Nov. 24, 1970 J. H. LENNON 3,543,022

METHOD AND APPARATUS FOR CHARGING DISCRETE SMALL AREAS OF XEROGRAPHIC PLATES TO DIFFERENT POTENTIALS IN CONTINUOUS TONE PRINTING

Filed July 1, 1966

2 Sheets-Sheet 1

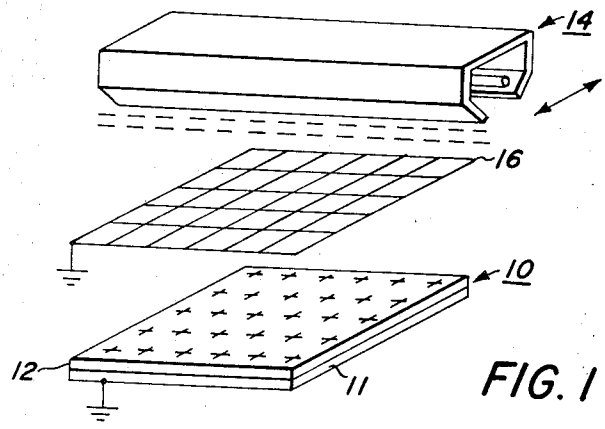


FIG. 1

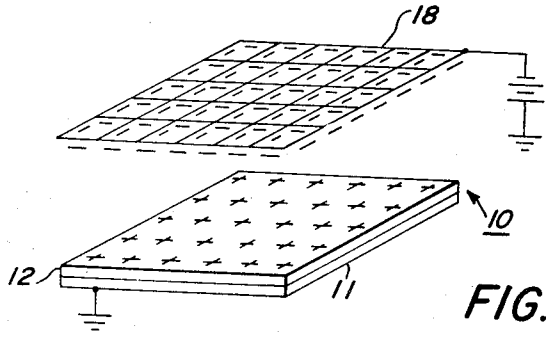


FIG. 2

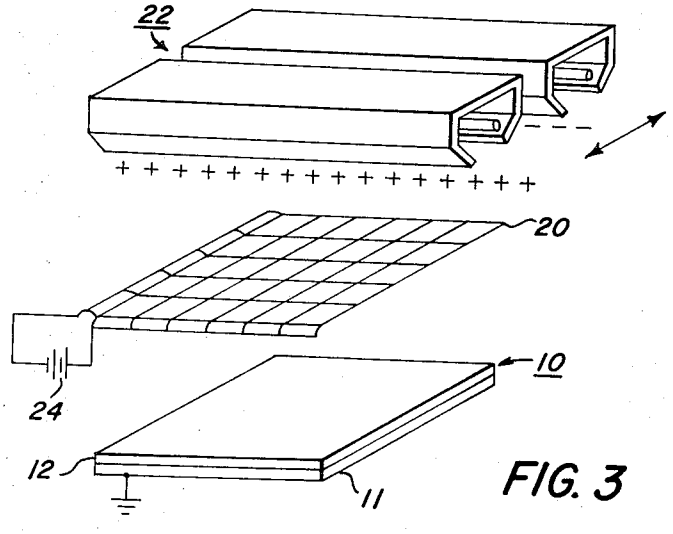


FIG. 3

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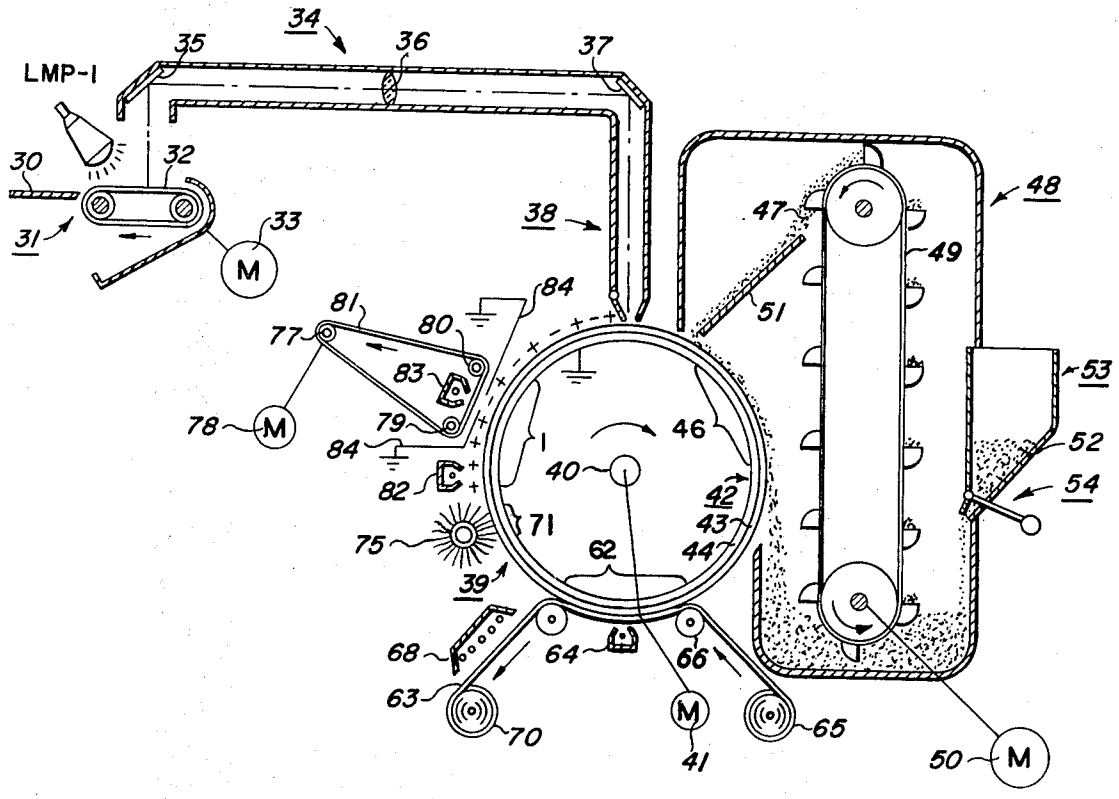


