

July 11, 1972

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3,676,118

REFLEX XEROGRAPHIC IMAGING SYSTEM

Filed Aug. 26, 1970

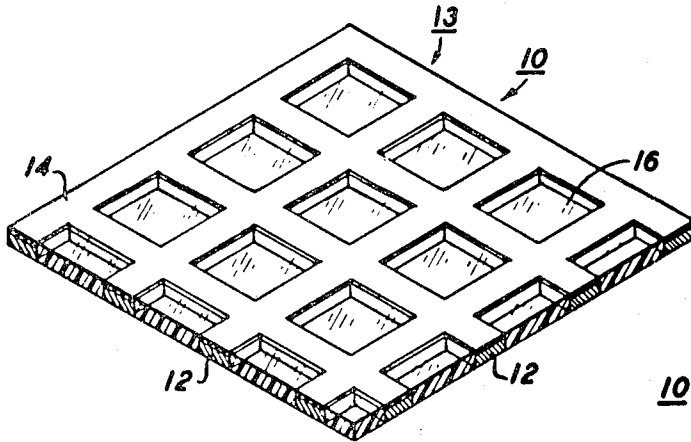


FIG. 1

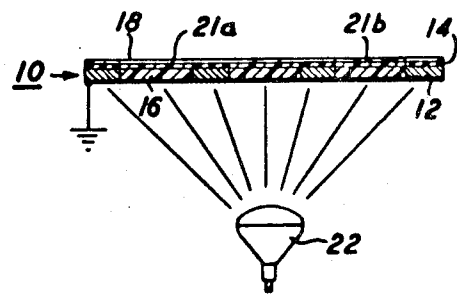


FIG. 2B

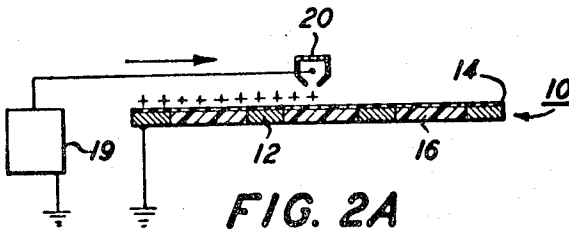


FIG. 2A

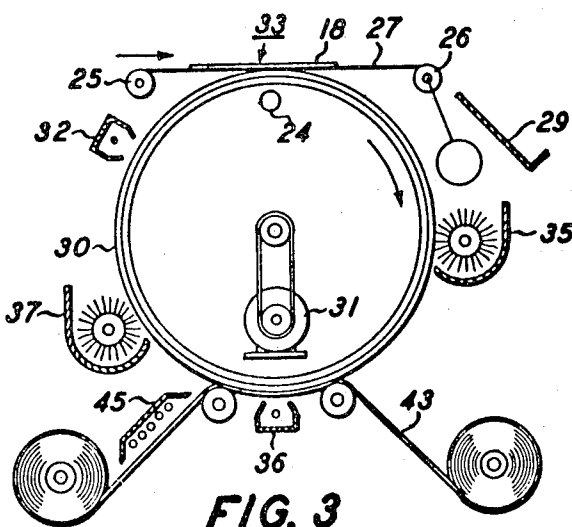


FIG. 3

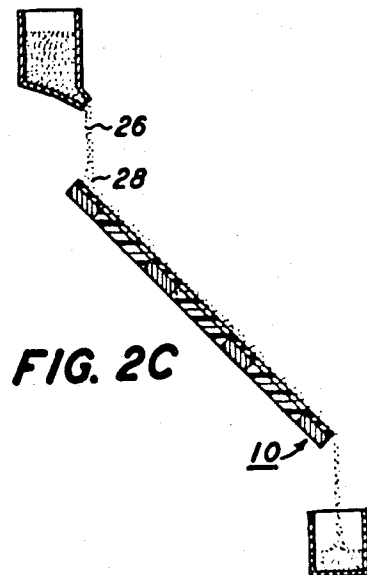


FIG. 2C

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3,676,118

REFLEX XEROGRAPHIC IMAGING SYSTEM
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Continuation-in-part of application Ser. No. 619,618,
Mar. 1, 1967. This application Aug. 26, 1970,
Ser. No. 67,115

Int. Cl. G03g 5/00, 13/00
U.S. Cl. 96—1.5

12 Claims

ABSTRACT OF THE DISCLOSURE

A xerographic imaging system employing a new xerographic plate adapted for reflex exposure, the plate comprising an opaque electrically conductive grid of grid portions and interstices, the grid portions overcoated with an imaging photoconductor and the interstices at least partially filled with a material substantially transparent to that wavelength radiation to which the imaging photoconductor is photosensitive, said material preferably comprising a photoconductive or electrically "leaky" dielectric filler material to form a plate preferably having a smooth face at the imaging photoconductor face of the plate.

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of application Ser. No. 619,618 filed on Mar. 1, 1967, now abandoned.

This invention relates in general to an electrophotographic imaging system and more particularly to a xerographic imaging system utilizing a novel xerographic plate adapted for use in a reflex exposure xerographic process.

Electrostatography is exemplified by the process of xerography, for example, as disclosed in Carlson Pat. 2,297,691 wherein a xerographic plate comprising a layer of photoconductive insulating material on a conductive backing is given a uniform electric charge over its surface and is then exposed to the subject matter to be reproduced, usually by conventional projection techniques. This exposure discharges the plate areas in accordance with the radiation intensity that reaches them and thereby creates a latent electrostatic image on or in the photoconductive layer. Development of the latent image is effected with an electrostatically charged finely divided material, such as an electroscopic powder referred to in the art as "toner," that is brought into surface contact with the photoconductive layer and is held thereon electrostatically in a pattern corresponding to the latent electrostatic image. Thereafter the developed xerographic powder image may be transferred to a support surface to which it may be affixed by any suitable means.

