except that an oil soluble red dye, Calco Oil Red N-1700 available from American Cyanamid Company is incorporated into the Piccotex 120 subcoating on the donor sheet. The resulting image residing on the donor sheet now has a red background. The image is fixed to the donor sheet by heating slightly to evaporate the Sohio Odorless Solvent. The image is projected by means of an overhead projector giving unusual color effects due to the red dye in the subcoating.

Images produced by the above examples can be employed in projection slides for use in the various types of projectors. By employing various dyes in the solvent softenable layer, unusual color effects may be obtained when the image is projected. Particularly, effects can be obtained, for example, by employing a purple colored imaging layer on a transparent red solvent softenable layer or a green imaging layer on a transparent yellow solvent softenable layer. It is to be noted that images produced in accordance with this invention can be employed after fixing directly as a projection image without further treatment. Previously, images produced in accordance with the prior art in manifold imaging process required polishing or buffing in order to obtain true color projection images.

Although specific components in proportion have been stated in the above description of the preferred embodiment of the invention, other typical materials as listed above if suitable may be used with similar results. In addition, other materials may be employed to synergize, enhance or otherwise modify the properties of the solvent softenable layer. For example, various dyes, particles made up of two or more layers, blends of materials, complexes and electrical sensitizers such as Lewis acid may be added to the solvent softenable layer.

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. An imaging method which comprises the steps of

b. activating said imaging layer with an activator, said activator comprising an electrically resistive solvent capable of at least softening said fixative layer, whereby said imaging layer mixes with said first layer,

c. subjecting said imaging layer to an electric field, exposure to electromagnetic radiation actinic to said material and a receiver sheet overlying said imaging layer,

d. exposing said imaging layer to a pattern of electromagnetic radiation to which said layer is sensitive and,

e. while under said field separating said donor and receiver sheet whereby said imaging layer fractures in imagewise configuration with the exposed portion residing on one of the donor and receiver sheets and the unexposed portion residing on the other of said sheets.

2. The method of claim 1 further including the step of fixing by means of heat at least one of said exposed and unexposed portions of said imaging layer.

3. The method of claim 1 wherein the solvent softenable material is a thermoplastic material.

4. The method of claim 1 wherein the electrically photosensitive material is an organic material.

5. The method of claim 4 wherein the organic material is phthalocyanine.

6. The method of claim 1 wherein the fixative layer contains a dye material.

7. The method of claim 1 wherein the fixative layer comprises at least two materials at least one of which is at least softenable in said activator and one of which is insoluble in said activator.

8. The method of claim 1 wherein the fixative layer is from about 1 micron to about 5 microns in thickness.

9. The method of claim 1 wherein the donor sheet and the solvent softenable layer are transparent.

10. The method of claim 1 wherein the fixative layer comprises a modified polystyrene.

11. The method of claim 1 wherein the fixative layer comprises a styrene-vinyl toluene copolymer.

* * * * *

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,653,889 Dated 4/4/72

Inventor(s) Ray H. Luebbe Jr. & John F. Bryne

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 34, "tO" should read --to--

Column 4, line 9, delete --phenanthrenylazo) phloroglucinol,--;

Column 4, line 39, "carboxyphphenyl" should read --carboxyphenyl--;

Column 4, line 43, "debenzoylamine" should read --dibenzoylamine--;

Column 4, line 52, "bephenyl" should read --biphenyl--;

Column 4, line 68, "tetanium" should read --titanium--

Column 5, line 6, "nuphthylidene" should read --naphthylidene--;

Column 5, line 6, "2-phenyl-4-diphenylidene-pxayoline" should read --2-phenyl-4-diphenylidene-oxazoline--;

Column 5, line 49, "caldium" should read --cadmium--;

Column 5, line 54, "sulphonoc" should read --sulphonic--

Column 6, line 58, "phthalocyanium" should read --phthalocyanine--

Column 7, line 6, "tetraphyridylphthalocyanine" should read --tetrapyridylphthalocyanine--

Column 9, line 30, "fractional" should read --frictional--

Column 12, line 21, "mil" should read --ml.--;

Column 12, line 23, "ispropyalcohol" should read --isopropyl alcohol--;

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,653,889 Dated 4/4 '72

Inventor(s) Ray H. Luebbe Jr. & John F. Bryne - 2 -

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 12, line 42, "mil" should read --ml.--, both occurrences;

Column 12, line 44, "mil" should read --ml.--

Claim 1, line 1, insert after "of" --(a) providing a donor sheet and a receiver sheet and sandwiched therebetween a fixitive layer comprising solvent softenable material and an imaging layer comprising electrically photosensitive material, said material being structurally fracturable in response to the combined effects of an applied electric field and exposure to electromagnetic radiation to said material,--

Claim 1, line 1 of (c), delete "exposure to electromagnetic radiation actinic to said material and a receiver sheet overlying said imaging layer"

Claim 9, line 2, delete "solvent softenable" and insert in its place --fixitive--.

Signed and sealed this 1st day of May 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents