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[54] **DEVELOPMENT OF LATENT ELECTROSTATIC IMAGE EMPLOYING NOVEL DEVELOPMENT ELECTRODE**

4 Claims, 2 Drawing Figs.

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[50] Field of Search 96/1, 1.2; 117/17.5

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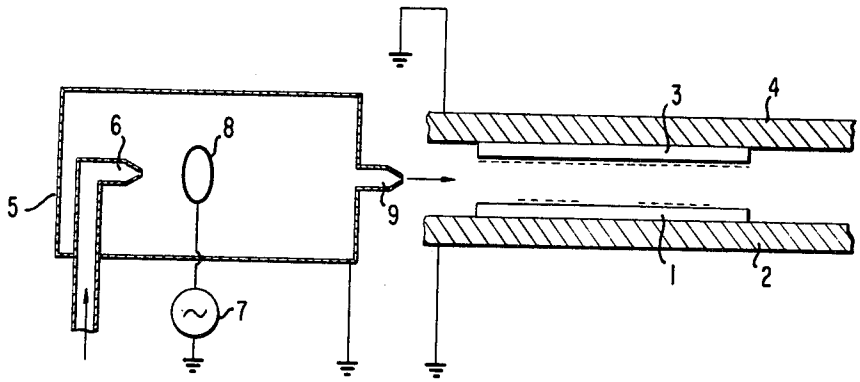
ABSTRACT: A process of developing a latent electrostatic image, which comprises facing across a small clearance an insulator having a latent electrostatic image and another insulator for electric field regulating, having the same polaity as said insulator, uniform charges and characteristics substantially similar to the dark attenuation characteristics of said insulator under the developing condition, and feeding developing particles having the same polairity as that of said latent electrostatic image to the clearance, whereby to develop said latent electrostatic image.



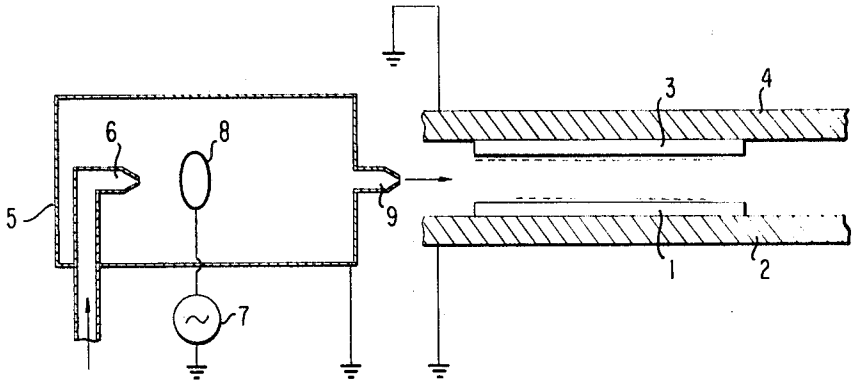


FIG. 1

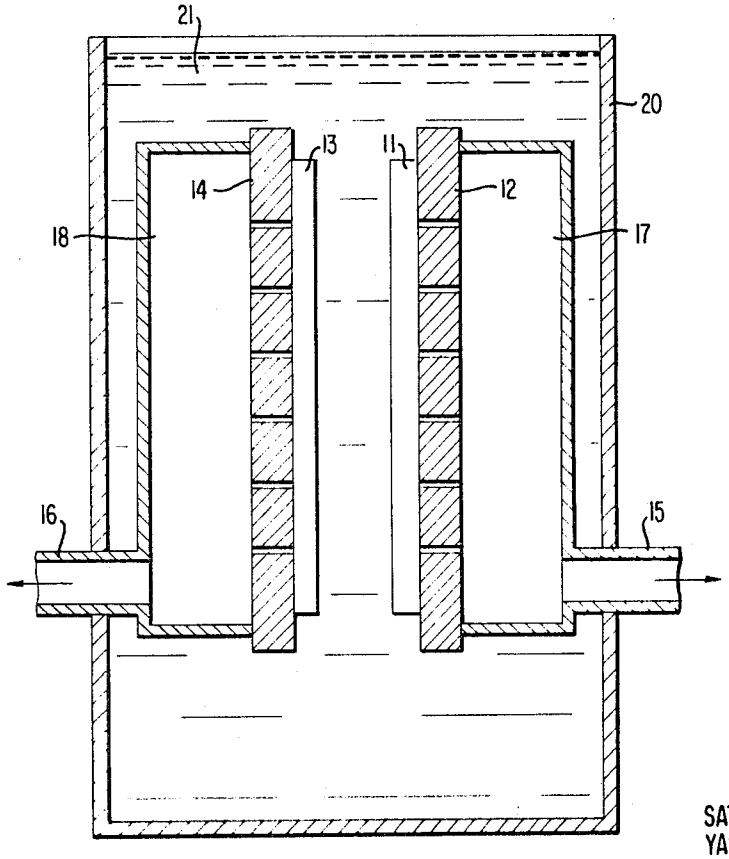


FIG. 2

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DEVELOPMENT OF LATENT ELECTROSTATIC IMAGE EMPLOYING NOVEL DEVELOPMENT ELECTRODE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a process of developing a latent electrostatic image, wherein more developing particles are caused to adhere to an area of lower charge density in a pattern of charges formed on the surface of an insulator, and no developing particles are caused to adhere to a maximum charge density area.