In exposing the xerographic plate to the subject matter to be reproduced it has generally been necessary to expose the plate other than by reflex type methods. In making a size to size reproduction of a transparency the transparency may be placed closely adjacent or in contact with the photoconductive insulating surface and the plate exposed by shining light through the transparency. However this most simple and convenient exposure system may not be employed when the original is opaque as it often is. Especially when exposing xerographic plates to opaque originals it has generally been necessary to expose the plate utilizing expensive and bulky lenses or similar optical systems for example by illuminating the image side of a document or other original and bringing the reflected rays from the original into focus in the plane of the xerographic plate to expose it to the image of the original. To accomplish this requires an expensive, bulky, complicated, lens-optical system.

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In contrast, in conventional reflex type exposure an image sensitive member may be placed sensitive side down on the original to be copied preferably with the image side of for example a document original facing the image sensitive member and light (or heat as used in the Thermofax process) is radiated onto the two sheets through the back or non-sensitive side of the image sensitive member. The image sensitive member transmits the non-absorbed fraction of the light falling on it, the transmitted light being largely absorbed by dark image portions of the original and largely reflected by the lighter or whiter background areas of the original to sensitive corresponding portions of the image sensitive member. The image produced by this reflected light on the image sensitive member is a mirror-reverse of the original which when transferred to another support material produces a right reading reproduction of the original.

Reflex type exposure systems, compared to the exposure systems used in most commercially available xerographic copying machines, are generally less expensive, simpler, more compact and much more light efficient because the original is closely adjacent the image sensitive member and thus the member is exposed to most of the light reflected from the subject to be reproduced. The reflex type exposure process has been found to be useful in silver halide photography, Thermofax and the Verifax copying processes.

Reflex type exposure systems have not gained commercial acceptance in xerographic imaging machines for a number of reasons, an important one being that many photoconductive insulating materials and electrically conductive backing materials utilized in xerographic plate construction are essentially opaque to actinic radiation (that wavelength radiation which will photo-electrically activate the photoconductive insulating material rendering it more electrically conductive in light struck portions) and thus it is impossible when utilizing such materials to transmit radiation through the back of the plate to the original. Further any illumination of sufficient intensity to penetrate the photoconductive insulating layer is normally sufficient of itself to discharge any electrostatic charge placed on the photoconductive layer in a sensitizing process irrespective of any additional radiation reflected back to the photoconductive insulating surface from the subject to be copied.

Despite the obstacles that are present in trying to evolve an acceptable reflex type exposure system for use in xerography the advantages of this type of exposure have prompted various reflex exposure concepts of varying merit to be used in the xerographic process.

For example as disclosed in Van Wagner et al. Pat. 3,094,910 a reflex type exposure system for xerography is described wherein a partially transparent xerographic plate is exposed from the back according to conventional reflex exposure techniques. The xerographic plate comprises a photoconductive insulating member taking the form of an amorphous selenium over-coated electrically conductive screen with open interstices. Although this configuration has advantages, a characteristic of this system is that it is difficult to develop the latent image on the xerographic plate especially by conventional cascade development techniques since marking material tends to clog the screen interstices which produces, in background areas as well as in image areas an undesirable half-tone pattern corresponding to the interstices. Also it is found that clogging greatly increases the difficulty of cleaning the plate after transfer of the marking material image to a transfer sheet in order to ready the plate for a new xerographic processing cycle for example in an automatic xerographic imaging machine. Also it is found that the open

interstices reduce the ability of the photoconductor portions of the plate to accept charge.

Byrne Pat. 2,917,385 suggests a reflex exposure xerographic plate comprising a light transmitting electrically conductive support layer for a dot pattern of opaque conductive material which opaque pattern is overcoated with a photoconductive insulating material. In this structure, Byrne discloses that the interstices between the dot pattern may be filled with transparent or translucent resinous insulating materials thereby resulting in a smooth faced plate thereby obviating the problems presented by the Van Wagner et al. structure. However, the insulating resins contemplated by Byrne are highly insulating dielectric materials and retain electrostatic charge after exposure resulting in a background print out of a pattern corresponding to the interstitial areas.

Optionally in the reflex plate of Byrne the portions of photoconductive insulating material may be countersunk into the transparent electrically conductive portions or the interstices between the dot pattern may be filled with conductive inorganic materials. In either instance a smooth face is presented thereby obviating one of the primary disadvantages of the Van Wagner et al. configuration, mentioned above. However, in both cases, the conductive areas adjacent the photoconductor areas reduce the ability of the photoconductor portions to accept charge, i.e. the conductive areas draw the deposited electrostatic charge thereby leaving the photoconductor areas inadequately charged. When exposure takes place under such conditions resolution will be decreased due to the inadequately charged photoconductive areas.

Despite developments typified by the above, commercially available xerographic devices, because of the problems mentioned, still do not employ a reflex type exposure system since prior art systems of this type have involved compromise in the method of making or in the structure or operation of the photosensitive member producing deterioration in the reproduced image.

Thus there is a continuing need for an improved method of exposing xerographic plates and in particular a need for a better system employing novel xerographic plates to reflex expose originals to be reproduced xerographically.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide a novel exposure xerographic system which overcomes the above noted disadvantages and satisfies the above noted wants.

It is a further object of this invention to provide a xerographic plate capable of being exposed by simpler, less expensive and less complex methods than the lens type optical systems presently used in xerography.

It is a further object of this invention to provide a novel reflex exposure xerographic plate imaging system wherein the plate may be developed by conventional development techniques to produce high quality images free from half-tone background pattern.

It is a further object of this invention to provide a reflex exposure xerographic plate imaging system not requiring special light sources or special positioning of light sources interposed between the plate and the original to be copied.

It is a still further object of this invention to provide a reflex xerographic plate imaging system which avoids optical focusing of the image pattern.

It is a still further object of this invention to provide a reflex exposure xerographic plate of greater durability than prior art reflex exposure plates.

It is a still further object of this invention to provide a novel reflex exposure imaging system capable of producing high quality continuous tone and solid area images as well as quality line copy images.

The foregoing objects and others are accomplished in accordance with this invention by providing a xerographic plate of a novel construction having great utility in a

flex type exposure xerographic system comprising an opaque electrically conductive grid, grid portions being overcoated with an imaging photoconductor the grid interstices at least partially filled with a photoconductive or electrically "leaky" dielectric filler material substantially transparent to that wavelength radiation to which the imaging photoconductor is photosensitive, said material preferably comprising a material to form a plate preferably having a smooth face at the imaging photoconductor face of the plate. Preferably, it is this smooth face which is placed contiguous to the subject to be copied and which is subsequently xerographically processed.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention as well as other objects and further features thereof, reference is made to the following detail disclosure of this invention taken in conjunction with the accompanying drawings wherein:

FIG. 1 is an enlarged isometric view of an embodiment of the novel xerographic plate according to the invention.

FIG. 2 is a side sectional view of an embodiment of the novel plate of this invention and a schematic representation of exemplary xerographic charging, exposing and developing steps to produce a visible marking material image on the surface of the plate.

FIG. 3 is a schematic representation of an exemplary embodiment of a reflex exposure automatic xerographic imaging system employing an embodiment of the novel xerographic plate of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1 there is illustrated novel xerographic plate 10 comprising opaque electrically conductive grille 12, said grid in grid portions being overcoated with a layer of photoconductive insulating material 14 the interstices of said grid being filled with a transparent material 16 to give at least one smooth face 13 to said plate.

For convenience, hereinafter in the specification and claims structures similar to 12 in FIG. 1 will be referred to as a grid, which is intended to include any mesh, screen, gauze, foraminous material either in rectangular, dot pattern or similar configuration.

Grids for use herein, of which grid 12 is illustrative may come in many shapes and sizes but preferably, to provide adequate image resolution, grid 12 should have from about 40 to about 500 alternating grid and interstitial portions to the lineal inch which is comparable to spacing similar to that commonly used in half-tone work. For example, if a copy is desired comparable to newspaper pictorial work there will generally be a spacing of between about 60 and 120 grid and interstitial portions per lineal inch.

Grid 12 should preferably also be substantially opaque so that electrically charged photoconductive insulating material deposited on grid portions is not discharged when the plate is exposed to actinic light incident from the back side of the plate. The commercially available grids which are preferred for use herein are available in thicknesses generally from about 2 to 12 mils, and are found to be entirely satisfactory in providing sufficient electrical conductivity and sufficient opacity to be used herein.

Flat surfaced electroformed copper, nickel or nickel plated copper grids available from the C. O. Jelliff Mfg. Corp. under the trademark Lektromesh are preferred grids for use herein because of the wide range of grids available, their strength and because such grids have substantially smooth surfaces to facilitate the depositing thereon and the tenacious adherence thereto of the photoconductive insulating layer. Also preferred are flat punched or etched screens or electro-deposited grids resembling punched sheets available in a wide variety of sizes from Perforated Products, Inc. of Boston, Mass. Ordinary wire

screens, for example of the overlapping wire type may be utilized herein and are suitable especially for resinous binder photoconductive insulators.

Photoconductive insulating material 14 may be any suitable photoconductive insulator known in the art which is preferably reasonably fast and sensitive to at least a substantial portion of the visible spectrum. Amorphous selenium is found to be a preferred photoconductive insulating material for use herein because of its extremely high quality image making capability, relatively high light response, capability to receive and retain charge of different potentials and of different polarity and its ability to be xerographically processed many times in succession. Also preferred are photoconductors comprising selenium with arsenic or tellurium. A more detailed disclosure of such selenium mixtures may be found in Ullrich Pat. 2,803,542; Mayer et al. Pat. 2,822,300; Mengali Pat. 2,745,327 and Paris Pat. 2,803,541.

Other vitreous type photoconductors may be used as the imaging photoconductor herein including the cadmium sulfoselenide and related photoconductors as described in Corrsin Pat. 3,151,982.

Other preferred photoconductors are zinc oxide binder systems preferably dye sensitized. Such plates are easily manufactured from readily available inexpensive materials. If used in automatic xerographic machines, plates of ZnO must be rested sufficiently in the dark to restore electrical resistivity for a new imaging cycle. Phthalocyanine binder systems of the type described in copending application Ser. No. 375,191 filed June 15, 1964 which are reusable photoconductors and are found to adhere tenaciously to grid portions are also preferred photoconductive insulating materials.

However any suitable photoconductive layer may be used in carrying out the invention. Typical photoconductive insulating materials include: selenium doped with materials such as thallium, cadmium sulfide, cadmium selenide, etc., particulate photoconductive materials such as zinc sulfide, zinc cadmium sulfide, French process zinc oxide, phthalocyanine, cadmium sulfide, cadmium selenide, zinc silicate, cadmium sulfoselenide, linear quinacridones, etc. dispersed in an insulating inorganic film forming binder such as a glass for example see Corrsin Pat. 3,151,982 or an insulating organic film forming binder such as an epoxy resin, a silicone resin, an alkyd resin, a styrene-butadiene resin, a wax or the like, for example see Middleton et al. Pats. 3,121,006 and 3,121,007. Other typical photoconductive insulating materials include: blends, copolymers, terpolymers, etc. of photoconductors and non-photoconductive materials which are either copolymerizable or miscible together to form solid solutions and organic photoconductive materials of this type include: anthracene, polyvinylanthracene, anthraquinone, oxadiazole derivatives such as 2,5-bis-(p-aminophenyl-1), 1,3,4-oxadiazole; 2-phenylbenzoxazole; and charge transfer complexes made by complexing resins such as polyvinylcarbazole, phenolaldehydes, epoxies, phenoxies, polycarbonates, etc., with Lewis acid such as tetrachlorophthalic anhydride; 2,4,7-trinitrofluorenone; metallic chlorides such as aluminum, zinc or ferric chlorides; 4,4-bis-(dimethylamino)benzophenone; chloranil; picric acid; 1,3,5-trinitrobenzene; 1-chloroanthraquinone; bromal; 4-nitrobenzaldehyde; 4-nitrophenol; acetic anhydride; maleic anhydride; boron trichloride; maleic acid; cinnamic acid; benzoic acid; tartaric acid; malonic acid and mixtures thereof.

Transparent material 16 may be any substantially transparent material which can be filled into the interstices of grid 12 and which preferably may accept charge yet substantially discharge it (at least about 60 percent or more of the initial charge) before the latent electrostatic image is developed. It is found that a transparent material capable of temporarily holding a charge is preferred since the initial presence of the charge in transparent material plate areas 16 permits better charging efficiency for

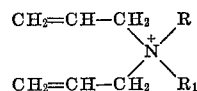
the plate photoconductor portions 14 while the dissipation or "leaking" off of this charge before development of the latent electrostatic image by contacting with marking material eliminates undesirable background in non-image areas.

A preferred method of rendering the transparent portions 16 temporarily capable of holding a charge is to employ as a filler a "leaky" transparent material. By "leaky" is meant a material which initially will accept a charge for example during the charge sensitization step in the process of xerography and retain it for a sufficient time to effectively aid in charging the photoconductor portions 14 of the plate, but will substantially completely dissipate that charge through adjacent grounded electrically conductive portions of grid 12 before the developing step to bring transparent portions of the plate preferably to a potential approximating the potential of light struck discharged photoconductor portions. It is found that for most photoconductors, a transparent material which will substantially completely dissipate a charge deposited on it, in a time of about 0.1 second or more is sufficient to effectively aid in charging photoconductor portions 14. Because the charging step in xerograph is ordinarily followed in close sequence by the exposure and developing steps and because some photoconductors tend to leak away a substantial part of their charge in a matter of minutes or less, it is preferred to have a transparent filler material which will substantially completely dissipate its charge in less than about 10 seconds. Preferred transparent materials which are "leaky" by the above defined limits of substantially completely dissipating charge between about 0.1 and 10 seconds are such organic plastic materials as cellulose acetate, ethyl cellulose, some epoxy resins, esters of sugar such as sucrose acetate, sucrose acetate isobutyrate and cyanoethyl sucrose, phenolics, polyvinyl fluoride, some polystyrenes, polyvinylidene chloride, polyvinylidene fluoride, cellulose nitrate, polyvinyl alcohol, polyvinyl acetate and polyvinyl carbazole and mixtures and copolymers thereof.

Typical transparent non-plastic filler materials include glass and related materials. Glasses suitable as "leaky" fillers for use herein are described in an article New Glass Compositions Possessing Electronic Conductivities, Journal of the Electrochemical Society, 112, No. 10 (October 1965).

It will be understood that various fillers, plasticizers and additives may also be added to the aforementioned and other commercially available transparent materials to change their electrical properties to make them "leaky" for use herein.

For example, a series of relatively polar, alcohol or water soluble polymers, may be rendered sufficiently leaky by incorporation of a few percent of a suitable ionically conductive or hygroscopic material. Suitable polymers include polyethylene glycols, for example carbowaxes, available from the Union Carbide Corp., gelatin, polyvinyl alcohol, polyamides such as soluble nylons, and similar materials. Suitable ionically conductive additives include polymeric quaternary amine resins including a polymer of vinylbenzyl trimethyl ammonium chloride, available from Dow Chemical Co. under the designation Resin 2611.7 (a more detailed disclosure of similar additives may be found in Silvernail et al. Pat. 3,011,918) and polycationic polyelectrolytes available under the designation Conductive Polymers 261, PCL 7001, PCL 7006 from the Calgon Corp. and believed to be aqueous solutions of a polymer consisting of at least 90 percent of repeating units derived from monomers of the formula



where R is 4-4c alkyl and R₁ is the same as R or a -propion-amide. Other antistatic additives for plastics in-

clude polyethylene glycol acrylates, for example see Blanton Pat. 2,841,567 and polyvinyl pyrrolidone, for example see Barb British Pat. 802,237.

Also non-polymeric antistatics may be incorporated in plastics to render them leaky; for example quaternary ammonium salts as more fully described in Gruber Pat. 2,897,170. Quaternary ammonium phytates may be used in a similar manner, for example see McDermott Pat. 3,226,321. These may be included in any of the water or alcohol based resins listed above in quantities limited by their compatibility, generally found to be typically 5-10 percent dry weight of antistatic based upon resin solids. They may also be used in some solvent based resins as indicated above.

Other ionically conductive or hygroscopic impurities may be included in any of the solvent or water based resins listed above to render them "leaky," for example, LiCl , AlCl_3 , ZnCl_2 (and their hydrates), BF_3 , and the boric acid complexes of sugars. Typical concentrations of these materials are found to vary from 1-10 percent dry weight of additive relative to polymer solids. Proper concentrations can be ascertained by those skilled in the art and will vary depending upon specific materials used.

In fact it is generally found that any transparent material possessing a dielectric constant and a bulk electrical resistivity such that the product of these two values is between about 10^{12} and 10^{14} ohm-centimeters is "leaky" and satisfies that requirement for use as a transparent filler material herein. The product of the dielectric constant and the bulk electrical resistivity will be referred to hereinafter as the resistivity of a material.

Alternatively, the transparent material portions 16 may be rendered temporarily capable of holding a charge by making for example a transparent resinous or polymeric material photoconductive by treating it with a suitable sensitizing agent. Thus light struck transparent areas as well as photoconductor portions will discharge upon illumination. This is preferably accomplished by providing a photoconductive plastic hole filler sensitive to a spectral region not required for the imaging photoconductor. The hole filler should preferably use and thus effectively absorb a sufficient amount of radiation in this region to discharge the photoconductive filler in the holes.

As a practical matter, for most document copying, this means that the imaging photoconductor on the grid should be highly sensitive to visible radiation, while the hole filler photoconductor should be sensitive only in the ultraviolet, which is not required for imaging from ordinary visible inks. The light source, of course, should include a substantial portion of ultraviolet radiation. For example a commercial black light fluorescent lamp is preferred because it includes a good deal of near ultraviolet radiation as well as enough white light to expose the preferred imaging photoconductors provided for herein. Preferably the hole filler photoconductor should be fully exposed by the incident ultraviolet light, while the imaging photoconductor should be fully exposed by the visible radiation which has been first filtered through the hole photoconductor and then reflected from the document.

