

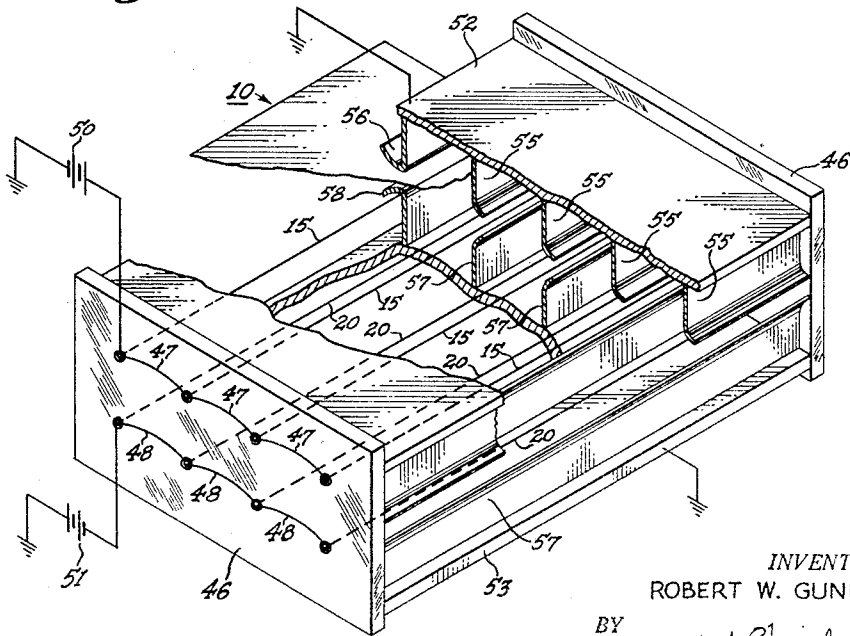
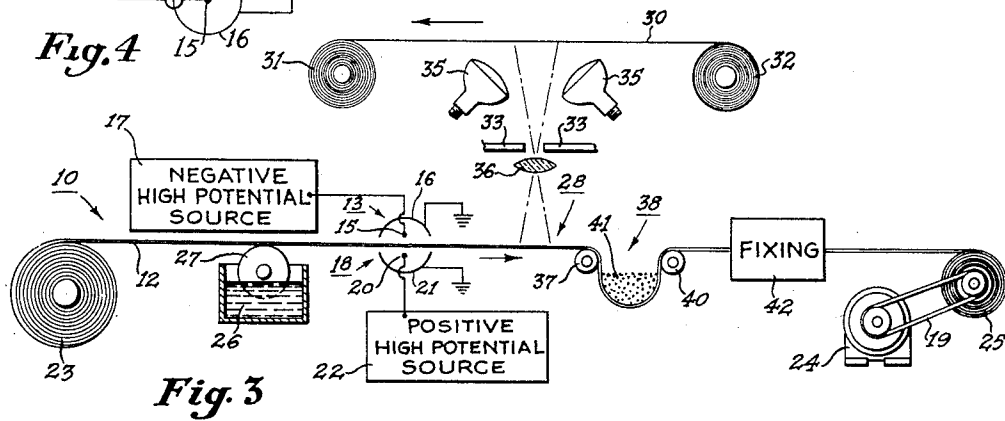
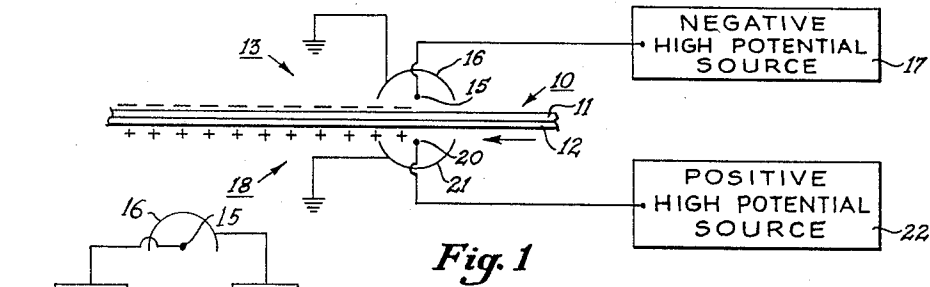
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2,885,556

SIMULTANEOUS CHARGING DEVICE AND METHOD

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SIMULTANEOUS CHARGING DEVICE AND METHOD

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This invention relates in general to xerography and more particularly to the formation of the electrostatic charge pattern on the surface of xerographic plates.

