

Dec. 2, 1969

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3,481,669

PHOTO-CHARGING OF XEROGRAPHIC PLATES

Filed March 1, 1965

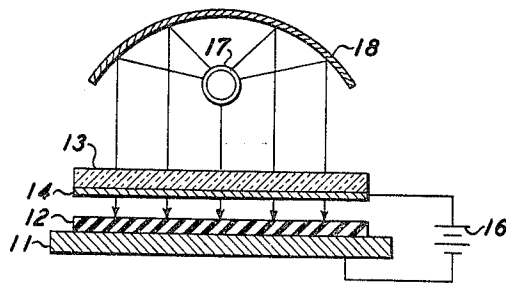


FIG. 1

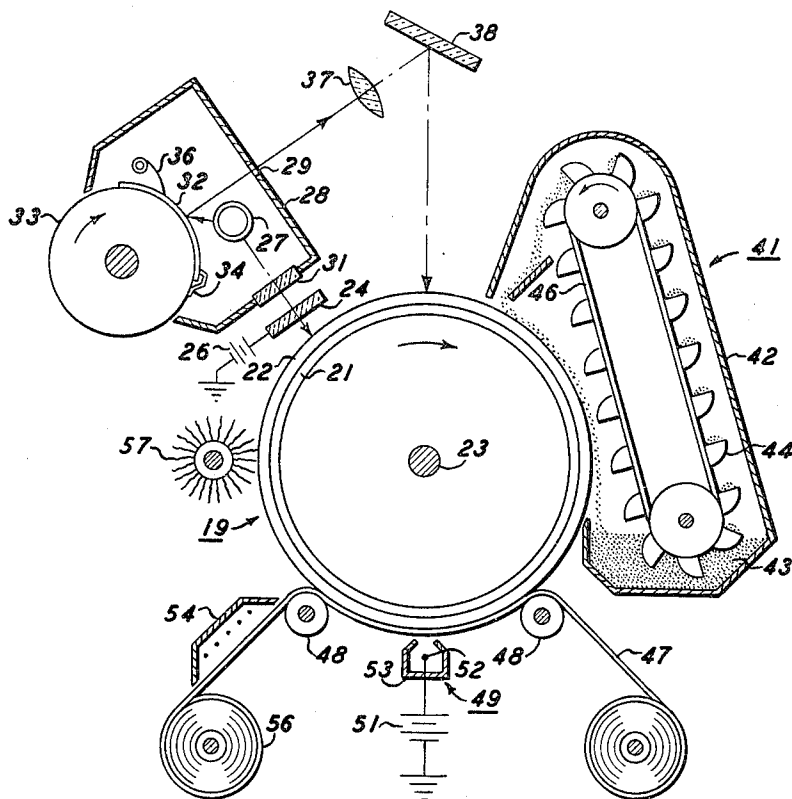


FIG. 2

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1

3,481,669

PHOTO-CHARGING OF XEROGRAPHIC PLATES
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Filed Mar. 1, 1965, Ser. No. 436,145

Int. Cl. G03g 13/00

U.S. Cl. 355—3

12 Claims

ABSTRACT OF THE DISCLOSURE

A xerographic apparatus is disclosed wherein charging and exposure are accomplished with the same source of electromagnetic radiation. The radiation means comprises uniformly exposing means having a wavelength which is not substantially longer than the threshold wavelength for electron transmission from the photoconductive insulating layer of the xerographic plate and means producing a pattern of electromagnetic radiation having a wavelength to which the photoconductive insulating layer shows photoconductive response.

This invention relates to xerography and, more specifically, to a method and apparatus for charging and exposing a xerographic plate.

Xerographic office copying has undergone an extremely large growth in the past few years. In this copying technique, as originally disclosed by Carlson in U.S. Patent 2,297,691, and as further amplified by many related patents in the field, a photoconductive insulating layer making up a part of a xerographic plate is first given a uniform electrostatic charge over its entire surface to sensitize it and is then exposed to a light image which selectively drains away the charge in illuminated areas of the photoconductive insulator, leaving behind charge in the nonilluminated areas to form a latent electrostatic image. This latent image is then made visible by developing it through the deposition of finely divided, electroscopic, marking material on the surface of the photoconductive insulating layer, as a result of which the marking material conforms to the pattern of the latent image. The marking material is generally made up of a powdered mixture of a thermoplastic and a colorant, such as a dye or pigment, and is known in the art as "toner." Where the photoconductive insulator is reusable, this visible toner image is transferred to a second surface, such as a sheet of paper, after development and fixed in place on the paper to form a permanent visible reproduction of the original. Where, on the other hand, a cheap, nonreusable photoconductive insulating material is employed, the toner particles are fixer in place directly on its surface with the elimination of the transfer step from the process.