Any suitable photoconductive filler may be used which satisfies the above noted properties. Typical such materials include unsensitized French process ZnO in any suitable Electrofax binder, such as the water soluble melamine-formaldehyde resins listed in Kucera Pat. 2,959,481, or the styrene-butadiene emulsions described in Griggs et al. Pat. 2,875,054, as well as in the solvent type binders such as listed in Middleton Pat. 3,121,006.

Lewis acid sensitized aromatic resins such as polyvinyl carbazole sensitized with tetrachlorophthalic anhydride or 2,4,7-trinitrofluorenone are especially preferred because the spectral sensitivity of such films may be made to extend from the ultraviolet to approximately 4200 angstrom units with all longer wavelengths being effectively transmitted by the film. This has the advantage

over for example an interstitial filling of ZnO in that the polyvinyl filler would be clear rather than light scattering. Polyvinyl carbazole fillings are preferably applied from solution in relatively strong solvents, such as toluene/cyclohexanone; dichloromethane/dioxane and similar mixtures.

The triphenyl amine polymer described in Fox Pat. 3,265,496, preferably complexed with a weak electron acceptor such as tetrachlorophthalic anhydride, alone or in a substantially transparent binder as described therein is also preferred as a photoconductive filler material for similar reasons.

The following examples further specifically define the novel xerographic plate herein and methods of making said plate. The parts and percentages are by weight unless otherwise indicated. The examples below are intended to illustrate various preferred embodiments of the xerographic plate of this invention.

EXAMPLE I

A copper Lektromesh grid, about 4 mils thick with about 16 percent open area with about 100 openings and grid portions per lineal inch is wiped and cleaned with dilute sulfuric acid to prepare it for coating. A layer of photoconductive insulating amorphous selenium is vacuum deposited on grid portions by the method as described in Bixby et al. Pat. 2,753,278 to a uniform thickness of about 20 microns.

The selenium coated grid is placed, the selenium coated face down in a mold, the mold surface coated with a tetrafluoroethylene polymer available under the trademark Teflon from the E. I. du Pont de Nemours & Co.

A polymeric composition having a resistivity of between about 10^{12} and 10^{14} ohm-cms. is prepared in the following manner:

A solution of an alcohol soluble polyamide resin available under the trademark Zytel-61 from the E. I. du Pont de Nemours & Co. is prepared by combining about 15 parts of Zytel-61 resin and about 100 parts of an 80/20 mixture of methanol and water. The mixture of resin and solvent is heated to facilitate solution. About $\frac{1}{2}$ part of PCL-7006 a conductive polymer available from Calgon Corporation, described in Belgium Pat. 682,255, is added with stirring to the solution and dissolved. The solution is poured into the mold and dried for about 30 minutes at about 90°F . The coating is repeated until about $4\frac{1}{2}$ mils of the leaky filler is obtained in the interstitial areas. The back surface of the member is then sanded, buffed and polished to render it smooth and even.

The selenium coated screen with the interstices filled with a transparent plastic is removed from the bottom of the mold to yield a xerographic plate face comprising a pattern of finely interspersed alternating areas of amorphous selenium and transparent plastic. This front, selenium coated face is also lightly sanded and buffed to polish it and render it very smooth.

The plate is used to produce an image by uniformly charging the front face of the plate by a corona discharge device available commercially as a part of the Model D Processor available from Xerox Corporation to about +600 volts, laying a photograph containing line copy and continuous tone image portions image side down on a sheet of about 2 mil transparent Mylar polyester film interposed between the original and the front face of the plate, exposing the back side of the plate at about 10 f.c.s. with a tungsten filament lamp and gravitating marking material across the front face of the plate to form a visible mirror reverse image of the original photograph on the plate surface. The image developed on the plate is electrostatically transferred to a receiving sheet and heat fused. The image exhibits good solid area coverage and negligible background. The xerographic plate is wiped clean of any residual toner and is reused as described to form other images.

9 EXAMPLE II

The technique of Example I is followed with the exception that the interstitial filler is polyethylene available under the trade name Alathon, and manufactured by the E. I. du Pont Co. of Wilmington, Del., which has a resistivity of about 10^{16} ohm-cms. The polyethylene solution is prepared by dissolving 35 parts of Alathon in about 100 parts methanol. The solution is then poured into the mold in the same manner as Example I and dried resulting in a transparent insulating filler of about 4 mils thickness. The plate is then used to produce an image in the same manner outlined in Example I. The image exhibits good solid area coverage but there is a significant degradation of image quality due to a print out in the form of a half tone pattern corresponding to the interstitial areas of the reflex plate. This is due to the use of the high dielectric material as a filler between the interstices of the grid.

EXAMPLE III

Example I is followed except that the interstitial filler is nitrocellulose which is a leaky material having a resistivity of between 10^{12} and 10^{14} ohm-cms. and is available from the Hercules Powder Co. The nitrocellulose solution is prepared by dissolving about 25 parts of RS Nitrocellulose of $\frac{1}{2}$ sec. viscosity in about 75 parts of a one/one solvent mixture of ethanol and ethyl acetate. The solution is poured into the mold to give a dried thickness of transparent filler in the interstitial areas of about 4 mils. The plate is imaged as in Example I with the same excellent results.

EXAMPLE IV

The first two paragraphs of Example I are followed. A solution is prepared of about 20 parts polyvinylidene chloride which is high electrically resistive material available under the designation of Saran F-120 from Dow Chemical Co.; about $\frac{1}{2}$ part lithium chloride and about 80 parts methyl ethyl ketone. The solution is coated to fill the interstitial areas of the grid with a dried filler composition having a resistivity of between 10^{12} and 10^{14} ohm-cm. in a thickness of about 4 mils. After drying the front face of the plate is finished to render it smooth. The plate is imaged as in Example I with the same excellent results.