FIG. 4

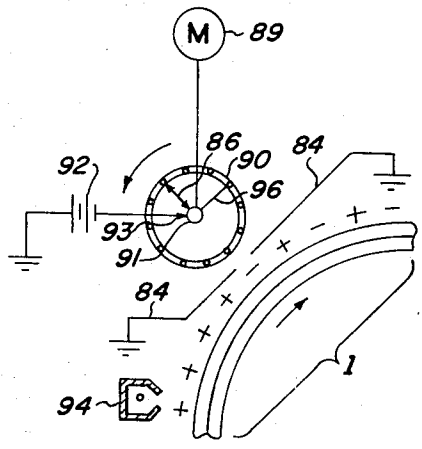


FIG. 5

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3,543,022

# METHOD AND APPARATUS FOR CHARGING DISCRETE SMALL AREAS OF XEROGRAPHIC PLATES TO DIFFERENT POTENTIALS IN CONTINUOUS TONE PRINTING

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U.S. Cl. 250—49.5 40 Claims

## ABSTRACT OF THE DISCLOSURE

A system for charging a xerographic plate wherein a multiplicity of small discrete alternating areas of charge at two different potentials of substantially different values (which includes areas at different polarities) are deposited on a xerographic plate thereby facilitating solid area coverage in developed xerographic images.

This invention relates to xerography and, in particular, to a charging system for improving the quality of xerographically processed images especially large solid area and continuous tone images.

In the process of xerography, for example, as disclosed in Carlson Pat. No. 2,297,691, 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 an electrostatic latent 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 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 is usually transferred to a support surface to which it may be affixed by any suitable means.

Excellent results have been obtained with the xerographic process using the cascade method of development for line copy work such as letters or lines on a white background and for half tone images.

The system of cascade development of latent electrostatic images has found extensive commercial acceptance in both manual and automatic xerographic copiers and generally consists of gravitationally flowing developer material consisting of a two-component material of the type disclosed in Walkup Pat. No. 2,638,416 over the xerographic plate bearing the latent image. The two components consist of an electroscopic powder termed "toner" and a granular material termed "carrier" and which by mixing require triboelectric 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.

However, it has been a characteristic of the xerographic process that broad areas of charge remaining on the photoconductive insulating layer after exposure of the xerographic plate to the original to be copied, which broad areas may correspond to large black or dark areas in the original, do not develop by certain methods as for instance, the cascade method of development.

This characteristic shows up in copies developed by the cascade and other developing methods as a quality reproduced image only around the edges of the large solid



area with a hollowed-out or undeveloped portion in the center of the broad area. Continuous tone images show this characteristic in much the same manner.

The characteristic is generally attributed to be a result of the phenomenon that although latent electrostatic images are usually regarded as surface charge patterns, the capability of the charge pattern to attract oppositely charged particles to the charge is dependent on the nature and magnitude of the electric fields in the air space near the image surface. The presence of a surface charge does not ensure the presence of electrical fields in this air space. In fact where a surface charge is uniform in density over a large area, electric fields in the central portions are found to be contained within the photoconductor and not in the air space. Thus, the central portion of such a charge pattern would exhibit negligible attraction for developer particles.

One manner of ensuring that the field is outside the photoconductor, in the air space, capable of attracting toner is to provide surface charge differences or discontinuities in a given area. There is a charge discontinuity or variation at the edges of large solid area and continuous tone latent electrostatic images which explains why the edges of such images develop in quality fashion.

Of course, there exist situations wherein large solid area and continuous tone development would be of great value especially by the commercially employed cascade method of development. For this reason interesting innovations have been proposed in the past to improve solid area coverage.

The development electrode is one solution and calls for an electrode with a low bias potential placed close to the xerographic plate at the point of development to pull the electrostatic field out of the photoconductor into the air space. Good quality solid area and continuous tone images have been produced by use of a development electrode. However, with continuous type, automatic equipment, wherein the xerographic plate commonly takes the form of a drum, it is not usually feasible to provide a development electrode spaced closely enough to the drum surface for the purpose of improving large solid area and continuous tone image quality, without seriously interfering with the flow of developer and hence slowing down the speed of the machine, increasing the danger of developer jams and deleteriously affecting the relatively sensitive surface of the xerographic plate by the increased abrading effect of developer on drum surface.

A second avenue of approach, includes what may be termed screen techniques wherein uniformly chargde areas can be transformed to an array of dots or lines which can then be developed by the fields resulting from the surface charge differences thus created. Such a broken electrostatic latent image can be created (1) by initially charging the xerographic plate in a screen pattern; (2) masking the original image during projection or by (3) selectively discharging the plate surface either before, during or after image exposure. Dessauer and Clark, "Xerography," Focal Press, page 276 (1965).

Initial charging of a plate in a screen pattern (1) has been accomplished in the past by depositing patterns of charge through conductive screens by contact charging with a screen surface on a low conductivity roller but many problems surround this approach to achieving broad area coverage including direct contact of charging apparatus with the relatively sensitive surface of the xerographic plate which increases the danger of plate chipping and abrasion.

Masking the original image during projections (2) to mask the projected image to subtract light in a screen pattern will be seen to be effective only in systems involving discharged area development. Subtraction can take

place only in the lighted areas and only in discharged area development situations are these areas developed. Presently available automatic continuous xerographic machines operate almost universally on the principle of charged area development.

Selectively discharging the plate (3) has been accomplished by a mask including a series of clear and opaque lines on a film base held stationary in the exposure slit with the lines parallel to the direction and motion of the xerographic plate surface. This technique is more fully disclosed in Carlson et al. Pat. 3,120,790, but a disadvantage of this system is that the quality of line copy images may be deleteriously effected by diminishing the width of image lines running parallel to the direction of the lines on the mask. Also discharge by exposure to light to create charge discontinuities, under ordinary operating conditions, rarely discharges the exposed plate areas completely, i.e., to zero potential, since under ordinary exposure conditions there is a residual potential left on the plate in exposed areas. This yields a weaker electric field in the air space above the plate than if the discharged areas were completely discharged. Additionally, if a plate is exposed sufficiently to discharge the exposed areas to about zero potential, it ha sbeen found that either exposure times must be greatly increased, thus slowing down the operation of especially automatic xerographic type copying machines, or that lamp radiation intensity must be greatly incresaed with attendant increased power input and costs and increased heat dissipation problems.

Also, with the lower upper limit on the value of potential some photoconductors will accept, the masking technique is less than satisfactory for many photoconductors. Acceptance potential is a practical upper limit of potential that a plate may be raised to, before decay of the charge in the plate, even in absence of actinic light, begins to approximate the rate of charge acceptance.

Additionally, all the prior art screen techniques suffer from a common shortcoming, namely that charge discontinuities have always been produced in charge patterns of the same polarity wherein the optimum charge discontinuity is the difference between the potential the plate has been charged to and ground or zero potential. Optimumly, this limits the maximum attainable charge discontinuities to that amount of charge to raise a particular photoconductor to its acceptance potential. Of course, charging to these high potential levels creates many problems including imparting undue electrical stress to the photoconductor shortening photoconductor life and lowering copy quality; increased power consumption, increased danger of sparking and increased rate of decay of charge, even in the absence of radiation that normally makes the particular photoconductor conductive.

It is terefore an object of this invention to provie a novel charging system which overcomes the above-noted disadvantages.

It is a further object of this invention ot provide a charging system useful in the xerographic process and capable of producing high quality solid area and continuous tone images as well as line copy and half tone images.

It is a still further object of this invention to provide a charging system which is fully operable with the cascade method of image development as well as other xerographic developing techniques.

It is a still further object of this invention to provide a charging system wherein there is no direct contact of charging apparatus with the xerographic plate.

It is a still further object of this invention to provide a charging system to produce a stronger electric field in the air space above a xerographic plate using lower charge potentials than was heretofore possible in the art.

The foregoing and still further objects are accomplished in accordance with this invention by providing a charging system to deposit on the surface of a xerographic plate a



multiplicity of discrete, alternating areas of charge at two different potentials of a substantially different value, as by providing a multiplicity of discrete areas of charge of one polarity alternating with and adjacent to areas of charge of the opposite polarity. This resultant deposit of many surface charge discontinuities or variations on the surface of the plate may be accomplished in a number of ways as herein described including: (1) uniformly charging a plate with charge of a first polarity and then directing charge producing particles of the opposite polarity from a particle source above the plate, through a grounded or low bias conductive grid positioned between the particle source and the plate thus forming areas of charge of the opposite polarity on the plate, alternating with areas of charge of the first polarity; (2) uniformly charging a plate with charge of a first polarity and then depositing charge of the opposite polarity from a grid source of charge producing particles which is biased to the opposite polarity, thus forming areas of charge of the opposite polarity on the plate alternating with areas of charge of the first polarity; (3) depositing on a xerographic plate charge of both polarities at the same time by providing a source of both negative and positive charge producing particles and positioning between the plate and the particle source, a biased grid including insulating sets of wires, one set of wires biased positively to control deposit of particles of one polarity from the particle source and the other set of wires biased negatively to control deposit of particles of the other polarity to form alternating areas of charge of different polarities.

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

FIG. 1 is an isometric, schematic view of one system for charging a xerographic plate according to the invention;

FIG. 2 is an isometric, schematic view of a second system for charging a xerographic plate according to the invention;

FIG. 3 is yet another system for charging a xerographic plate according to the invention;

FIG. 4 is a schematic, cross-sectional view of a typical automatic, continuous type xerographic copying machine incorporating a system for charging a xerographic plate according to the invention;

FIG. 5 is a schematic cross-sectional view showing the charging station of a typical xerographic copying machine showing another embodiment of a charging system to charge a xerographic plate in accordance with the invention.

Referring now to FIG. 1, there is shown a xerographic plate **10**, electrically conductive grid **16** and charge producing particle source **14**.

Xerographic plate **10** is shown to include a grounded conductive base **11** and a photoconductive insulating layer **12**. The electrically conductive base **11** may be used in a xerographic plate configuration to facilitate making electrical connection with the base of the photoconductive insulating layer **12**.

The photoconductive insulating layer **12** may be composed of any photoconductive insulating material suitable herein. Selenium in its amorphous form is found to be a preferred photoconductive insulating material because of its extremely high quality image making capability, relatively high light response and capability to receive and retain charge areas at different potentials and of different polarity. 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 selenium, 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 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. Other typical photoconductive insulating materials include: blends, copolymer, 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, oxidiazole derivatives such as 2,5-bis-(p-amino-phenyl-1), 1,3,4-oxidiazole; 2-phenylbenzoxazole; and charge transfer complexes made by complexing resins such as polyvinylcarbazole, phenolaldehydes, epoxies, phenoxies, polycarbonates, etc., with Lewis acid such as phthalic 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.

On the surface of the photoconductive insulating layer **12** is shown a layer of uniformly deposited charge. In this embodiment, the initial charge is illustratively of positive polarity, but it is understood that all polarities shown in all the figures may be replaced by their opposites.

The uniform layer of positive charge may be placed upon the xerographic plate **10** in any one of a number of ways well known in the art, for example, by vigorously rubbing the layer with a soft material such as a cotton or 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 by roll charging as described in Straugham, Mayer, Proc. Nat. Electronics Conf., 13, 959, 962 (1958), by depositing charge from a corona discharge device which generally can apply either positive or negative charge producing particles and of which there are many shapes and forms. 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. Also, radioactive sources as described in Dessauer, Mott, Bogdonoff, Photo Eng., 6, 250 (1955) as well as other sources of corona are available for use herein.

Source **14** is illustrated to be an adaption of the type disclosed in Vyverberg Pat. 2,836,725 and is shown to be emitting negative charge producing particles.

Shown between the uniformly charged plate and source **14** is grounded conductive grid **16**. In operation, grid **16** in grid portions intercepts the negative charge producing particles flowing from source **14** and carries them to ground thus shielding the uniformly positively charged areas of the xerographic plate below said grid portions. The interstices of conductive grid **16** permit charge producing particles from corona source **14** to deposit in patterned configuration on the surface of the plate. In areas of deposit, the negative charge producing particles first neutralize the positive charge already found on the plate and then build up a pattern of discrete, alternating areas of negative charge in the positive layer of charge on the plate, the areas of negative charge corresponding approximately to the pattern of the interstices of conductive grid **16**.

Preferably, the plate should be charged when it is at its highest insulating values or when there is an absence of electromagnetic radiation that would make the photoconductor photoelectrically conductive. To allow the charge to remain on the surface of the layer once placed there by the inventive charging system herein, of course charging must take place in the absence of that wavelength radiation or light which will make the particular photoconductor photosensitive.

It is to be understood that grid **16** can be formed in a variety of ways of one or a combination of parallel wire, punched metal sheets, wire screen and the like. The dimensions of the grid portions, as well as the spacing between grid portions, can be varied over a rather wide range, although it is desirable to keep the maximum linear dimension of both grid portions and interstices not more than about 0.02 inch to ensure more natural and higher quality continuous tone and large solid area rendition. Thus, while a coarse screen having 50 or 60 dots or lines to the inch will be useful for some purposes, such as in the direct production of half-tone images, finer screens, such as those having 100, 200, 300, 400 and even more dots or lines to the inch will give a more nearly continuous tone appearance to the finished print.

The grid is shown to be grounded, but it may be biased to regulate its capability to intercept charge producing particles from source **14**. Generally, a bias of up to ±1,000 volts is found to be suitable.

Spacing of the grid above plate **10** can als be varied over a rather wide range, although spacings between about 0.005 inch to about 0.015 inch from the surface of the plate are found to produce optimum quality images.

As an example of a preferred embodiment of the charging system shown in FIG. 1, good quality prints of large solid areas and continuous tones, as well as line copy and half tone, result by utilizing the xerographic process with the illustrated charging system employing a plate comprising an amorphous selenium photoconductive insulating layer upon an aluminum backing. A uniform layer of positive charge is deposited on the selenium by twice passing across the plate at a rate of abut 2 inches per second a corona source of the type disclsed in Vyverberg Pat. 2,836,725 spaced about ½ inch above the plate, the corona wire biased to about 9,000 volts positive. Of course, the same result may be achieved by passing the plate relative to a stationary corona source.

A grounded grid is positioned about 0.010 inch above the surface of the selenium, the grid taking the configuration of a mesh size 100 x 100, 0.005 inch square openings, 25% open area copper screen. With the screen in position above the plate, the same corona source is passed across the plate at a rate of about 2 inches per second and a distance of about ½ inch above the plate surface, this time the corona wire being negatively biased to about 5,500 volts.

Of curse, biases spoken of herein can be either constant D.C. or pulsating, such as that obtained by half-wave rectification of alternating currents.

After charging according to the invention the plate **10** is exposed to an original to be reproduced, to produce a latent electrostatic image which is developed, for example, by the cascade method of development. The developed image may then be transferred to a support material, such as paper, and fixed or bonded to the support material by conventional xerographic techniques.

The improved quality of reproductions resulting from the charging system disclosed herein, followed by the conventional xerographic steps of exposing and developing is attributed to the effect of producing a pattern of small areas of charge of one potential immediately adjacent other areas of charge at a different potential to provide electrical lines of force from an area of one potential to an adjacent area of a different potential, thus causing the lines of force to extend outside the surface of the photoconductor to the air space immediately above the surface, where the lines of force can attract toner particles and the plate can become developed even in charge areas corresponding to large solid area and continuous tone portions of the original.

It is clear that where the electrical properties of the particular photoconductor and operating requirements

permit it, the pattern areas of charge will generally not only be of a different potential from the surrounding charge, but also will be of a polarity opposite to the polarity of immediately adjacent areas of charge since this condition generally presents the greatest charge differential or variation. Throughout the description herein, the pattern areas of charge will be illustratively shown and described to be opposite in polarity to the immediately adjacent areas of charge, but it is understood that the invention in its various embodiments also has utility and may be employed by producing pattern areas of charge of one potential immediately adjacent areas of charge of the same polarity at a different potential. For example, quality cascade developed large solid area images from commerically available equipment are possible if the potential difference between pattern charge areas and immediately adjacent charge areas is not less than about 300–500 volts. In a liquid development system, for example, as described in Gundlach Pat. 3,068,115 a potential difference of about 100 volts is sufficient to produce quality prints. Thus, for example, in a liquid development operation, charge pattern areas at 600 volts positive potential and immediately adjacent charge areas at 700 volts positive potential deposited according to the invention would produce quality large solid area images.

It should be appreciated that other developing methods besides cascade and liquid development are suitable herein, for example, magnetic brush, see Giamo Pat. 2,930,-351, powder cloud development, see Carlson Pat. 2,221,-776, skid development see Mayo Pat. 2,895,847, and others.

Also, plates sensitized according to the invention may be developed by first passing toner charged to one polarity, for example, positive over the plate to develop the discrete areas of negative charge and then passing toner charged negatively over the plate to develop the remaining, discrete areas of positive charge. In this way even for coarser grids of 50 or 60 mesh, high quality continuous tone images result because of the elimination of any half tone pattern caused by development with toner charged to a single polarity. Double developing by two successive passes of oppositely charged toner may be less than an entirely satisfactory development method especially in automatic, continuous type xerographic copying machines and the process of double developing described in Bixby Pat. 3,013,890 wherein the carrier bears both positive and negative toner and double developing may be effected by a single pass of the developer may prove to be more satisfactory.

Referring now to FIG. 2, there is shown xerographic plate **10** of a type previously described and biased grid **18**.

On the surface of photoconductive insulating layer **12**, there is shown a layer of uniformly deposited positive charge which may be deposited as described in the system illustrated in FIG. 1.

Immediately above the uniformly charged xerographic plate is biased grid **18** is shown to be emitting negative charge producing particles.

In operation, it is found that grid **18** suitably biased, itself becomes a corona source which emits charge producing particles to deposit them in pattern configuration on the surface of the plate. In areas of deposit, the negative charge producing particles first neutralize the positive charge already found on the plate and then build up a pattern of discrete areas of negative charge on the plate immediately adjacent areas of positive charge, the areas of negative charge corresponding approximately to the grid portions of grid **18**.

It is found that biased grid **18**, which may be constructed of similar materials and geometry generally similar to conductive screen **16** illustrated in FIG. 1, is suitable as a corona source to emit corona in pattern configuration for use in the instant embodiment.

It is, of course, obvious to those skilled in the art that the diameter of grid portions which preferably are in wire form, because of the availability of corona wire of this type, can be made to vary over a large range provided the voltage applied to the wires is sufficient to create corona discharge at a potential below that at which sparking takes place. A practical upper limit of corona discharge wire diameter has been found to be about 0.010 inch. For wires above this size, sparking becomes an increasing factor. A suitable wire for construction of grid **18** is a smooth stainless steel wire having a diameter of 0.0035 inch.

Spacing of the grid **18** above the plate can also be varied over a rather wide range, although spacings between about 0.005 inch to 0.125 inch from the surface of the plate are found to produce optimum quality images.

A wide range of voltages supplied to grid **18** may be suitable herein so long as the voltage is sufficient to create a corona discharge at a potential below that at which sparking takes place for the particular grid configuration. Generally, voltages between about 4,000 and 10,000 volts are found to be satisfactory. For example, with a grid made up of a 0.0035 inch diameter stainless steel wire, a grid voltage of 6,500 volts is found to be preferred because of the high corona discharge emitted. With the grid biased to 6,500 volts, it is found, for example, that an application of corona for about two seconds followed by exposure, development and transfer is sufficient to produce quality, large solid area images.

Referring now to FIG. 3, there is shown xerographic plate **10**, biased grid **20**, and a source **22** of both positive and negative charge producing particles. In this embodiment, there is a simultaneous depositing of both positive and negative charge producing particles onto the surface of the xerographic plate.

Corona source **22** is indicated to be two discharge devices of the type disclosed in Vyverberg Pat. 2,836,725, one device biased positively to emit positive charge producing particles and the other device biased negatively to emit negative charge producing particles. One such device operated by an alternating potential could also be used since charge producing particles of both polarities are then made available in alternate half cycles. It is apparent that other corona sources, as previously described herein, are also suitable.

Between the plate and source **22** is shown biased grid **20** comprising a grid or a screen or a network of insulated and oppositely biased sets of wires. An exemplary grid would include one set of essentially parallel wires overlying a second set of essentially parallel wires, essentially coplanar with and perpendicular to the first set of wires. One set of wires is connected, for example, to the anode end of a voltage source which is shown as battery **24** and the other set of wires is connected to the cathode end of battery **24**.

In operation, it has been found that a grid of generally similar material and of a geometry generally similar to grid **16** illustrated in FIG. 1 regulates the flow of mixed polarity charge producing particles from source **22** and deposits them in a pattern of discrete alternating areas of charge at two different polarities and potentials on the surface of the xerographic plate. For the low grid potentials specified herein some negative charge producing particles are deflected from the negatively charged grid portions to be deposited on the plate and some are attracted to positively charged grid portions to be grounded, thus preventing their passage to the plate. Some positive charge producing particles are deflected from positively charged grid portions to be deposited on the plate and some are attracted to negatively charged grid portions to be grounded, thus preventing their passage to the plate. In this way alternating areas of charge are formed on the plate.

Spacing of the grid **20** above the plate can be varied over a rather wide range, although spacings between about 0.005 inch to 0.015 inch from the surface of the plate are found to produce optimum quality images.

A wide range of voltages applied to the sets of wires of grid **20**, may be suitable herein although positive and

negative voltages between about 10 volts and 100 volts are found to be preferred.

For the above range of voltages for the grid portions, quality large solid area images result when the two discharge devices are oppositely charged to about 6,500 volts and passed at a rate of about 2 inches/second over the plate at a distance of about ½ inch from the surface of the plate.

For ease of operation, the two discharge devices are generally passed over the plate together, although passing one device and then passing the oppositely charged device is also found to be suitable.

Referring now to the xerographic copying machine illustrated in FIG. 4, incorporating an embodiment of the invention disclosed herein adjacent station **1**, an original copy to be reproduced is placed on a support tray **30** from which it is fed onto a feed apparatus generally designated **31**. On the feed apparatus, the original is moved on an endless belt **32** driven by motor **33** to pass the optical axis of projection lens system **34** that is illuminated by projection lamp LMP–**1**. The image of the original is reflected by mirror **35** to an adjustable objective lens **36** and then reflected by mirror **37** downwardly to a variable slit aperture assembly **38** and onto the surface of a xerographic plate in the form of a drum **39**.

Xerographic drum **39** includes a shaft **40** mounted in suitable bearings in the frame of the machine and is driven in a clockwise direction by a motor **41** at a constant rate that is proportional to the transport rate of the original, whereby the peripheral rate of the drum surface is identical to the rate of movement of the projected radiation image. Drum surface **42** comprises a layer of photoconductive insulating material **43** on a conductive backing **44** that is sensitized prior to exposure by an embodiment of the novel charging system disclosed herein as schematically illustrated to be at station **1**.

The exposure of the drum **39** to the radiation image discharges the photoconductive layer in the areas struck by radiation whereby there remains on the drum a latent electrostatic image in image configuration corresponding to the radiation which is projected from the original. After exposure, the drum surface continues its movement to pass through a developing station **46** in which a two-component developer material **47**, which may be of a type as herein disclosed, is cascaded over the drum surface by means of a developing apparatus **48**.

In the developing apparatus, the material is carried up by a conveyor **49** driven by suitable drive means from motor **50** and then released onto chute **51** whereby it cascades down over the drum surface. The toner component **52** of the developer that is consumed in develping is stored in dispenser **53** and is dispensed in amounts controlled by gate **54**.

After developing, the xerographic powder image passes through an image transfer station **62** at which the powder image is transferred to a moving support surface **63** aided by a corona generating device **64** that is energized from a suitable high potential source.

The moving support surface **63** to which the powder image is transferred may be of any convenient type, such as paper, and may be obtained from a supply roll **65** fed over guide roll **66** and over suitable tensioning rolls being directed into surface contact with the drum in the immediate vicinity of transfer corona generating device **64**. After transfer, the support surface **63** is separated from the drum surface and guided beneath fusing apparatus **68** which serves to fuse or permanently fix the toner image to the support surface **63**. In this case, a resistance heating type fixer is illustrated. However, other techniques known in the art may be utilized for fixing, including solvent vapor fusing and radiation heat fusing. After fixing, the support surface is rewound on take up roll **70** for later reference. Shields **84** optionally inhibit transfer of particles from the biased screen, except in the region between shields to provide a more distinctively patterned configuration of charge on the drum surface.

In operation, the drum surface passes corona source **94**, receiving a uniform layer of charge illustrated, for example, to be positive charged. The drum surface then passes beneath the region between shields **84** adjacent screen **90** to receive, by corona discharge, from the biases screen a distinct pattern of negative charge deposited in the layer of uniform positive charge on the surface of the drum. The drum is then exposed to an image pattern of light and shadow, developed to produce a marking particle image which is transferred to a support surface producing quality copy.

It will be appreciated that the charging system illustrated in FIG. 3 may also be adapted for use in automatic, continuous-type xerographic copying equipment by adaptations similar to those employed with the charging systems illustrated in FIGS. 4 and 5.

Thus is described the novel charging system of this invention which has various embodiments adapting it for use in the xerographic process for depositing different polarity charges in a pattern configuration on the surface of a xerographic plate to provide better quality solid area and continuous-tone images.

It will be understood that various 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 to 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.

After separation of the support surface **63** from the drum, the xerographic drum surface passes through a cleaning station **71** at which its surface is brushed by cleaning brush assembly **75** whereby residual developing material remaining on the drum surface is removed.

The charging system illustrated in FIG. 4 and positioned at station **1** relative to the surface of xerographic drum **39** employs the basic steps illustrated in FIG. 1 adapted for use in automatic, continuous-type xerographic copying equipment as illustrated in FIG. 4. More specifically, the charging system includes two corona sources **82** and **83** which may be an adaptation of one of the types herein described, advancing endless conductive screen **81** and grounded conductive shields **84**.

The surface of the drum attains a uniform layer of charge of a single polarity, illustratively positive, as it passes corona source **82**.

Screen **81** generally similar in makeup to conductive screen **16** illustrated in FIG. 1 is positioned adjacent the drum surface by guide and tension rollers **79** and **80** and continuously advanced relative to the drum surface by drive roller **77** powered by motor **78**.

The screen may be grounded or biased to potentials in the preferred ±1,000-volt range by grounding or suitably biasing the drive roller **77** or one of the guide and tensioning rollers **79** and **80**.

Conductive screen **81** is advanced in a counter-clockwise direction at a constant rate whereby the peripheral rate of the drum surface is about identical to the rate of movement of screen **81** in the region between grounded conductive shields **84**, beneath corona source **83** emitting particles illustratively negative to produce areas of negative charge on the plate. Shields **84** may optionally be used to inhibit charge transfer from corona source **83**, except in the region between the shields, to provide a more distinctly patterned configuration of different charge areas on the plate.

The pattern of alternating areas of both positive and negative charges on the drum surface is then advanced to the exposure station where the photoconductive layer is discharged in image configuration in the areas struck by radiation. The latent image continues past the developing station **46** and the transfer station **62** to produce high-quality large solid area and continuous tone copy as well

as quality line and half-tone copy on moving support surface **63**.

Referring now to FIG. 5, there is shown isolated from the rest of the xerographic copying apparatus the drum surface adjacent the charging station **1** and another embodiment of the charging system disclosed herein which may be characterized as a mechanized adaptation of the system illustrated in FIG. 2.

This embodiment of the charging system includes corona source **94**, endless biased grid **90** on low conductivity roller **86** and grid biasing means shown to be a combination of a battery **92** and a brush **93** to impart a bias to electrically conductive, insulated shaft **91** which imparts bias to the grid by electrical conductor **96**.

Screen **90** is generally similar in material and geometry to biased screen **81** illustrated in FIG. 2 and is positioned adjacent the drum surface by being on roller **86** driven by insulated shaft **91** which is attached through suitable drive means to motor **89** which rotates the roller and screen in a counter-clockwise direction at a constant rate whereby the peripheral rate of the drum surface is about identical to the rate of movement of screen **90** in the region between grounded conductive shields **84**.

What is claimed is:

**1.** The method of charging a xerographic plate to provide a multiplicity of discrete, alternating areas of charge of opposite polarity comprising:

(a) uniformly electrostatically charging the xerograhic plate to a single polarity charge;

(b) depositing charge-producing particles on the plate in a multiplicity of discrete small areas to charge said areas to an opposite polarity.

**2.** The method of charging a xerographic plate to provide a multiplicity of discrete, alternating areas of charge at two different potentials comprising:

(a) uniformly electrostatically charging the xerographic plate to a first potential;

(b) depositing charge-producing particles in a multiplicity of discrete small areas on said plate to charge said small areas to a substantially uniform second potential.

**3.** The method according to claim **2** wherein said first potential differs from said second potential by at least about 100 volts.

**4.** The method of charging a xerographic plate according to claim **2** to provide a multiplicity of discrete, alternating areas of charge at two different potentials wherein charge-producing particles are deposited by directing them through a biased conductive grid overlying the plate to deposit said particles in grid interstitial pattern configuration on the plate thereby charging the plate in pattern areas to said second potential.

**5.** The method of claim **4** wherein the polarity of the charge charging the plate to said first potential is of a polarity opposite the polarity of charge charging the plate to said second potential.

**6.** The method of claim **4** wherein the bias of said conductive grid is about ground.

**7.** The method of claim **4** wherein the bias of said conductive grid is not greater than about 1,000 volts.

**8.** The method of claim **7** wherein the bias of said conductive grid is of a polarity opposite to the polarity of the charge-producing particles.

**9.** The method of claim **4** wherein said biased conductive grid is positioned above the plate at a distance between about 0.005 and 0.015 inch.

**10.** The method of claim **9** wherein said grid comprises interstitial areas and grid portions, the maximum linear dimension of an interstitial area being not more than about 0.02 inches.

**11.** The method of charging a xerographic plate according to claim **2** wherein charge-producing particles are deposited by directing them from a biased grid to deposit said particles in a grid pattern configuration on the plate, thereby charging the plate in pattern areas to said second potential.

**12.** The method of claim **11** wherein the polarity of the charge charging the plate to said first potential is of a polarity opposite the polarity of charge charging the plate to said second potential.

**13.** The method of claim **11** wherein said biased grid is biased to a voltage of between about 4,000 and 10,000 volts.

**14.** The method of claim **12** wherein said biased grid is positioned above the plate at a distance between about 0.005 and 0.125 inch.

**15.** The method of claim **13** wherein said biased grid comprises interstitial areas and grid portions, said grid portions comprising wire of diameter not greater than about 0.010 inch.

**16.** The method of charging a xerographic plate to provide a mutiplicity of discrete, alternating areas of charge at two different potentials of substantially different value comprising directing particles capable of producing charge of both polarities through a grid superposed between about 0.005 and 0.015 inch above the plate, said grid comprising a first set of wires wherein said wires are essentially parallel to each other, said first set of wires biased positively to a first potential of between about 10 to 100 volts and a second set of wires wherein said wires are essentially parallel to each other and essentially perpendicular to and co-planar with said first set of wires, said second set of wires biased negatively to a second potential of between about 10 to 100 volts.

**17.** A xerographic imaging method comprising the steps of:

(a) providing a xerographic plate;

(b) uniformly electrostatically charging said plate to a first potential;

(c) charging a multiplicity of discrete small areas on said plate to a second potential differing from said first potential;

(d) exposing said charge plate to a pattern of activating electromagnetic radiation; and

(e) developing said pattern with electroscopic marking material whereby a visible image having developed solid image areas is produced.