In the art of xerography, to form an electrostatic charge pattern a xerographic plate composed of a photoconductive insulating material on a conductive surface as, for example, brass, aluminum, or the like is given an electrostatic charge across the surface of the photoconductive insulating material. The charge is generally placed on the surface through the use of a corona discharge electrode or the like while the backing support for the photoconductive insulating layer is maintained at ground potential. The grounded backing member causes deposition on the surface of the plate of ions created through corona discharge because of fields of force existing through the surface being charged.

The plate is in a sensitive condition after a uniform charge is placed on the surface of the plate. On exposure, charge is dissipated in areas where the plate is struck by light, thereby forming an electrostatic charge pattern. The photoconductive insulating layer is a material which, when struck by light, decreases resistance characteristics, and in areas where light strikes, charge is dissipated rapidly whereas in areas not struck by light charge remains in position.

This invention relates to image formation in xerography on plates not backed by good conductors such as the metals described above. When metals are used as the backing member, the metal is grounded at one point and, since conduction takes place readily, all points are at ground potential during sensitizing or charging of the surface of the photoconductive insulator. However, with poorer conductors the materials do not conduct as well as the good conductors and thus all points are not easily grounded. Therefore, attempts to use poorer conductors or insulators as the backing member have generally resulted in copy produced which lacks in quality due to the fact that the fields of force through the photoconductive insulator are not uniform throughout. Attempts to ground all areas of a surface of the backing member contacting the surface to a grounded material have generally been unsuccessful. Air pockets, minute particles, variances in the surface, or the like, tend to prevent uniform charging, thereby resulting in fields of force which vary from point to point through the photoconductive insulating layer.

The term "good conductivity" as used throughout this invention is intended to mean "resistivity in the order of from 10^{-6} ohm-cm. to about 10^{-2} ohm-cm." Although this invention is particularly applicable to plates having backing members exhibiting greater resistivity than plates backed with materials exhibiting good conductivity, it is to be realized that plates backed by materials of good conductivity will charge uniformly and produce high quality images when the techniques of this invention are used, and such plates are intended to be encompassed by this invention.

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It is an object of this invention to devise novel methods to improve the art of xerography.

It is an object of this invention to devise a novel charging apparatus.

It is another object of this invention to devise novel methods of charging xerographic plates.

It is a further object of this invention to devise novel methods of charging photoconductive insulating layers not supported on conductive layers.

It is a still further object of this invention to improve upon methods for applying a uniform electrostatic field through a photoconductive insulating layer backed by an insulating material.

Other objects and advantages of this invention will be apparent in view of the following descriptions taken in the light of the accompanying drawings, wherein:

Fig. 1 is a view of one embodiment of charging according to this invention;

Fig. 2 is an embodiment of a charging device according to this invention;

Fig. 3 is a schematic view of an embodiment of a xerographic machine using a paper backed plate according to this invention; and,

Fig. 4 is a schematic of the charging apparatus of this invention employing A.C. and D.C. potentials.

For a better understanding of the invention, reference is now had to Fig. 1 wherein is shown one technique of charging according to this invention. The plate generally designated 10 composed of a self-supporting photoconductive insulating layer 11 overlying a supporting member 12 is, as shown, being moved from right to left. Positioned above the photoconductive insulating layer 11 is a corona discharge electrode 13 comprising a corona discharge wire 15 and a shield 16. Corona discharge wire 15 is connected to a negative high potential source 17 and shield 16 is held at ground potential. Positioned on the rear side of plate 10 is a corona discharge electrode 18 composed of corona discharge wire 20 and shield 21. Corona discharge wire 20 is supplied with positive high potential from positive high potential source 22 and shield 21 is grounded. As shown in this figure, as the plate moves between the corona discharge electrodes 13 and 18, a charge of opposite sign is deposited on the opposite sides of plate 10.

The plate 10 of this figure comprises a layer of photoconductive insulating material overlying an insulating support base. Thus, the deposited charges reside on the outer surfaces of the two layers.

The photoconductive insulating layer may comprise any of a number of materials as, for example, zinc oxide in a resin binder, selenium, a mixture of selenium and tellurium, zinc magnesium oxide, zinc sulfide, zinc cadmium sulfide, cadmium sulfide, cadmium strontium sulfide, zinc silicate, sulphur, calcium tungstate, selenides or mixed selenides of cadmium and zinc, anthracene, titanium dioxide, or the like. These materials are, in some instances, coated directly on the backing or support surface and, in other instances, they are coated in a resin binder on the surface of a support material. Desirably, they are activated with small amounts, that is 0.01% to 0.001%, of metallic impurities, as is well known to those skilled in the art. Conventional coating techniques may be used when coating the layer on a support surface.

The support base may comprise any material which can be smoothly finished to allow the coating of a smooth, uniformly thick layer of the photoconductive insulating material on its surface. Such materials include, but are in no way limited to, glass, plastics, paper, and the like.

Reference is now had to Fig. 2 wherein an embodi-

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ment of a charging device according to this invention is illustrated. As in the previous figure, 15 represents the corona discharge wires of the upper corona discharge electrode, and 20 represents the corona discharge wires of the lower discharge electrode. In this embodiment, the upper and lower corona discharge electrodes are connected together by end walls 46 and thus comprise a single unit. End walls 46 are sheets of insulating material such as Lucite or the like. Corona discharge wires 15 are connected together by connecting links 47, and corona discharge wires 20 are connected together by connecting links 48. Wires 15 are connected to the positive end of battery 50, and wires 20 are connected to the negative end of battery 51. The negative end of battery 50 is grounded, and the positive end of battery 51 is grounded. The batteries 50 and 51 are for purposes of supplying the desired potential for corona discharge to wires 15 and 20. It is to be realized, of course, that other known techniques of supplying a high potential to corona discharge wires 15 and 20 are intended to be encompassed by the scope of this invention.

At the upper end of the simultaneous charging corona discharge electrode of this figure is plate 52. A similar plate 53 is at the base of the device. Plates 52 and 53 are layers of conductive material and are grounded as illustrated. Extending downward from plate 52 are arms 55 and 56. Arms 55 and 56 are composed of conductive material and are in electrical contact with plate 52. The combination of arms 55 and 56 and plate 52 partially surrounding corona discharge wires 15 creates the upper corona discharge electrode 13 discussed in Fig. 1. The lower discharge electrode has extending upwards from plate 53 arms 57 and 58 which are conductive materials electrically connected to plate 53. The two forward arms 56 and 58 are shaped at their ends as illustrated to provide guide means for a plate 10 to move therebetween. Arms 57 and 55 are also shaped at their ends to guide and position the plate 10 as it moves therebetween through the corona discharge electrode. Although a particular device is illustrated in this figure, it is to be realized that modifications may be made which will occur to those skilled in the art and such modifications are intended to be encompassed in this invention.

Reference is now had to Fig. 3 wherein is shown an automatic type of machine according to this invention. As in Fig. 1, the corona discharge electrodes are designated 13 and 18, the corona discharge wires 15 and 20, the shields 16 and 21, the negative high potential source 17, the positive high potential source 22, the plate 10, and the photoconductive insulating layer 11. In this embodiment the photoconductive insulating layer 11 is supported on a paper backing material 12. The corona discharge electrodes 13 and 18 are connected, as in Fig. 1, to supply negative charge to the photoconductive insulating layer and positive charge to the reverse side of plate 10. The shields are, as in Fig. 1, grounded. The plate, which in this embodiment is flexible, is supplied from supply roll 23 and is wound on take-up roll 25. A tray 26 carrying water is positioned next in the path of movement of plate 10 following movement off supply roll 23. Positioned to rotate through the tray is rotating roller 27. Rotating roller 27 comprises a rubber roller or a roller covered with a water absorbent material, such as cotton or the like. Positioned within tray 26 is a supply of water. Plate 10 passes over and in contact with roller 27 and the rotation of roller 27 carries with it on its surface water from within tray 26 to the backing member 12 of plate 10. The plate is backed in this embodiment by a paper base which may be a low cost wood pulp or a high strength bond according to the future use to be made of the paper plate.

The conductivity of the paper base tends to vary according to moisture content. It has been found that images may be formed and developed on paper plates by using the conductivity of the paper base brought about

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by the moisture content of the paper alone. However, since moisture content relates to humidity conditions, as humidity varies, so too, the moisture content of the paper base will vary, and hence the quality and reproducibility of images will vary substantially. Thus, as a general rule, the paper base backing member is moistened to increase conductivity and to stabilize exposure conditions. Moistening may be accomplished as illustrated or by swabbing the exposed surface of the paper base with moistened cotton, by passing the paper surface over and in contact with a conductive liquid, through the use of a doctor blade, or through the use of other techniques known generally to those in the art.

The plate is next moved between corona discharge electrodes 13 and 18 whereat opposite charges are simultaneously supplied to the opposite surfaces of plate 10 to bring about a usable potential difference and charge density in the art of xerography on plate 10. Since the backing member has been made conductive by wetting with water, the deposited charges are believed to exist at the interface between the paper base and the layer of photoconductive material and on the outer surface of the photoconductive insulating layer. The plate is next moved to an exposure station generally designated at 28. Positioned above the exposure station is a moving web 30 of copy to be reproduced supplied from copy supply spool 31 and wound up on copy take-up spool 32. Lamps 35 project light to the copy, which is reflected through a slit defined by guides 33 and through lens 36 to plate 10. The movement of the copy 30 is synchronized with the movement of plate 10 and an electrostatic charge pattern of the copy is produced at exposure station 28. It is to be understood, of course, that other means of creating the charge pattern through exposure of the plate are intended to be encompassed by this invention as, for example, light may be transmitted through the copy to be reproduced rather than reflected back from the copy, or single sheets may be exposed along a moving surface, or means may be provided to stop movement of plate 10 for a stationary exposure, or the like. Copy 30, after passing through the exposure area, is moved to the copy take-up roll 32. The plate, after moving through exposure station 28, passes over roller 37 into development zone generally designated 38 defined by roller 37 and roller 40. In this figure, developer powder particles 41 are shown positioned within a loop of plate material. As the loop moves, the particles are cascaded across the surface of the plate material, and thereby develop the image pattern. Other techniques of development known generally to those in the art may be used such as, for example, powder cloud development, magnetic development, or the like.

The plate is next moved to fixing station 42 wherein the developed image is permanently affixed to the surface of the photoconductive insulating layer, thereby resulting in the finished copy. This may be accomplished by solvent fusing, heat fusing, covering the surface carrying the developed image with a plastic material, or the like. In this figure the plate 10 is then wound up on take-up spool 25. It is to be realized, of course, that it may be desired in some instances to cut individual frames of the copy or the like, and such final deposition of the finished image may be made according to techniques known generally to those in the art. Conventional driving means may be used to move the plate through the different stations and guides may be provided as, for example, at the edges of the plate to assure proper positioning. In this figure the plate is illustrated as driven by a motor 24 connected to take-up spool 25 by belt 19.

Referring now to Fig. 4, there is illustrated the electrical circuit to apply an A.C. generating potential to the electrode structure of this invention to charge a chargeable member or plate in accordance with this invention. The discharge wires and shields, as in Figures 1 and 2, are numbered respectively 15 and 16. As illustrated,

each of the discharge wires 15 is connected to A.C. power source 8 and, as illustrated, each of the shields 16 is connected to D.C. potential source 7. Operation in accordance with this figure will be discussed below.

Although a particular corona discharge electrode is illustrated, it is to be realized that other corona discharge electrodes and other means of applying electrostatic charge are intended to be included herein. For example, in co-pending application Serial No. 154,295 a corona discharge electrode is described wherein a screen of wires is interposed between the surface to be charged and the corona discharge wire. The screen in that application acts to regulate the amount of charge deposited on the surface being charged. It is also to be realized that more than one corona discharge wire may be used in the corona discharge electrode to bring about proper charging and that such modifications of the corona discharge electrode are intended to be included in this invention. It is also to be realized that other charging sources as, for example, a radioactive source or the like may be used and such other sources are intended to be included herein.