EXAMPLE V

A nickel, perforated plate grid about 3 mils thick, with about 22 percent open area and with about 80 holes and grid portions per lineal inch available from perforated Products, Inc. is coated on grid portions with a phthalocyanine organic binder photoconductor made by milling for about 8 hours with porcelain pebbles about 6 parts of an epoxidized polyolefin available under the trademark SR Oxiron 2002 from FMC Corp., about 1 part of the X-crystal form of metal-free phthalocyanine prepared for example as described in copending application Ser. No. 505,723, filed Oct. 29, 1965; about $3\frac{1}{2}$ parts phthalic anhydride, about 9 parts n-butanol and about 15 parts acetone. The milled mixture is applied to the grid by spraying, the coating being cured for about 12 hours at about 150° C. to a thickness of about 20 microns.

After coating of the photoconductor on the grid portions a dispersion is made by ball milling about 5 parts zinc oxide, available under the designation AZO-ZZZ-33 from American Zinc Process Co., about 1 part on a dry weight basis of a silicone resin SR-82 available from General Electric Co. and sufficient toluene to give a good grinding viscosity.

The dispersion is then coated to partially fill the interstitial areas of the grid as described above in Example I and dried at about 250° F. for about 2 hours, the dried zinc oxide binder portions being about 2 mils thick.

The phthalocyanine coated screen with zinc oxide binder filled interstices is removed from the mold and the front surface comprising alternating areas of phthalocyanine and zinc oxide binder layers is lightly sanded and buffed to polish it and render it smooth.

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The plate is xerographically processed by charging it as in Example I to about -600 volts, laying a photograph image side down in contact with the front face of the plate, exposing the back of the plate with a commercial "black light" fluorescent lamp such as F40BL available from the General Electric Co., positioned about 6 inches from the plate for about 10 to 15 seconds and gravitating marking material across the front face of the plate to form a visible image. The image is electrostatically transferred to a receiving sheet and fused. The image is electrostatically transferred to a receiving sheet and fused. The image on the receiving sheet exhibits good solid area coverage and negligible background development. The xerographic plate is wiped clean of any residual developer and reused.

EXAMPLE VI

Example IV is followed except that the interstitial filler is polyvinyl carbazole available from Badische Anilin und Soda-Fabrik AG under the trademark Luvican M-170. A polyvinyl carbazole solution is prepared by dissolving about 10 parts of Luvican M-170 in about 100 parts of a 1/1 solvent mixture of toluene and cyclohexanone and then adding about 2 parts of tetrachloro phthalic anhydride with stirring until dissolved. The polymer composition has a resistivity of from about 10^{12} to 10^{14} ohm-cms.

The solution of the polymer composition is then used to fill the interstitial areas of the grid as described in Example IV and dried at 200° F. for about one hour.

The coating is repeated until the polyvinyl carbazole layer is about $3\frac{1}{2}$ mils thick.

The plate is used to produce images as described in Example IV.

EXAMPLE VII

The first four paragraphs of Example I are followed except that the grid is coated with a zinc oxide binder prepared by ball milling about $3\frac{1}{2}$ parts of zinc oxide (a pigment grade obtained from the New Jersey Zinc Co. under the designation Florence Green Seal No. 8), about 1 part of a silicone resin SR-82 available from the General Electric Co. and sufficient toluene to give good grinding viscosity.

The plate is xerographically processed by uniformly charging the smooth face of the plate according to the procedure of Example I, to about -600 volts, laying a photograph, image side down, in immediate contact with the charged front surface, exposing the back side of the plate with about a 10 watt lamp at a distance of about $1\frac{1}{2}$ feet for about 6 seconds and gravitating marking material across the zinc oxide photoconductor face of the plate to form a visible image of the original photograph, the image exhibiting good solid area coverage and negligible background development.

EXAMPLE VIII

A copper Lektromesh grid about 4 mils thick with about 16 percent open area and with about 100 openings and grid portions per lineal inch is wiped and cleansed with carbon tetrachloride and dilute nitric acid, then rinsed with distilled water, to prepare it for coating.

An amyl alcohol slurry is prepared containing about 15 percent of cadmium sulfoselenide a bright orange-red pigment available under the designation F-14854 from the Ferro Corporation and about 85 percent of a glass frit available under the designation AG 881 from the Harshaw Chemical Co. The slurry is sprayed onto the Lektromesh grid with an air brush using CO_2 as the propellant. After the spraying on of the enamel and drying but before cracking begins the coated Lektromesh grid is slowly moved into a firing oven and maintained at about 1200° F. for about 6 minutes and then cooled to room temperature to form an imaging photoconductive insulating material on the grid of about 40 microns in thickness.

Using amyl alcohol, a slurry is prepared containing the glass frit AG 881 which is a leaky dielectric transparent material. The slurry is spread with a doctor blade onto the imaging photoconductor side of the Lektromesh grid to fill the interstices with the slurry. After coating and drying the grid is slowly moved into a firing oven and maintained at about 1175° F. for about 6 minutes and then slowly cooled to room temperature to yield a xerographic plate having one substantially smooth face comprising a pattern of finely interspersed alternating areas of imaging vitreous photoconductor and substantially transparent glass in the grid interstices. The face is lightly sanded and buffed to polish it and render it very smooth. The plate is used to produce an image by uniformly charging the smooth face of the plate by a corona discharge device available commercially as a part of the Model D Processor available from Xerox Corporation to about -700 volts, laying a photograph containing line copy and continuous tone image portions, image side down in direct contact with the smooth face of said plate, exposing the back side of the plate at about 3 f.c.s. at the plate with a tungsten filament lamp and gravitating marking material across the smooth face of the plate to form a visible image of the original photograph, the image exhibiting good solid area coverage and negligible background development. The plate is cleansed and reused.