**18.** A xerographic plate charging apparatus comprising:

(a) a corona discharge device adjacent the xerographic plate;

(b) a grid interspaced between the plate and said corona discharge device said grid comprising a first set of wire wherein said wires are essentially parallel to each other, said first set of wires biased positively to a first potential of between about 10 to 100 volts, and a second set of wires wherein said wires are essentially parallel to each other and essentially perpendicular to and co-planar with the wires of said first set, said second set of wires biased negatively to a second potential of between about 10 to 100 volts, whereby corona particles of both polarities are directed through said grid to produce on the plate a multiplicity of discrete, alternating areas of charge at two different potentials.

**19.** The method of claim **5** whereby the plate is charged in a multiplicity of discrete small areas charged to an opposit epolarity from the polarity of said first potential.

**20.** The method of claim **12** whereby the plate is charged in a multiplicity of discrete small areas charged to an opposite polarity from the polarity of said first potential.

**21.** Xerographic plate charging apparatus comprising:

(a) means for advancing a xerographic plate surface;

(b) a first charging means positioned adjacent the path of such a plate whereby a plate may be substantially uniformly electrostatically charged;

(c) a second charging means after said first charging means, said second charging means comprising a source of corona and an advancing conductive screen adjacent the path of a xerographic plate and between said path and said source of corona, and

(d) means for advancing said conductive screen at about the same rate as said means (a) advances a xerographic plate, whereby a xerographic plate may be charged in a multiplicity of discrete, alternating areas of charge at two different potentials.

22. The charging apparatus of claim 21 wherein said source of corona produces electrostatic charge of polarity opposite to the polarity of charges produced by said first charging means.

23. The charging apparatus of claim 21 additionally comprising a grounded conductive shield having an open slot therein, said slot being about as wide as the imaging area of an advancing xerographic plate, and said slot being aligned between the source of corona and said path, whereby the corona charges produced by said source of corona may be deposited on a xerographic plate through said slot.

24. The charging apparatus of claim 21 wherein said advancing conductive screen is electrically grounded.

25. The charging apparatus of claim 21 wherein said advancing conductive screen is electrically biased to a potential in the range between about +1,000 volts and about −1,000 volts.

26. The charging apparatus of claim 34 wherein said advancing conductive screen is spaced adjacent the surface of said xerographic plate by a distance in the range between about 0.005 inch and about 0.015 inch.

27. Xerographic plate charging apparatus comprising:

(a) means for advancing a xerographic plate surface;

(b) a first charging means positioned adjacent the path of such a plate whereby a plate may be substantially uniformly electrostatically charged;

(c) a second charging means after said first charging means, said second charging means comprising a biased grid of conductive material, which omits charged particles, positioned adjacent said path, and

(d) means for advancing said biased grid at about the same rate as said means (a) advances a xerographic plate, whereby a xerographic plate may be charged in a multiplicity of discrete, alternating areas of charge at two different potentials.

28. The charging apparatus of claim 35 wherein said endless biased grid is mounted on an insulating roller operatively connected to advance said grid at about the same rate as means (a) advances a xerographic plate.

29. The charging apparatus of claim 27 wherein said second charging means produces electrostatic charge of polarity opposite the charge produced by said first charging means.

30. The charging apparatus of claim 27 wherein a grounded conductive shield having an open slot therein, said slot being about as wide as the path of a xerographic plate, and said slot being aligned between the second charging means and said path, whereby the charges produced by said second charging means may be deposited on a xerographic plate through said slot.

31. The apparatus of claim 36 wherein said biased grid is spaced from said xerographic plate by a distance in the range between about 0.005 inch and about 0.125 inch.

32. The charging apparatus of claim 27 wherein said endless grid is biased to a voltage in the range between about 4,000 volts and about 10,000 volts.

33. The apparatus of claim 21 wherein said advancing conductive screen comprises an endless conductive screen.

34. The apparatus of claim 21 additionally comprising a xerographic plate positioned in said path.

35. The apparatus of claim 27 wherein said biased grid comprises an endless biased grid.

36. The apparatus of claim 27 additionally comprising a xerographic plate positioned in said path.

37. A xerographic plate charging apparatus comprising:

(a) means for advancing a xerographic plate surface;

(b) a corona discharge device positioned adjacent the path of a xerographic plate surface whereby such a plate may be electrostatically charged;

(c) a grid interspaced between said path and said corona discharge device said grid comprising a first set of wires wherein said wires are essentially parallel to each other, said first set of wires biased positively to a first potential of between about 10 to 100 volts, and a second set of wires wherein said wires are essentially parallel to each other and essentially perpendicular to and co-planar with the wires of said first set, said second set of wires biased negatively to a second potential of between about 10 to 100 volts, and

(d) means for advancing said grid at about the same rate as said means (a) advances a xerographic plate surface, whereby charges of both polarities are directed through said grid to produce on a xerographic plate a multiplicity of discrete, alternating areas of charge at two different potentials.

38. The charging apparatus of claim 37 additionally comprising a xerographic plate positioned in said path.

39. The charging apparatus of claim 38 wherein said biased grid is spaced from said xerographic plate by a distance in the range between about 0.005 and about 0.015 inch.

40. The charging apparatus of claim 18 wherein said grid is spaced from said xerographic plate by a distance in the range between about 0.005 and about 0.015 inch.

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