Although this process has been very successful commercially, certain difficulties still exit with it. Consider, for example, the charging of the xerographic plate. A number of techniques have been developed for charging and the technique which has gained widest commercial acceptance is corona charging, as more fully described in U.S. Patents 2,588,699 to Carlson and 2,777,957 to Walkup. Essentially, this corona technique consists of spacing a filament or a plurality of filaments slightly from the surface of a xerographic plate having its conductive base grounded and applying a high potential to the filament so that an electrical breakdown, corona discharge occurs between the filament and the plate thus serving to raise its level of electrostatic charge with respect to ground potential. Notwithstanding the fact that this corona discharge technique has been found to produce excellent results and is employed in one form or another in virtually every commer-

2

cial electrostatic office copying machine, it suffers from certain inherent difficulties by the very fact that it operates on the principle of an ionizing electric field discharge. In certain instances, for example, the conditions of the atmosphere between the corona generating electrode and the xerographic plate to be sensitized can make important differences in the effectiveness of plate sensitization. Thus, reduced air pressure, wide changes in relative humidity, large amounts of impurities in the air and other factors may have relatively important effects upon the level of charge which is deposited upon the plate with the charging voltage held constant. In addition, dust and other atmospheric impurities within the machine may deposit on the corona discharge electrodes, thereby limiting their effectiveness. Furthermore, high voltage power supplies with specialized control circuits are often required in this type of charging. Thus, for example, in order to charge a plate surface to a potential of from about 600 to 800 volts, a potential of 4,000 to 10,000 volts may be required on the corona discharge electrode. Since corona charging is the technique of choice in commercial devices, it can easily be appreciated that other charging techniques known in the art suffer from similar and even more troublesome difficulties.

Accordingly, it is an object of this invention to provide a novel xerographic charging method.

It is also an object of this invention to provide a novel xerographic charging apparatus.

Yet another object of this invention is to provide a xerographic charging technique employing the principle of photoemission.

A still further object of this invention is to provide a simplified xerographic apparatus in which plate charging and exposure are accomplished with the same source of electromagnetic radiation.

These and still other objects may be accomplished in accordance with the present invention by exposing the xerographic plate to be charged to a source of light or other electromagnetic radiation whose wavelength is sufficiently short so that the energy of a photon of this radiation exceeds the work function of the xerographic plate to be charged. The use of light or other electromagnetic radiation of this threshold wavelength or lower transfers sufficient energy to electrons in the photoconductor to enable them to escape through the potential energy barrier at the surface of the photoconductor. The depletion of electrons from the surface of the photoconductor by photoelectric emission leaves the plate with a net positive charge which continues to build up during exposure as more electrons are emitted. In order to prevent the plate from recapturing emitted electrons by virtue of its increasing positive charge, a foraminous or transparent grid is provided adjacent the photoconductive surface and a positive potential is applied to it with respect to the photoconductor so as to capture emitted electrons. The potential applied to this electrode may be used to control the voltage to which the plate is charged. This voltage will not substantially exceed the electrode voltage because if it does, the plate will be positive with respect to the electrode and will tend to recapture emitted electrons.

The invention also contemplates the use of a relatively broad spectrum light source which, with proper filtering, may be used for both uniform charging and image-wise exposure of the photoconductor in the xerographic process, thereby eliminating one component of the conventional system. This is accomplished by filtering out all but the short wavelength, high energy light from the source for charging the plate and then using the longer wavelength from the high UV and/or visible portions of the spectrum for image-wise exposure. The short wavelength light charges the photoconductor by photoelectric emis-

sion, but does not expose it significantly because the plate does not show much, if any, photoconductive response to this short wavelength of light. On the other hand, the visible portion of the spectrum and longer UV will discharge the plate in image-wise configuration because plates show higher photoconductive response to these wavelengths of light but, at the same time, these wavelengths do not have sufficient energy to cause photoelectric emission so as to charge the plate.

Photocharging is also employed in a preferred embodiment in conjunction with a plate having hole traps at least in the upper portion of the bulk of the photoconductor so as to improve its charge retention ability. This plate is exposed either with penetrating radiation or from its rear surface through a transparent base so that the traps do not capture the holes of the hole-electron pairs created on light exposure as this would prevent the formation of an electrostatic image by exposure.

The nature of the invention will be more easily understood when it is considered in conjunction with the accompanying drawings of an exemplary preferred embodiment of the invention wherein:

FIG. 1 is a side sectional view of a simplified xerographic plate charging device and

FIG. 2 is a side sectional view of a complete xerographic copying apparatus employing the same light source for both charging and exposure of the image on the plate.

Referring now to FIG. 1, there is seen a xerographic plate in this including a conductive base 11 and a photoconductive insulating layer 12. It is to be noted that the electrically conductive base 11 is not necessarily included in the system but may be employed to facilitate making electrical connection with the base of the photoconductive insulating layer 12. Immediately above the photoconductive insulating layer 12 of the plate is an electrode made up of a transparent quartz layer 13 overcoated with an extremely thin, optically transparent, electrically conductive layer 14 of tin oxide or any other suitable material. The conductive portion of the electrode is connected to the positive side of a DC potential source 16 with the negative side connected to the conductive base 11 which may be grounded. Above the electrode, there is positioned a light source 17 and a reflector 18 positioned so as to reflect light through the electrode to the photoconductive insulating layer. The light source 17 and reflector 18 need not necessarily be positioned so that the light passes through the electrode; however, since the electrode should be positioned in fairly close proximity to the surface of the photoconductive insulating layer so as to most efficiently capture emitted electrons therefrom when the light strikes the plate, it is difficult to position the light source in such a way that the light will strike the plate directly without passing through the electrode. It is to be understood, however, that the invention contemplates positioning the electrode in many alternative locations even in back of or on the surface of the light source. Since it is a function of the electrode then, in most instances, to both capture emitted electrons and pass photons of the charging light, other alternative structures may also be used in place of the electrodes shown on the drawings. A typical alternative structure of this type is a grid or screen of stainless steel, copper, brass or any other suitable conductive material. Although the charging light passes only through the openings in the screen and not through the opaque or wire areas themselves, in fact, this type of a screen grid constitutes a preferred form of electrode for use in connection with this invention because it produces a very fine pattern of discontinuous charge over the surface of the plate in small discrete islands. This type of charge pattern is especially valuable in developing large, solid, dark areas or continuous tone images. With ordinary charging in which the charge pattern is originally uniform over the whole plate even when it is examined on a microscopic scale, low contrast originals do not produce high potential gradients except at

their extreme edges and, accordingly, the centers of these images tend to be hollow and not filled in unless complex specialized developing methods are used. This discontinuous charge pattern, however, provides a great multiplicity of high potential gradients over the whole surface of the plate so that even when large, solid, dark areas or continuous tone originals are used to expose the plate the latent electrostatic image produced will include small high potential gradients throughout the image area, resulting in greatly improved development even when conventional developing techniques are employed. The screen used may include openings which are square, round, linear, irregular etc. in shape and may vary widely in size and frequency. Typical structures include those having openings which cover from 20-80% of the screen area and vary in frequency from 20 to 500 per inch. Because of the macroscopic uniformity of the charge pattern even when it is made through such a screen, all such patterns will be referred to as "uniform" throughout this specification and the appended claims.