Referring now to FIG. 2 there is illustrated a xerographic reflex exposure imaging method utilizing an embodiment of a plate according to the invention. As is well known in the art, generally the first xerographic processing step is to form a latent electrostatic image on the plate 10. The latent image is illustratively formed by uniformly electrostatically charging the plate (FIG. 2A) and then at least partially discharging the plate in light struck areas of the plate as shown in FIG. 2B.

As shown in FIG. 2A a uniform electrostatic charge illustratively positive is first placed on the surface of plate 10 thereby sensitizing it. A uniform layer of charge may be placed upon a xerographic plate in any number of ways well known in the art, for example, by vigorously rubbing the layer with a soft material such as a silk handkerchief or a soft brush or a fur or by induction charging, an example of which is described in Walkup Pat. 2,934,649 or for example by depositing charge from a corona discharge device which generally can apply a positive or negative charge and may be adapted to many sensitizing applications. For example, corona discharge devices of the general description and generally operated as disclosed in Vyverberg Pat. 2,836,725 and Walkup Pat. 2,777,957, have been found to be excellent sources of corona useful in the charging of xerographic plates. Corona source 20 is illustrated to be an adaptation of the type disclosed in the Vyverberg patent and is charging the plate by being traversed across the plate while being connected to direct current high voltage source 19. To facilitate acceptance of charge by the plate, conductive grid 12 should preferably be grounded as illustrated.

Preferably the plate should be charged when it is at its highest insulating value or when there is an absence of electromagnetic radiation that would make the photoconductor electrically conductive. Also, after the plate is sensitized and before exposure it should be kept in the dark to preserve its sensitivity.

Other methods of forming a latent image on plate 10 are known in the art and include first forming such a charge pattern on a separate photoconductive insulating layer according to conventional xerographic reproduction techniques and then transferring this charge pattern to plate 10 by bringing the two layers into very close proximity and utilizing breakdown techniques as described, for example, in U.S. Pats. 2,982,647 to Carlson and 2,825,814 and 2,937,943 to Walkup. In addition, charge patterns conforming to selected, shaped, electrodes or combinations of electrodes may be formed on the plate by the "TESI" discharge technique as more fully described in

U.S. Pats. 3,023,731 and 2,919,967 both to Schwartz or by techniques described in U.S. Pats. 3,001,848 and 3,001,849 both to Walkup as well as by electron beam recording techniques, as described in Glenn Pat. 3,113,179.

Next as illustrated in FIG. 2B a sheet of a copy 18 to be reproduced having a dark image area 21a and a white non-image background area 21b is placed contiguous to the sensitized photoconductive insulating layer as shown in FIG. 2B. In general, the copy should be placed in contact with or close enough to the plate so that spreading of the reflected light does not seriously affect image quality. Generally spacings less than about 2 or 3 mils are found to produce images of acceptable qualities. The original 18 may be displaced a slight distance from the plate by an external holding means or by a film of clear material placed between the original and the plate, the clear material for example being glass or a sheet of clear plastic film such as Mylar polyester film available from the E. I. du Pont de Nemours & Co. Light now illuminates the plate from any suitable light source for example, light bulb 22. The light passes through the transparent material portions 16 of the plate but where incident light hits the opaque grid portions 12 light is not permitted to pass to the sensitized photoconductive insulating layer portions 14. In transparent material areas 16 nothing reflects the light and accordingly incident light passes through these interstitial areas of the grid pattern to illuminate the copy 18. Where the incident light strikes the dark image areas 21a, it is largely absorbed. Thus, the photoconductive insulating portions immediately beneath the dark image areas of the original are not discharged and retain their electrostatic charge. When the light strikes the white non-image areas 21b of the copy 18, a portion of the light is reflected and scattered thereby, striking corresponding photoconductive insulating portions 14 underneath the white non-image areas. Wherever the photoconductive insulating material is struck by light it is rendered electrically conductive thereby permitting the charge on the surface of these portions to pass through the photoconductor to the opaque conductive grid 12, to ground.

Referring now to FIG. 2C the latent electrostatic image thus formed is then rendered visible by depositing electrostatically attractable material thereon by any suitable means known to those skilled in the art to produce on plate 10 a mirror-reverse image of the original.

Alternatively, the paper, plastic or other material on which it is desired to place the visible image may itself be placed in contact with the xerographic plate bearing the electrostatic image and the electrostatically attractable material deposited directly thereon thereby obviating the necessity for transferring the developed image from the plate to the paper as well as eliminating having to clean the plate.

However since transfer of the developed image to another support surface, for example paper will produce a right reading image of the original, transfer will be preferred in many applications. Alternatively the electrostatic image may be transferred to a suitable support material such as Mylar film and developed thereon to produce a right reading image of the original which may also be used as a transparency for projection.

Cascade development has been found to be commercially suitable in many applications and is illustratively known in FIG. 2C. Cascade development generally consists of gravitationally flowing developer material 26 consisting of a two-component material of the type disclosed in Walkup Pat. 2,638,416 over the plate bearing the latent image. The two components consist of an electroscopic power termed "toner" 28 and a granular material termed "carrier" and which by mixing acquire triboelectrical charges of opposite polarities. In development the toner component, usually oppositely charged to the latent image, is deposited on the latent electrostatic image to render that image visible.

Any suitable developing method may be used herein. Typical xerographic developing methods are liquid development for example see Gundlach Pat. 3,068,115; magnetic brush development for example see Giamo Pat. 2,930,351; powder cloud development for example see Carlson Pat. 2,221,776; skid development illustratively described in Mayo Pat. 2,895,847; and others.

The developed visible image whether on the plate itself or after transfer to a suitable support material may then be fixed, for example, by heating or employing solvent vapors to render it permanently usable.

Of course the process illustrated in FIG. 2 is subject to many other variations known to those skilled in the art and may be automated by various machine adaptations an example of which is illustrated in FIG. 3.