Although charging is shown accomplished through the use of corona discharge electrodes while the plate is moved relative thereto, it is to be realized that stationary corona charging of a stationary plate, or moving electrodes around a stationary plate, or the like, are also intended to be included in this application. Stationary charging of a stationary plate may be accomplished through the use of a corona discharge electrode covering the entire photoconductive insulating layer surface of the plate and a corona discharge electrode covering the area of the backing member of the plate so that both sides of the plate are simultaneously charged. Other known techniques of simultaneously charging the surfaces are intended to be included in this invention.

The potential supplied to the corona discharge wires, as, for example, wires 15 and 20, is above the point of corona emission which is dependent on the diameter of the wire, the position of the wire or wires in respect to the shield and the like. Generally, the potential should be in the neighborhood of from 6,000 to 8,000 volts.

Although in Figs. 1 and 3 the image surface of the plate is negatively charged and the surface of the backing member is positively charged, there is no intention to be limited to such charging. The image surface of the plate may be positively or negatively charged. What is intended to be shown in these figures is opposite charging of the opposite surfaces.

Although this invention is not limited to deposition of charge of a specific sign on the photoconductive insulating layer, it is noted that in some instances the charge should be negative and in others positive. Whether or not the charge must be of a specific sign is dependent on such factors as the particular base layer on which the photoconductive insulating material is placed, the particular photoconductive insulating material, and the like. For example, when using a paper base coated with zinc oxide in a resin binder, it is desirable to charge the photoconductive insulating layer with negative charge. The photoconductive insulating layer in such an instance acts like an n-type semiconductor. Such a semiconductor tends not to hold a positive charge on its surface and also tends not to discharge a positive charge when exposed to a light and shadow pattern. On the other hand, an n-type semiconductor will, when charged with negative charge, discharge properly when exposed to a pattern of light and shadow and will tend to hold charge.

Illustrative of corona charging is one technique which utilizes a high A.C. potential supplied to the corona discharge wires. In such a system, the shield is biased to the charge potential desired on the surface being charged by the particular corona discharge electrode. Thus, if it is desired to charge the plate of Fig. 1

to a positive 600 volts, an A.C. corona generating potential is applied to the corona discharge wire 15 and a positive limiting potential of 600 volts D.C. is applied to the shield 16. When the photoconductive insulating layer attains a charge of 600 volts, the flow of corona current to the photoconductive insulating layer will stop, thus charging the surface to the 600 volt desired potential. The backing member during the charging of the surface would be simultaneously charged to create a potential difference between the surface which will be valuable for use in xerography. For example, it may be desired to charge the backing member to ground potential. In such a case the shield of the corona discharge electrode directed towards the backing member will be grounded and the potential difference created between the backing member and the photoconductive insulating layer will be 600 volts.

The corona discharge electrodes may be positioned at varying distances from the plate. Positioning will depend upon potentials supplied to the corona discharge wires, potentials supplied to the shields, spacing of discharge wires from shields, desired potentials on the plate, and the like. Spacings of about $\frac{1}{4}$ inch between the discharge wire and the shield and about $\frac{1}{4}$ to $\frac{1}{2}$ inch between the discharge wire and the surface to be charged are generally used in xerography and have been found to work well with this invention.

It is to be realized that a potential difference between the opposite surfaces is desired, rather than potentials of opposite sign. Thus, it is feasible to charge one surface to plus 800 volts and the other surface to plus 300 volts. This may be accomplished using the A.C. corona charging means described above by biasing one shield at 800 volts D.C. and the other shield to 300 volts D.C.

In this invention, both surfaces of the plate are charged simultaneously. Charging is for purposes of creating a strong field through the photoconductive insulating layer so that on exposure, charges in areas struck by light will be dissipated from the surface rapidly. If the plate is backed by an insulator or other poor conductor, charges move from the surface to the interface between the photoconductive insulator and the support base and thus establish a developable difference in the fields of force throughout the photoconductive layer. To obtain a developable field, it is necessary to create a high charge density on each side of this layer. High charge density on each side may be attained by applying corona discharge simultaneously to each side. When corona discharge is simultaneously applied, the electrostatic fields of force created are confined to the region between the oppositely deposited charges and the field from either charged surface to external areas is negligible. Thus, the potential is kept low and in the neighborhood of a usable potential in the art of xerography. However, if one surface is charged and the other is not, the field of force would exist between the charges on the surface and the opposite charges in the areas which are not in close proximity. Thus, the field of force would not be confined and the potential on the surface would be substantially higher and probably in the sparking range, thus producing a charge of little value in the art of xerography. Furthermore, in actuality an attempt to deposit charge on a surface of a layer without flowing charge to the other surface of the layer will result in no charge deposition or charge deposition without uniformity. If techniques are used to bring about charge deposition to the desired potential without flowing charge to the other surface of the layer, then the charge density would not be sufficient enough to create usable xerographic charge patterns. Accordingly, in this invention opposite charges and differing potentials are simultaneously applied to the two surfaces of the plate to create a potential difference and a charge density usable in the art of xerography.

The potential difference desired will vary depending on a number of factors, such as the thickness of the photoconductive insulating layer, insulating characteristics of the photoconductive insulating layer, dielectric breakdown

strength of the photoconductive insulating layer, conductivity characteristics of the backing layer, and the like. As a general proposition, however, it may be stated that valuable and usable reproductions may be made in xerography when a potential difference of from 150 volts to 900 volts exists through the photoconductive insulating layer. A potential difference of about 500 volts is generally preferred.

The use of simultaneous corona charging of both surfaces of a plate according to this invention has the advantage of presenting an ocean of ions to the surface for charging purposes. All areas of the surfaces are exposed to this ocean of ions and deposition takes place in a uniform amount through all areas of the surfaces. Physical contact, on the other hand, of the backing member to a grounded electrode or the like generally results in contact with isolated areas. It is to be realized that the isolated areas may be microscopic in size and the surrounding areas often not contacted, when physical contact is being used, are not given the opportunity to charge. This invention overcomes that difficulty and presents to all areas charge for deposition to bring about uniform charging to a desired amount and thereby improves charging of plates composed of a photoconductive insulating layer overlying a material of less than good conductivity and results in high quality copy while using such plates.

While there has been described what at present is considered to be a preferred embodiment of the invention, it is to be understood that many changes and modifications may be made herein without departing from the essential spirit of the invention. It is intended, therefore, in the appended claims to cover all such modifications as fall within the true scope of the invention.

What is claimed is:

1. In electrostatic photography, means for imparting electrostatic charges to a chargeable member comprising a pair of charging electrode structures located in spaced relation directly opposite to each other, means for locating said chargeable member between said charging electrode structures, means for connecting each of said electrode structures through an A.C. corona generating potential power source, a first shielding structure associated with one of said electrode structures, a second shielding structure associated with the other of said charging electrode structures, and means for connecting a different direct current potential to each of said shielding structures.

2. Apparatus according to claim 1 in which said means

for connecting a different direct current potential to each of said shielding structures applies a direct current potential difference between each of said shielding structures about equal to the potential difference desired through a chargeable member to be charged.

3. Apparatus according to claim 1 in which one of said shielding structures is grounded and in which said other shielding structure has a direct current potential of about 600 volts applied thereto.

4. In electrostatic photography, means for sensitizing a xerographic plate by imparting electrostatic charges thereto comprising a pair of charging electrode structures located in spaced relation directly opposite to each other, means for locating said xerographic plate between said charging electrode structures, means for producing relative travel between said xerographic plate and said charging electrode structures in a direction substantially parallel to the length of said xerographic plate, means for connecting each of said electrode structures through an A.C. corona generating potential power source, a first shielding structure associated with one of said electrode structures, a second shielding structure associated with the other of said charging electrode structures, and means for connecting a different direct current potential to each of said shielding structures to apply a direct current potential difference between each of said shielding structures about equal to a potential difference greater than about 150 volts to create a direct current field through said xerographic plate to cause deposition of a potential difference through said xerographic plate for use in electrostatic photography.

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