

[54] CORONA CHARGE METHOD

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[51] Int. Cl. G03g 13/02

[58] Field of Search 250/49.5 AC, 49.5 ZC, 325,
250/324, 326; 317/262 A; 96/1 C, 1 PC

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[57]

ABSTRACT

A method for charging an electrophotographic member comprising a photoconductive insulating layer, an insulating substrate, and a conductive layer interposed between the photoconductive insulating layer and the insulating substrate, the conductive layer being unconnected to any source of reference electric potential, the method comprising the steps of relatively moving the electrophotographic member and two corona discharge electrodes, the first of which precedes the second, exposing the photoconductive insulating layer of the electrophotographic member to the first corona discharge electrode, the polarity of which is opposite to that of the majority carriers of the photoconductive insulating layer and subsequently exposing the photoconductive insulating layer of the electrophotographic member to the second corona discharge, the polarity of which is the same as that of the majority carriers whereby the electrophotographic member is readily charged even though the conductive layer is unconnected to a source of reference electric potential.

7 Claims, 4 Drawing Figures

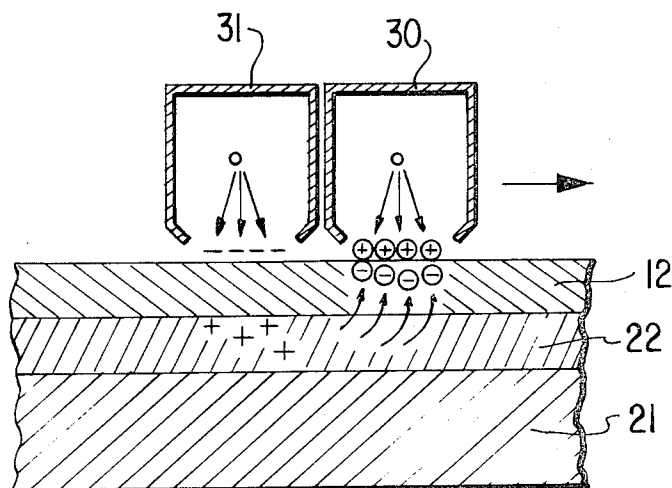


FIG. 1

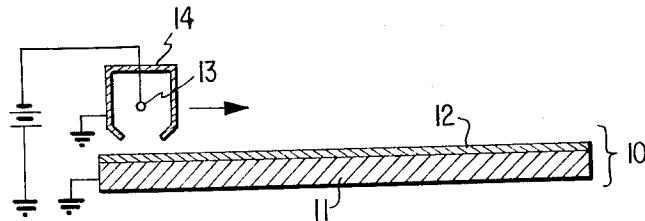


FIG. 2

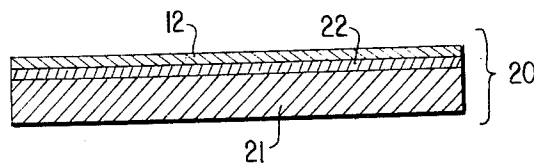


FIG. 3

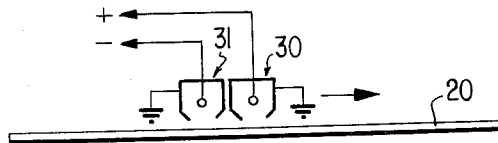
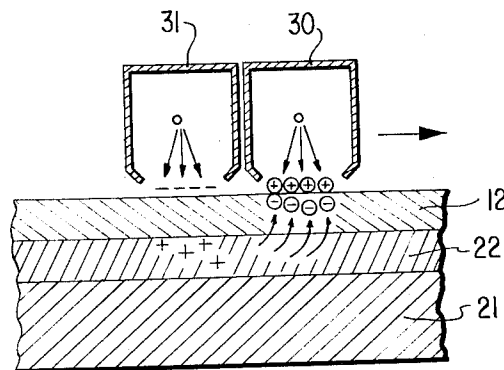


FIG. 4



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CORONA CHARGE METHOD

SIMPLE EXPLANATION OF THE FIGURES

FIG. 1 is a representative sectional side view showing a state of practicing conventional corona charge method.

FIG. 2 is a side view showing an example of layer structure of an electrophotographic material.

FIG. 3 is a representative side view of a preferred embodiment of corona discharge method of this invention.

FIG. 4 is a sectional side view of an electronic photo material and corona charge electrode to show the principle of this invention.

DETAILED DESCRIPTION OF THE INVENTION

This invention relates to a new charging method for use in electrophotography.

An electrophotographic material in general comprises a conductive support provided with an electrophotoconductive insulating layer or insulating layer thereon. One of the typical materials comprises a metal plate vacuum evaporated with photoconducting selenium, and the other comprises a paper which has been coated or impregnated with conductive polymer material and a mixture of photoconductive zinc oxide powder and insulative resin coated thereon.

It is not difficult to charge such an electrophotographic materials by corona discharge. FIG. 1 is a sectional view of a conventional embodiment of charging device. In this Figure, the numeral 10 is an electrophotographic material provided with a photoconducting insulating layer 12 on an electroconductive support such as metal plate. Layer 12 may also be an insulator of the type described at 2 in U.S. Pat. No. 3,216,853. 13 is a corona wire extending over a few centimeter upwardly of photoconductive insulating layer, and the upside, front and back of the said corona wire 13 are covered with a shield case 14. The corona wire is applied for example with negative high voltage, and a shield case and conductive support 11 are grounded. When a voltage of -6KV - -7KV is applied to the corona wire keeping the distance of a few centimeter between a corona wire 13 and shield case 14, corona ion would be discharged from a corona wire against the photoconductive insulating layer, whereby negatively charging the layer.

In order to uniformly charge the photoconductive layer in its whole area, the corona discharge electrode (wire and shield case) may be moved in the direction of an arrow mark at a constant speed, or the electrophotographic material may be moved in the direction contrary of an arrow mark under the stationary electrode.

When the electrophotographic material is one in which the photoconductive layer provided on an electroconductive support as shown in FIG. 1, it is possible to obtain satisfactory results by use of the conventional method.

But it becomes difficult to perform discharging as explained in the FIG. 1, when the electrophotographic material, a sectional view of which is shown in FIG. 2, comprises a high insulating support 21 on which a conductive layer 22 is provided, and further a photoconductive insulating layer 12 is provided on the layer 22. It is because a conductive layer is not grounded. It is especially the case where the high insulation support

comprises a plastic film such as polyester, polyethylene, polyvinyl chloride and cellulose triacetate.

In case, the support 21 is an ordinary paper, the problem can be eliminated in practical use by providing an electrophotographic material as shown in FIG. 2 on a conductive plate and by contacting the support 21 to the conductive plate to enable grounding to some degree, because the paper (support) has absorbed atmospheric moisture whereby decreasing its insulating ability compared with the said plastic film, although paper originally has good insulation. However, if material such as polyester having extremely high insulation is used as a support 21, it would no longer be grounded even if an electrophotographic material 20 should be provided on the conductive plate. Accordingly it is impossible to charge the material by the method as shown in the FIG. 1.

When the support 21 is very thin and the conductive layer 22 have extremely high conductivity as a metal plated film, grounding can be carried out by means of spark generated between the conductive layer 22 and the grounded conductive plate, if an electrophotographic material 20 is provided on the grounded conductive plate against which corona discharge should be given downwardly. However, the grounding by means of spark is not considered suitable, as the charged potential of photoconductive insulating layer can not be stabilized, and as the photoconductive insulating layer senses to light generated at the time of sparking. And also said sparking is dangerous. In case a conductive layer 22 has not so high insulation as that of a metal and is made from copper iodide, electroconductive carbon, or electroconductive high polymer material, the necessary spark would not be generated, and accordingly charging can hardly be obtained.

Up to today, for charging and electrophotographic material as shown in the FIG. 2, the method has been employed, in which the photoconductive insulating layer is removed at an edge portion to disclose the conductive layer, and then the disclosed portion is grounded. This method, however, has a disadvantage that it accompanies complicated manufacturing procedures to prepare such an electrophotographic material, conductive layer of which is only partially disclosed and that the grounding would be incomplete when the conductivity of the layer is not so large.

Accordingly, this invention provides a new charging method being suitable to charge the electrophotographic material as shown in the FIG. 2.

The present invention is characterized by the method, in which two corona discharge electrodes are closely disposed over the photoconductive insulating layer or insulating layer provided over a conductive layer, and while the corona discharge electrodes and electrophotographic material are relatively moved so that one of the electrodes preceding the other, high voltage with polarity being difficult to charge the electrophotographic material is applied to the preceding corona discharge electrode and high voltage with polarity being suitable to charge the material is applied to the other electrode.

FIG. 3 is a sectional view of an equipment to embody the method of the invention.

Numeral 30 is a preceding corona discharge electrode and 31 is a succeeding corona discharge electrode, both of which are arranged closely and driven to the direction of an arrow mark at a constant speed, and

the electrophotographic material stays. The electrophotographic material may be moved instead of the corona electrodes. High positive voltage has been applied to the corona wire of the preceding corona discharge electrode, and approximately the same strength of negative voltage has also been applied to the corona wire of the succeeding corona discharge electrode. The shield case is grounded.

FIG. 4 is an enlarged close sectional view showing the principle of the present invention.

The photoconductive insulating layer of N-type semiconductor which is difficult to or cannot positively be charged. A little quantity of positive ion from the preceding corona discharge electrode 30 is first given to the surface of the photoconductive layer on where it deposits. And then free electrons from a conductive layer 22 arrive at the surface through the photoconductive insulating layer 12 to neutralize the said positive charge. As a result of which a conductive layer 22 would have surplus positive ion encouraging the deposition of negative ion coming to the surface of the photoconductive insulating layer 12 from the preceding corona discharge electrode 31. Thus, both of the positive and negative corona ion encourage each other, whereby negatively charging the surface of the photoconductive insulating layer 12. When both of the corona discharge electrodes are moved, under such a condition to the direction of an arrow mark, the surface of the photoconductive insulating layer can be uniformly charged negatively.

As can be seen from the principle of this invention, the electrophotographic material to be used by the present invention is preferred not to be charged by the application of corona from the corona discharge electrode of the preceding electrode, and it is at least necessary not to be charged. And it is also necessary that the discharge by the application of corona from the succeeding corona discharge electrode is not excessively limited by the application of corona from the preceding corona discharge electrode. A certain kind of insulating layer can be selectively charged either positively or negatively. Such an insulating layer cannot be charged by means of the method of this invention. And the other kind of insulating layer, once it had been charged, and even if it has not been charged at that time, it cannot usually be charged by corona discharge of the counter polarity.

For example, if an Electrofax paper, that is, a paper coated with a mixture comprising photoconductive zinc oxide powder and an insulating resin, which has previously been exposed to corona discharged positively, should subsequently be subjected to exposure of negative corona discharge, it occurs sometimes that said paper can hardly be charged. Such an electrophotographic material cannot be charged by the method according to the present invention. Photoconductive selenium and many other photoconductive insulating layers can be charged by the method of this invention.

By this invention, the demand to the conductivity to the lateral direction of conductive layer (low resistance layer) is relaxed. Namely, it is possible to use a conductive layer having higher resistance and to improve uniformity of charge contribution to the material having the conductive layer of the same electric-resistance. Should it be wished to equalize the charge quantity on two insulating layers, each having different light-conductivity, provided on the same conductive layer, it

can be carried out by varying the thickness of conductive layer.

In the conventional charging method, if grounding is accomplished at the end portion of a conductive layer the layer of which has high resistivity to the lateral direction, charge density at the surface of area being far from the end portion is inclined to decrease when the area to be treated is so large. However, the disadvantage can be avoided according to this invention.

The material which brings particularly remarkable effect by this invention has a structure provided with a low resistance layer or conductive layer, as shown in the FIG. 2, having lateral resistance not more than $10^9 \Omega/\text{square}$ by surface resistance, on a plastic film or a laminate of paper and plastic film, having vertical resistance of more than $10^{10} \Omega$.

Hereinafter described are preferred embodiments of the invention:

Embodiment 1:

The surface of a polyethylene terephthalate film having thickness of 100μ was first achieved by the application of ultraviolet rays, and further vacuum evaporated by aluminum of 0.2μ in thickness. And the surface was again vacuum evaporated with selenium of 25μ in thickness, whereby an electrophotographic material has been obtained. This electrophotographic material was charged by the method as explained with reference to the FIG. 3. A preceding corona discharge electrode having the following structure was used. Corona wire was of stainless steel having diameter of 0.1 mm; the distance between a shield case and corona wire was 15 mm; and the distance between the said corona wire and electrophotographic material was 15 mm. The same conditions as mentioned above were applied to the succeeding corona discharge electrode except that the distance between the corona wire and the electrophotographic material was 12 mm. Voltage of -7.5KV was applied to the preceding corona wire, and $+7 \text{KV}$ was applied to the succeeding corona wire.

The electrophotographic material and both of the corona discharge electrodes were relatively moved at a speed of 4 cm/sec. And the electrophotographic material was charged positively.

Embodiment 2:

Surface of a cellulose triacetate film having thickness of 100μ was coated by a conductive polymer (Trade name "Dow Chemical ECR-34", made by Dow Chemical International Ltd. that the quantity of the coating after dried would be 2 g/m^2 , and was further applied with a mixture, with its thickness after dried being 7μ comprising 100 parts by weight of photoconductive zinc oxide and 20 parts by weight of styrenated alkyd resin (Trade name: Styresol 4,400, made by Nippon Reihihold K.K.) thereby an electrophotographic material was obtained.

The above electrophotographic material was charged by the method as previously described with reference to the FIG. 3. Preceding and succeeding corona discharge electrodes had the same structures as for those used in the Embodiment 1. Voltage of $+7.5 \text{KV}$ was applied to the preceding corona wire, and -7KV was applied to the succeeding corona wire. The electrophotographic material and both of the corona discharge electrodes were relatively moved at a speed of 3 cm/sec., whereby the electrophotographic material could be charged negatively.

What is claimed is:

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1. A corona charging method for an electrophotographic material characterized in that two corona discharge electrodes are closely positioned above said electrophotographic material comprising a photoconductive insulating layer or insulating layer which is non-grounded, not connected to any source of electric potential and provided on a conductive layer which, in turn, is provided on an insulating substrate; relatively moving both of the electrodes, one of which is preceding the other, and said electrophotographic material, exposing without illuminating said electrophotographic material to the corona discharge of the preceding corona discharge electrode of a polarity which tends not to deposit charges on said insulating layer and by the corona discharge of the succeeding corona discharge electrode of a polarity which easily deposits charges on said insulating layer.

2. A method as in claim 1 where said photoconductive insulating layer is N-type and the polarities of said two corona discharge electrodes are respectively positive and negative.

3. A method as in claim 1 where said photoconductive insulating layer is P-type and the polarities of said two corona discharge electrodes are respectively negative and positive.

4. A method for charging an electrophotographic member comprising a photoconductive insulating layer, an insulating substrate, and a conductive layer interposed between said photoconductive insulating layer and said insulating substrate, said conductive

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layer being unconnected to any source of reference electric potential, said method comprising the steps of:

relatively moving said electrophotographic member and two corona discharge electrodes, the first of which precedes the second;

exposing the photoconductive insulating layer of said electrophotographic member to said first corona discharge electrode, the polarity of which is opposite to that of the majority carriers of said photoconductive insulating layer; and

subsequently exposing the photoconductive insulating layer of said electrophotographic member to said second corona discharge, the polarity of which is the same as that of said majority carriers

whereby said electrophotographic member is readily charged even though said conductive layer is unconnected to a source of reference electric potential.

5. A method as in claim 4 wherein said photoconductive insulating layer is N-type and the polarities of said first and second corona discharge electrodes are respectively positive and negative.

6. A method as in claim 4 where said photoconductive insulating layer is P-type and the polarities of said first and second corona discharge electrodes are respectively negative and positive.

7. A method as in claim 4 where said source of reference electric potential is ground.

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