Referring now to FIG. 3 an embodiment of a xerographic plate according to the invention in the form of a drum 30 comprising the plate 10 on a transparent support 40 such as glass or a clear plastic is rotated by a motor 31 and sequentially passes a sensitizing station 32 illustrated as a corona discharge device and an exposure station 33 employing a reflex exposure system in accordance with the present invention, a developing station 35 depicted as a brush development device, a transfer station 36 illustratively using a corona device for electrostatic transfer and a cleaning station 37 depicted as a brush cleaning device. Exposure station 33 is shown as using a line light source 24 disposed adjacent and beneath xerographic drum 30, supply roll 25 and take-up roll 26 powered by motor 50 and adapted to advance clear plastic film 27 such that the relative motion of the film in the area where it contacts xerographic drum 30 is identical to the surface velocity of drum 30.

In operation an original 18 is placed on advancing sheet 27 and progressing linear portions of said original are exposed by line light source 24 from light transmitted through sheet 27 and through the grid interstitial portions of transparent filler of xerographic drum 30. Some of this light is reflected off light, non-image, background areas of the original to selectively expose and at least partially discharge the surface of drum 30 in corresponding areas. The original after being progressively exposed by the line light source is passed into receiving tray 29. The latent image pattern now on the surface of the xerographic drum is developed at developing station 35 and then transferred to a transfer web at transfer station 36. The transferred image on web 43 is fixed by fixing station 45 depicted as a heat fixing device. After transfer of the image, residual developer is removed from the xerographic drum surface at cleaning station 37 and the drum is then resensitized by corona charging at sensitizing station 32 to prepare it for another imaging cycle.

Although specific components and proportions have been stated herein in the description of preferred embodiments of the novel reflex exposure xerographic plate for this invention other suitable materials as listed herein may be used with similar results. In addition, other materials may be added to the plate configuration as herein described to synergize, enhance or otherwise modify its property. For example, although most grids for use herein as commercially supplied will be sufficiently electrically conductive and opaque, electrical conductors or opaque materials may be surfaced layered onto a grid even an insulating, transparent grid to enhance their electrical conductivity and capacity for use herein. The term grid as used herein and in the claims is intended to encompass this variation.

In addition, of course, the novel plate herein may be used in non-reflex exposure imaging systems, for example in more conventional optical-lens system exposure systems to provide a xerographic plate to give enhanced solid area image development and an extended tonal range.

It will further be understood that various other changes in the details, materials, steps and arrangements of parts

which have been herein described and illustrated in order to explain the nature of the invention will occur and may be made by those skilled in the art upon a reading of this disclosure and such changes are intended to be included within the principle and scope of this invention.

What is claimed is:

1. A xerographic plate adapted for reflex exposure comprising:

- (a) an opaque, electrically conductive grid comprising alternating grid portions and interstices;
- (b) an imaging photoconductive insulating material overcoating the grid portions of said grid; and
- (c) a solid material substantially transparent to that wavelength radiation to which the imaging photoconductive insulating material is photosensitive at least partially filling said interstices, said material providing an area which is capable of accepting a charge and retaining it for at least about 0.1 second and will substantially discharge said charge in about 10 seconds, and wherein resistivity of said substantially transparent material is between 10^{12} and 10^{14} ohms-centimeters.

2. A xerographic plate according to claim 1 wherein said substantially transparent material fills said interstices such that a free surface of said material is in the same plane as the free surface of immediately adjacent portions of the overcoating of said imaging photoconductive insulating material to provide a plate having a smooth face of a pattern of alternating discrete, small areas of said imaging photoconductive insulating material on said opaque, electrically conductive grid and areas of the said substantially transparent material.

3. A xerographic plate according to claim 2 wherein said opaque, electrically conductive grid comprises from about 40 to 500 alternating grid and interstitial portions to the lineal inch.

4. A xerographic plate according to claim 3 wherein said imaging photoconductive insulating material comprises a material selected from the group consisting of amorphous selenium and its alloys, a phthalocyanine binder system, a zinc oxide binder system and a photoconductive glass binder system.

5. A xerographic plate according to claim 1 wherein said substantially transparent electrically leaky material comprises a photoconductive insulating material.

6. A xerographic plate according to claim 1 wherein said substantially transparent electrically leaky material comprises an organic resin.

7. A xerographic plate according to claim 1 wherein said substantially transparent electrically leaky material comprises an ester of sugar.

8. A xerographic plate according to claim 1 wherein said substantially transparent material comprises a glass.

9. A xerographic plate according to claim 6 wherein said organic plastic is selected from the group consisting of cellulose acetate, ethyl cellulose, polyvinyl fluoride, polyvinylidene chloride, polyvinylidene fluoride, cellulose nitrate, polyvinyl alcohol, polyvinyl acetate, polyvinyl carbazole and mixtures and copolymers thereof.

10. A xerographic plate according to claim 5 wherein said substantially transparent photoconductive insulating material is selected from the group consisting of zinc oxide binder systems and Lewis acid sensitized aromatic resins.

11. A xerographic imaging method comprising the steps of:

- (a) providing a xerographic plate according to claim 2;
- (b) uniformly electrostatically charging said plate;
- (c) placing an original in superposed relation to but not more than about 3 mils from, the imaging photoconductive insulating material face of said plate;
- (d) exposing the back surface of said plate to activating electromagnetic radiation which is transmitted through substantially transparent material portions of said plate to strike said original and be selectively

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more absorbed in relatively darker image portions of said original and more reflected and light scattered in relatively lighter non-image portions of said original said reflected and scattered light at least partially discharging portions of said reflected and light scattering portions of said original to form a latent electrostatic image on said imaging photoconductive insulating material surface of said plate; and
 (e) developing said latent electrostatic image with electrostatic marking material to render said image visible.
 12. A xerographic imaging method according to claim 11 wherein the development step is carried out after the initial charge on said substantially transparent material portions of said plate has been discharged to at least about 40 percent of its initial value.

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U.S. Cl. X.R.

96—1 R, 1.4

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,676,118 Dated July 11, 1972

Inventor(s) George R. Mott

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

Claim 11, column 15, line 10, the word
"electrostatic" should read --electroscopic--.

Signed and sealed this 9th day of January 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents