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ELECTRICAL CHARGING UTILIZING A TWO-PHASE LIQUID MEDIUM

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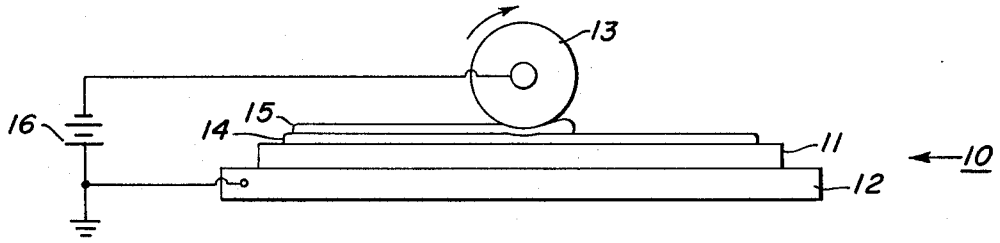


FIG. 1

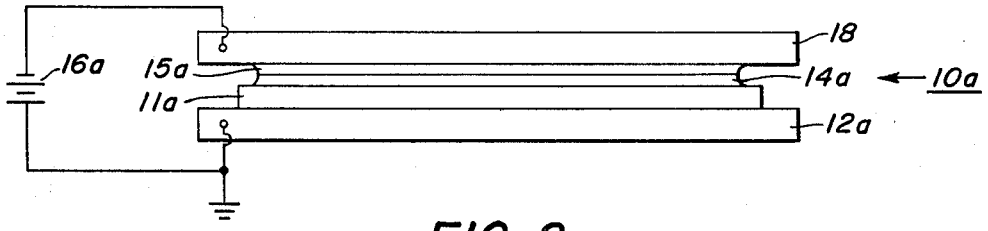


FIG. 2

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ELECTRICAL CHARGING UTILIZING A TWO-PHASE LIQUID MEDIUM

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ABSTRACT OF THE DISCLOSURE

Insulating or photoconductive insulating members are charged by passing the charge through a two-phase liquid medium which is in contact with the charging electrode and the member to be charged.

This invention relates to electrical charging of an insulating surface generally, and is particularly applicable to the electrostatic sensitization of xerographic plates used in xerographic imaging.

Various methods are known for applying a surface charge to an insulating layer such as the photoconductive insulating layer of a xerographic plate. Known methods include, for example, charging by means of corona discharge, triboelectric charging, induction charging, as well as others described in the patent literature and elsewhere.

Charging by means of direct contact with an electrode raised to a sufficiently high potential with respect to the insulating layer has been proposed, but this method has several drawbacks. Uniform surface contact between the electrode and the photoconductive insulating layer is difficult to achieve, so xerographic prints made from plates sensitized in this manner usually have a mottled appearance. Moreover, rather high voltages must be applied. The above-mentioned drawbacks have been reduced somewhat, and improved results have been achieved by modifying the contact charging method to include the use of a thin liquid film between the electrode and the insulating layer. For example, the use of a film consisting of a conductive liquid, or of an electrolytic liquid, is described in U.S. Patent 2,987,660. The use of an electrically insulating liquid film is described in U.S. Patent 2,904,431.

It has now been found that even greater improvements are gained through the use of films comprising two liquids instead of one. Developable charge patterns can be formed on xerographic plates according to this method with lower applied voltages, especially when plates of the binder type are used. That is, plates having a photoconductive insulating layer made up of a particulate photoconductor (such as zinc oxide) dispersed in an insulating binder material (such as a resin). The instant method has, moreover, been found especially suitable for xerographic printing processes involving image development with liquid developers.

Briefly summarized, the instant method includes charging an insulating layer overlying a conductive substrate by impressing a voltage across the substrate and an electrode separated from the surface of the insulating layer by a liquid film comprising an electrolytic liquid and an insulating liquid. In the preferred mode: a thin layer of an isoparaffinic hydrocarbon is coated on the imaging surface of a zinc oxide xerographic binder plate; water is added to the nip between said layer and an electrode in the form of a gravure roller. While a negative potential is applied to the roller, with respect to the substrate, it is rolled across the plate, whereby the imaging surface becomes uniformly electrostatically charged to a negative polarity. The plate may then be exposed to an optical image and developed with a liquid developer in accordance with processes known to those skilled in the art of xerography. Alternatively, known xerographic "dry" developing methods may be used after the liquid film has been allowed to evaporate from the plate.

The instant invention is described in detail in connection with the accompanying drawing in which:

FIG. 1 illustrates plate charging by means of a roller electrode; and,

FIG. 2 illustrates an alternate embodiment comprising a sandwich structure for plate charging.

FIG. 1 schematically illustrates the process of electrostatically charging a chargeable layer in contact with a conductive substrate.

For purposes of describing the process, this figure illustrates the electrostatic sensitization of xerographic plate **10** by means of a movable electrode in the form of a roller **13**. Plate **10** comprises photoconductive insulating layer **11** overlying conductive substrate **12**. In accordance with the present invention, an insulating liquid coating **14**, approximately 20 to 30 microns in thickness, is first applied to the surface of layer **11** by, for example, dip coating, spraying, swabbing, or any other conventional method.

A second layer **15** of an electrolytic liquid is then applied to the coated surface as the energized roller electrode is moved across the plate in the direction indicated by the arrow. The electrolytic liquid is conveniently applied by placing a small quantity in the nip between roller **13** and the coating **14** with a medicine dropper or the like. Layer **15** forms uniformly only in the nip of the roller where it is temporarily held in position by the roller. After emerging from the nip of the roller, layer **15** comprises a multitude of droplets because of the finite contact angle of the electrolytic liquid on the surface of coating **14**. Of course, any other coating method in which the layer is held in position while contacted by the electrode may instead be used to form layer **15**, if desired.

In the illustrated embodiment, electrode roller **13** is connected to the negative terminal of potential source **16**. The positive terminal is connected to conductive substrate **12**, which is preferably grounded. This arrangement produces an electrostatic surface charge of negative polarity on layer **11**. If a positive charge is desired, the electrode should instead be connected to the positive side of a power source. Again, the conductive substrate is preferably grounded.

FIG. 2 illustrates electrostatically charging the surface of a chargeable member in contact with a conductive substrate by means of a stationary electrode. In this particular embodiment, an electrical potential is impressed across a sandwich structure made up of a xerographic plate, a two-liquid thin film, and a substantially flat electrode.

As illustrated, xeroraphic plate **10*a*** comprises photoconductive insulating layer **11*a*** overlying conductive substrate **12*a***. The two-liquid film, comprising coating **14*a*** of an insulating liquid and layer **15*a*** of an electrolytic liquid, may be formed as above, or by any conventional method. Electrode **18**, comprising an electrically conductive member such as a metallic plate, is temporarily placed in contact with the liquid coated xerographic plate. With the members arranged as illustrated, an electrical potential is applied by means, for example, of power source **16*a***. In the schematic illustration, electrode **18** is shown connected to the negative terminal of power source **16*a*** and the grounded substrate **12*a*** is shown as connected to the positive terminal. This arrangement will produce a negative electrostatic charge on the surface of photoconductive insulating layer **11*a***. The polarity of the surface charge is a matter of choice, however, which is ordinarily determined by the electrical properties of the chargeable surface. If a positive surface charge is

desired, a plus voltage is instead connected to electrode **18**.

When the present invention is used to electrostatically sensitize or charge xerographic plates having a substrate of relatively poor electrical conductivity (such as electrophotographic copying paper), it is desirable to apply a conductive liquid (such as an aqueous graphite dispersion) to the underside of the substrate. One terminal of the power supply may then be conveniently connected to the substrate or to a conductive support for the paper during the charging process. This procedure is especially effective with absorbent or porous substrates, for example, a plate having a cellulosic fibrous backing of paper, or the like.

The following examples are presented to further illustrate the present invention, and to demonstrate the improved results that may be derived from its application to xerography.

Example I

In the manner described in connection with FIG. 1, a xerographic plate comprising a sheet of commercially available electrophotographic copying paper having a photoconductive layer of particulate zinc oxide dispersed in a resin binder was coated with a film of Isopar G, a liquid isoparaffinic hydrocarbon of Humble Oil and Refining Company. The thickness of the liquid coating, corresponding to coating **14** of FIG. 1, was approximately 20 to 30 microns. Tap water was then added to the nip between the insulating liquid coating and a gravure roller connected to a negative terminal of a 600 volt electrical power supply. With the paper supported on a conductive backing, the roller was then rolled back and forth across the paper resulting in the formation of a substantially uniform electrostatic charge on the imaging surface of the electrophotographic paper. The charged paper was then processed according to known xerographic techniques, including exposure to an optical image of a standard test pattern and development by immersion in a liquid developer. The liquid developer comprised 0.5% by weight of Colitho Reflex Blue Ink, No. CO 16 (Columbia Ribbon and Carbon Manufacturing Company, Inc.), suspended in Freon 113 fluorocarbon (E. I. du Pont de Nemours and Company). Well-defined prints having high contrast and high image resolution were produced.

Example II

The procedures set forth in Example I were repeated except that after sensitization the paper was allowed to dry in air before it was exposed to an optical image. Prints comparable to those of Example I were produced.

Example III

Using the embodiment illustrated in FIG. 1, commercial electrophotographic copying paper was sensitized in the manner set forth in Example I except that the electrode roller was connected to the negative terminal of a 900 volt power supply. After charging in the manner described, the paper was allowed to dry in air. Other sheets of electrophotographic copying paper were similarly sensitized except that single-liquid films were used instead. In one instance, plain water was used. In addition, each of a series of sheets were coated with one of the following insulating liquids: gasoline, cyclohexane, 1-propanol, and Isopar G. The sensitized sheets were then subjected to electrometer tests to compare the magnitude of the charges produced. The results were as follows: water/Isopar G (the present invention) 110 volts; water only, 10–20 volts; gasoline only, 10 volts; cyclohexane only, 0 volt; 1-propanol only, 0 volt; Isopar G only, 0 volt.

Example IV

To illustrate the use of the present invention in applying a positive polarity surface charge, a standard xerographic plate comprising a 20 micron layer of vitreous selenium overlying an aluminum substrate was coated with a film of Isopar G. Water was then added to the nip between the insulating film and a steel gravure roller connected to the positive side of a potential source. After the roller was moved back and forth across the plate, the sensitized plate was successfully used for xerographic copying, including the process steps of exposure to an optical image and development by immersion in a liquid developer comprising electroscopic particles suspended in an insulating liquid.

The two-liquid films for establishing charging contact between an electrode and a chargeable surface according to the present invention may comprise a wide variety of materials in addition to those mentioned above. The insulating liquid used for coating the chargeable surface is preferably a film former and should have a bulk resistivity of at least about 10^9 ohm-centimeters. Examples of other suitable liquids include: kerosene, cyclohexane, and other aliphatic hydrocarbons; gasoline aromatic hydrocarbons, such as benzene and toluene; chlorinated hydrocarbons, such as carbon tetrachloride and 1,2-dichloroethane; dimethyl silicone fluids, and other silicones; trichlorotrifluoroethane, and other fluorocarbons.

The second liquid layer, shown as layers **15** and **15***a* in the drawing, may comprise any electrolyte. In addition to tap water, the following liquids are typical of those useful in the present invention: solutions of electrolytes in water; mixtures of 50 percent tap water–50 percent isopropanol (by vol.); water-alcohol solutions; and other polar solutions which form a second liquid phase when spread on the first liquid layer.

The instant surface charging method is not limited to electrostatic sensitization of xerographic plates, but may be used to apply a surface charge to any chargeable member in contact with a conductive backing. The chargeable member need not be permanently adhered to its backing; electrical contact need only be maintained while the electrical potential is applied as explained herein. For example, a substantially uniform electrostatic charge may be applied to a sheet of Mylar in temporary contact with a copper substrate by means of the present invention. When applied to xerography, however, surface charging by means of the present invention is ordinarily done in the absence of actinic radiation for the photoconductive material included in the plate. Thus, plate sensitization is normally carried out in darkness so that the photoconductive insulating layer is in a condition to readily retain an electrostatic charge. Materials and plates used in this process are well-known and are commercially available.

A xerographic plate sensitized in accordance with the present invention may be used in xerography in the usual way. That is, the charge may be selectively dissipated in image configuration by exposure to an optical image, by means of a camera, projector, or any other means known to the art. Similarly, any suitable developing method may be used. In addition to liquid development referred to herein, various dry-component development methods are well known. These include, for example, cascade development and magnetic brush development, as well as others.

Although described in terms of specific embodiments and materials, limitation of the present invention thereto is not intended. Rather, it is intended that the invention be viewed broadly within the full scope of the appended claims.

What is claimed is:

1. The method of establishing a charging contact between a chargeable surface and an electrode, comprising:

forming a first layer of insulating liquid on said chargeable surface;

forming a second layer of electrolytic liquid over said first layer; and

positioning said electrode in contact with said second layer.

2. The method of applying an electrostatic charge to the chargeable surface of a member in contact with an electrically conductive substrate, comprising:
coating said surface with an insulating liquid,
forming an electrolytic liquid layer thereover;
positioning an electrode in contact with said electrolytic liquid layer; and,
establishing an electrical potential between said substate and said electrode.

3. The method of claim 2 wherein said insulating liquid has a bulk resistivity of at least 10^9 ohm-centimeters.

4. The method of electrostatically charging a xerographic plate comprising a photoconductive layer overlying a conductive substrate, said method comprising:
coating said photoconductive layer with a thin layer of an insulating liquid;
forming an electrolytic liquid layer over said thin layer;
positioning an electrode in contact with said electrolytic liquid layer; and,
establishing an electrical potential between said substrate and said electrode.

5. The method of claim 4 wherein said insulating liquid has a bulk resistivity of at least 10^9 ohm-centimeters.

6. The method of electrostatically charging an electrophotographic plate on a conductive support, said electrophotographic plate including a photoconductive layer comprising zinc oxide dispersed in a resin binder, comprising:
forming a first layer of insulating liquid, on said photoconductive layer;
forming a second layer of electrolytic liquid over said first layer;
positioning an electrode in contact with said second layer; and,
establishing an electrical potential between said conductive support and said electrode.

7. The method of electrostatically charging a photoconductive insulating layer overlying a cellulosic fibrous backing, comprising:
forming a first layer of insulating liquid on said photoconductive insulating layer;

forming a second layer of electrolytic liquid on said first layer;
positioning an electrode in contact with said second layer; and,
establishing an electrical field through said electrode, the first and second layers, and said photoconductive insulating layer.

8. The method of claim 7 wherein said photoconductive insulating layer comprises a particulate photoconductor dispersed in a resin binder.

9. The method of electrostatically charging a photoconductive insulating layer overlying a cellulosic fibrous backing, comprising:
forming a first layer of insulating liquid on said photoconductive insulating layer;
placing a quantity of electrolytic liquid on said first layer;
rolling an electrode raised to an electrical potential with respect to said photoconductive insulating layer across the liquid layers whereby a second layer of electrolytic liquid is formed and an electrostatic charge is applied to said photoconductive insulating layer.

10. The method of claim 9 wherein said electrode comprises a conductive roller.

11. The method of claim 9 wherein said photoconductive insulating layer comprises zinc oxide in a resin binder.

12. The method of claim 9 with the additional step of applying a conductive liquid to said backing before rolling said electrode.

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