As explained above, the selection of the photoconductor to be employed and the light source to be employed are interrelated and each should be considered when selecting the other because the light source must be capable of supplying light which is approximately shorter than the threshold wavelength, which may be defined as $h\nu/\text{work function}$ of the photoconductor; where h is Planck's constant and c is the speed of light. Taking the amorphous form of selenium as an example, the threshold wavelength in angstrom units would have to be shorter than 12,395 divided by the voltage equivalent of the work function for selenium which is equal to a wavelength of about 2,620 angstrom units. It should be noted that this is only an approximation and that slightly higher wavelengths may be employed because the work function for the materials are calculated at absolute zero and the materials are ordinarily operated at higher temperatures, resulting in higher internal excitation of electrons within the photoconductor. Although even photoconductors with fairly high work functions may be employed in connection with the invention and charged by using fairly short wavelength radiation, say for example in the 2,000 angstrom unit region, the use of the shorter wavelengths may require the exercise of care in the selection of the atmosphere between the charging light and the photoconductor because some gases will absorb the short wavelengths preventing their transmission to the surface of the photoconductor. Thus, for example, it has been found that oxygen tends to partially absorb at about 2,000 angstrom units or shorter wavelengths. Of course, this consideration may be disregarded with the devices to be used in a vacuum or partial vacuum such as exists in outer space. When the system is used on earth it may be placed in a container whose surface extends almost to the surface of the photoconductor with either a vacuum or a non-absorbing gas in the container or the area between the light source and the photoconductor may be continuously flushed with a non-absorbing gas such as nitrogen.

Any suitable photoconductive insulating layer may be used in carrying out the invention. Typical photoconductive insulating layers include: amorphous selenium, alloys of sulfur, arsenic or tellurium with amorphous selenium, amorphous selenium doped with hole trapping materials such as thallium, cadmium sulfide, cadmium selenide, etc., particulate photoconductive materials such as zinc sulfide, zinc cadmium sulfide, French process zinc oxide, metal-free phthalocyanide, cadmium sulfide, cadmium selenide, zinc silicate, cadmium sulpho-selenide, linear quinacridones, etc., dispersed in an insulating organic film forming binder such as a glass or an insulating organic film forming binder such as an epoxy resin, a silicone resin, an alkyl resin, a styrene-butadiene resin, a wax or the like. 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-amino-phenyl-1), 1,3,4-oxadiazole; 2-phenylbenzoxazole; and charge transfer complexes made by complexing resins such as polyvinylcarbazole, phenol-aldehydes, epoxies, phenoxies, polycarbonates, melamines, etc., with Lewis acids such as phthalic anhydride; 2,4,7-trinitrofluorenone; metallic chlorides such as aluminum, zinc or ferric chloride; 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.

Since the technique of this invention produces positive charging and some photoconductors operate more effectively when charged to one polarity or the other, those which operate best with positive charging will usually, but not always, be used. It is to be noted, however, that selenium in its amorphous form with or without doping and alloys of the amorphous form of selenium constitute a preferred material for photoconductive insulating layer 12, because of their extremely high quality image-making capability and relatively high light response when positively charged. The photoconductor may also be coated on or alloyed with any suitable material to reduce its surface potential energy barrier or work function. This type of coating may be either photoconductive or not, so long as it is insulating enough in the dark to prevent destruction of the latent electrostatic image which is formed during the process. In fact the coating may even be impervious to light of the wavelength used for exposure providing the photoconductor is coated on a transparent base and exposed through this base.

In a preferred form of the invention, photoemissive charging is employed with a plate having hole traps at least in the upper layer of the bulk of its photoconductor. The high energy light in the UV range which is used for photoemissive charging penetrates very shallowly into the bulk of the photoconductive layer causing electron emission therefrom and leaving behind holes very near the surface but still in the bulk of the photoconductor. Since photoconductors which operate most efficiently with positive charging have a fairly high hole mobility, the holes created by the charging light tend to drain away to some extent through the bulk of the photoconductor to the conductive substrate. Accordingly, by employing such a hole trapping layer at least near the top of the photoconductor the holes created by photoemissive charging are trapped near the surface thereby allowing a higher level of charge to be built up on the plate. Although selenium in its amorphous form doped with a small amount of elemental thallium (for example .05% by weight) admirably performs the hole trapping function, any suitable hole trapping material may be employed. Typical hole trapping materials other than thallium doped selenium include cadmium sulfide and cadmium sulfoselenide. The hole trapping material may be employed throughout the whole thickness of the photoconductor or only as an upper layer on the order of a few microns thick since either structure will serve the function of trapping holes in the bulk near the upper surface of the photoconductor. It should be noted, however, that with either structure exposure from the upper surface of the plate with conventional light sources rich in light from the blue end of the visible spectrum and the longer UV wavelengths is to be avoided because light of these wavelengths is absorbed strongly very close to the upper surface in most photoconductors and, accordingly, can only form hole-electron pairs near that surface where the holes will be trapped thus preventing the formation of a latent image. In the case of amorphous selenium doped with thallium in its

top layer or even throughout its bulk, this type of absorption will take place very near the surface in the UV-blue portion of the electromagnetic spectrum. On the other hand, since selenium tends to transmit electromagnetic radiation from the orange-red end of the visible spectrum and X-ray, penetrating actinic radiation of this type may be used for exposure since the charge carriers are formed very close to the conductive substrate. Consequently, even when the solid thallium doped selenium plate is used having short range hole mobility throughout its bulk, most of the holes created by the exposing light source can travel through the photoconductor to the conductive base for discharge, thereby allowing movement of the electron up toward the hole trapped near the surface of the plate to discharge it and form the desired electrostatic image.

Another technique for forming hole-electron pairs in the photoconductor near the plate substrate involves depositing the photoconductor on a transparent substrate such as tin oxide coated glass and then making the exposure through this transparent substrate. In this way light from the UV and blue portions of the spectrum may also be employed in forming the image. In short, any exposure technique may be employed which generates the hole-electron pairs in the photoconductor close enough to the substrate so that the holes formed can move through the photoconductor to the substrate. The layered structure employing a thin layer of less than about 3 microns of a hole trapping material over a photoconductor with a long range for holes is, of course, an even more preferred plate structure for use with photoemissive charging because of the hole electron pairs may be created anywhere within the bulk of the photoconductor below the trapping layer since this underlying layer has a long enough range for holes so that they can reach the underlying substrate even from the position just below the trapping layer. An additional and important advantage of using a plate with a trapping layer is that photoemissive charging may be carried out using a broad spectrum light source including light from the blue end of the visible spectrum and the longer UV as well as the shorter high energy UV without a filter because, although the high energy UV causes electron emission from the surface, the longer UV and blue light does not discharge the plate because of the hole traps near its surface.

An exemplary xerographic copying apparatus adapted to employ the photocharging technique of this invention is shown in FIG. 2. The apparatus consists of a xerographic drum generally identified as 19 consisting of a grounded conductive substrate 21 and a photoconductive insulating layer of selenium 22 mounted thereon with the whole drum journaled for rotation on a cylindrical shaft 23. The drum, when in operation, is generally rotated at a uniform velocity in the direction indicated by the arrow in FIG. 2 so that portions of the drum periphery first move past the charging unit which includes an optically transparent electrode 24 of the type described above in connection with FIG. 1 connected to a source of positive potential 26. Above the electrode is a wide spectrum light source 27 which puts out light in the relatively short wavelength portion of the UV, the longer UV and the blue end of the visible spectrum. Typical light sources of this type operate by continuous or pulsed electric discharge in atmospheres of mercury, iodine, rare gases or metallic vapors. The light source 27 is included in a light-tight cabinet 28 with a slit 29 in one side of the cabinet. Also included in the cabinet between the light source 27 and electrode 24 is a filter 31 which passes the shorter wavelength UV only, thus filtering out the longer UV and visible portion of the spectrum. Electrode 24 and filter 31 may be combined by applying an optically transparent conductive layer to the surface of the filter. In this instance a photoconductor such as amorphous selenium is employed having a work function such that the shorter wavelength UV causes photoelectric emission of electrons

therefrom and which also shows photoconductive response to the longer UV and the blue end of the visible spectrum. When the light source 27 is turned on the short wavelength UV light of less than about 2,650 angstrom units passes through filter 31 and grid 24 to cause electron emission from the underlying photoconductive layer 22, and grid 24 captures emitted electrons by virtue of the electrical field applied to it from the potential source 26 until the potential on the photoconductor approaches that of the applied potential 26. At the same time, light from source 27 in an unfiltered form also impinges on the surface of the original image 32 to be reproduced. This original 32 is held on a cylindrical copy drum 33 by grippers 34 and the drum is rotated in the direction shown by the arrow at the same peripheral speed as that imparted to the xerographic drum. The trailing edge of the original 32 is held against the rotating copy drum 33 by spring-like fingers 36. A similar and much more detailed showing of a copy drum and associated mechanism for holding it and moving it past a light source, which may be employed in connection with the present invention, is shown in U.S. Patent 3,009,943 to Eichorn. The light from the unfiltered source 27 thus exposes the original image 32 to be reproduced and is reflected out through slit 29, through lens 37, off mirror 38, and then exposes the photoconductive insulating surface 22 of the xerographic drum 19. The lens prevents the passage of short wavelength UV and allows the passage of longer UV and visible light because it is made of glass. Since the photoconductive insulating selenium shows photoconductive response to visible and long UV, charge is drained off the plate surface in exposed areas to form a latent electrostatic image thereon corresponding to the dark areas on the original. Subsequent to charging and exposure, sections of the xerographic drum surface move past the developing unit, generally designated 41. This developing unit is of the cascade type which includes an outer container or cover 42 with a trough at its bottom containing a supply of developing material 43. The developing material is picked up from the bottom of the container and dumped or cascaded over the drum surface by a number of buckets 44 on an endless driven conveyor belt 46. This development technique, which is more fully described in U.S. Patent 2,618,552 to Wise and 2,618,551 to Walkup, utilizes a two-element development mixture including a finely divided, colored, marking particles or toner and larger carrier beads. The carrier beads serve both to deagglomerate the fine tone particles for easier feeding and charge them by virtue of the relative positions of the toner and carrier material in the triboelectric series. The carrier beads with toner particles clinging to them are cascaded over the drum surface. The electrostatic field from the charge pattern on the drum pulls toner particles off the carrier beds serving to develop the image. Then the carrier beads, along with any toner particles not used to develop the image, fall back into the bottom of the container 42 and the developed image moves around until it comes into contact with a copy web 47 which is pressed up against the drum surface by two idle rollers 48 so that the web moves at the same speed as the periphery of the drum. Toner in the developing mixture is periodically replenished from a toner dispenser not shown. A transfer unit 49 is placed behind the web and spaced slightly from it between rollers 48. This charging unit 49 is connected to a source of high positive D.C. potential identified as 51 and includes a corona discharge wire 52 surrounded by a conductive metal shield 53. The voltage is selected to be of such a value that it will cause a corona discharge onto the back surface of the copy web 47, and this charge is of the same polarity as the charge initially deposited on the drum and opposite in polarity to the charge on the toner particles utilized in developing the image. The discharge deposited on the back of web 47 pulls the toner particles away from the drum by overcoming the force of attraction between the particles and the charge on the drum.

Many other transfer techniques known in the art can be utilized in conjunction with this invention. For example, a roller connected to a high potential source opposite in polarity to the toner particles may be placed immediately behind the copy web or the web itself may be adhesive to the toner particles. After transfer of the toner image to web 47 the web moves beneath a fixing unit 54 which serves to fuse or permanently fix the toner image to the web. In this case a resistance heating type fixer is illustrated; however, here again other techniques known in the art may be utilized for fixing including the subsection of the toner image to a solvent vapor, spraying of the toner image with an adhesive overcoating, subsection of the toner image to electromagnetic radiation, etc. After fixing the web is rewound on a coil 56 for later use. Once the drum has passed the transfer station it continues around and moves beneath a cleaning brush 57 which prepares it for a new cycle of operation.

What is claimed is:

1. An apparatus for forming a latent electrostatic image comprising a xerographic plate including a photoconductive insulating layer, means to uniformly expose said xerographic plate to electromagnetic radiation having a wavelength which is not substantially longer than the threshold wavelength for electron emission from said photoconductive insulating layer, said source being positioned adjacent to said photoconductive insulating layer, means to collect electrons emitted from said photoconductive insulating layer and means to expose said xerographic plate to an electromagnetic radiation pattern having a wavelength to which said photoconductive insulating layer shows photoconductive response.

2. An apparatus for uniformly charging the photoconductive insulating layer of a xerographic plate comprising a source of electromagnetic radiation having a wavelength which is not substantially longer than the threshold wavelength for electron emission from said photoconductive insulating layer, said source being positioned adjacent to said photoconductive insulating layer, means to collect electrons emitted from said photoconductive insulating layer, and an optical filter between said photoconductive insulating layer and said source of electromagnetic radiation, said filter being adapted to block the passage of radiation of a wavelength to which the photoconductive insulating layer shows photoconductive response.

3. An apparatus according to claim 2 in which said collecting means comprises an electrically conductive electrode opposite said photoconductive insulating layer and a positive polarity potential source connected to said electrode.

4. An apparatus according to claim 2 in which said collecting means comprises a foraminous electrically conductive electrode connected to a positive polarity electrical potential source.

5. Apparatus for forming a latent electrostatic image comprising a xerographic plate including a photoconductive insulating layer, a broad band source of electromagnetic radiation adjacent said photoconductive insulating layer which emits in a wavelength range which includes a wavelength substantially shorter than the threshold wavelength for electron emission from said photoconductive insulating layer and a longer wavelength to which said photoconductive insulating layer shows photoconductive response, means to move said xerographic plate through an imaging path, first filter means to block radiation of wavelength to which said photoconductive insulating layer shows photoconductive response, said first filter means being positioned between said electromagnetic radiation source and a first portion of said imaging path, means to move an original image to be reproduced past a point adjacent said electromagnetic radiation path and to project the light reflected from the original at that point through an optical path including a second filter and onto the photoconductive insulating layer in a second portion of said imaging path, said second filter means being of a

type which blocks electromagnetic radiation of a wavelength no longer than the threshold wavelength for said photoconductive insulating layer.

6. Apparatus for forming a uniform charge for xerographic reproduction comprising xerographic plate including a photoconductive insulating layer at least the surface layer of which has a short range for holes, a source of electromagnetic radiation a wavelength which is not substantially longer than the threshold wavelength for electron emission from said xerographic plate, said source being positioned to irradiate said xerographic plate and a positively biased collecting electrode opposite said photoconductive insulating layer adapted to collect electrons emitted therefrom.

7. Apparatus according to claim 6 in which the photoconductive insulating layer of said xerographic plate is deposited on a transparent substrate and further including means to expose said xerographic plate after charging to an image to be reproduced through said transparent substrate with actinic electromagnetic radiation.

8. An apparatus according to claim 6 further including means to expose said xerographic plate after charging, said exposure means including a source of penetrating actinic electromagnetic radiation whereby hole electron pairs will be formed in said plate upon exposure at a sufficient depth so that said holes can reach the conductive substrate of said plate.

9. A method for uniformly charging a xerographic plate including a photoconductive insulating layer at least the surface layer of which has a short range for holes comprising exposing said surface layer to a source of electromagnetic radiation, said source including radiation of a wavelength which is not substantially longer than the threshold wavelength for electron emission from said xerographic plate and applying an electrical field adjacent said plate, said field being of a polarity to move emitted electrons away from said plate whereby it is left with a net positive charge.

10. A method of forming a latent electrostatic image comprising uniformly exposing a xerographic plate including a photoconductive insulating material on a conductive substrate, at least the surface layer of which has a short range for holes, with a source of electromagnetic radiation, said source including radiation of a wavelength which is not substantially longer than the threshold wavelength for electron emission from said xerographic plate,

applying an electrical field adjacent said xerographic plate, said field being of a polarity to move emitted electrons away from the free surface of said xerographic plate so that it is left with a uniform net positive charge, and exposing said charged xerographic plate to an image to be reproduced with penetrating actinic electromagnetic radiation so as to generate hole-electron pairs adjacent the surface of said photoconductive insulating layer most remote from said surface layer.

11. A method of forming a latent electrostatic image comprising uniformly exposing a xerographic plate including a photoconductive insulating material on a transparent conductive substrate, at least the surface layer of which has a short range for holes, with a source of electromagnetic radiation, said source including radiation of a wavelength which is not substantially longer than the threshold wavelength for electron emission from said xerographic plate, applying an electrical field adjacent said xerographic plate, said field being of a polarity to move emitted electrons away from the free surface of said xerographic plate so that it is left with a uniform net positive charge, and exposing said charged xerographic plate through its conductive substrate.

12. A method of forming a latent electrostatic image comprising uniformly exposing a xerographic plate including a photoconductive insulating material on a conductive substrate to electromagnetic radiation with an energy level in excess of the work function of said photoconductive insulating material, applying an electric field adjacent said xerographic plate, said field being of a polarity to move emitted electrons away from the free surface of said photoconductive insulating material whereby it is left with a uniform net positive charge, and exposing said uniformly charged xerographic plate to an image to be reproduced of electromagnetic radiation to which said photoconductive insulating layer shows photoconductive response.

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