2. Description of the Prior Art

When developing particles are caused to come near a latent electrostatic image on an insulator, for instance, a photoconductive insulating layer, the developing particles having the same polarity as the latent electrostatic image, more adhesion occurs at an area of lower charge density than at a more highly charged area due to the electrostatic repulsive force, as is well known. In this developing method, however, the developing particles do not adhere by electrostatic attraction, but adhere by the strength of the surface electric potential. The adhesion does not correspond to the charge density forming a latent electrostatic image. Therefore, much adhesion appears adjacent to an area having a large difference of charge density and little adhesion at a uniformly low charge area. As an attempt to overcome such disadvantage, a developing method has been proposed which comprises applying to a developing electrode a DC voltage which is the same as the surface potential at a maximum charge density area of a latent electrostatic image and generating an electric field proportional to the difference of charge densities on a lower charged area between the developing electrode and insulator.

However, the surface potential of a latent electrostatic image on an insulator is dark attenuated with the passage of time. Since the characteristics of this dark attenuation are too complex to be determined by a time constant, and differ markedly with the kind of the insulator and ambient state, it is very difficult to change the voltage to be applied to a developing electrode in accordance with the dark attenuation.

It is the principal object of the invention to provide a process of developing a latent electrostatic image on an insulator while compensating the electric field of an electric field regulator corresponding to the developing electrode according to the dark attenuation, wherein the foregoing disadvantages are overcome.

BRIEF SUMMARY OF THE INVENTION

The feature of the invention consists in the steps of facing, across a fine clearance, an insulator having a latent electrostatic image and another insulator for electric field controlling, having the same polarity as said insulator, uniform charges and characteristics substantially similar to the dark attenuation characteristics of said insulator, under the developing condition, and feeding developing particles having the same polarity as that of said latent electrostatic image to the clearance, whereby to develop said latent electrostatic image.

BRIEF DESCRIPTION OF THE DRAWING

The invention is illustrated by the accompanying drawing in which FIG. 1 and FIG. 2 are schematic side views of apparatus suitable for carrying out the invention.

DETAILED DESCRIPTION OF THE INVENTION

Two sheets of electrophotographic light-sensitive paper of the same kind, having a photoconductive insulating layer, are bonded to conductive plates respectively and are charged uniformly under the same conditions. A latent electrostatic image is formed on one of these light-sensitive papers by the projection method. As shown in FIG. 1, conductive plate 2 carrying the latent electrostatic image-formed light-sensitive paper 1 and other conductive plate 4 carrying other light-sensitive paper 3 are arranged in such a manner that the photoconductive insulating layer surfaces on light-sensitive papers 1, 3 face through a very small, constant interval. A maximum charge density area of the latent electrostatic image on light-sensitive paper 1 agrees substantially with the uniform charge density of light-sensitive paper 3. At a lower charge density area of the latent electrostatic image on light-sensitive paper 1, there is formed an electric field proportional to the difference between its charge density and the maximum charge density in the developing space between light-sensitive papers 1, 3. Developing particles are spouted into this space from means 5 for charging and spouting developing particles. For example, developing particles spouted in the form of an aerosol from developing particle feed nozzle 6 are charged, in the same polarity as that of the charges forming the latent electrostatic image, by corona discharge of an annular high voltage electrode 8 to which a high voltage is applied by high voltage power source 7, and then are supplied or scattered in the developing space through nozzle 9. In the developing space, the developing particles adhere to a lower charge density area of the charges forming the latent electrostatic image on light-sensitive paper 1 by electrostatic attraction but do not adhere to a maximum charge density area of the latent electrostatic image.

At this time, conductive plate 4 and conductive plate 2 may be grounded, as shown in FIG. 1, or electrically insulated completely in some case. In particular, in the case of using a photoconductive layer provided by coating a mixture of a photoconductive powder and insulating resin onto a thin metal support member, both of the supports should be insulated electrically to give a better result.

In this embodiment, light-sensitive paper 3 having the same characteristics as light-sensitive paper 1 to be developed is used, after charging as an insulator for electric field regulating in place of a developing electrode to which an external voltage is applied, so their surface potentials are similarly attenuated irrespective of the atmosphere. Therefore, the surface potential of light-sensitive paper 3 and the potential of a maximum charge density area of the latent electrostatic image on light-sensitive paper 1 are always equal and the developing is thus completed in the best state. In the case of forming a latent electrostatic image on a uniformly charged, photoconductive insulating layer of light-sensitive paper 1 by image exposure, in general, a maximum charge density area of the latent electrostatic image is also somewhat illuminated. Consequently, the surface potential is lower than before the image exposure. This results in generation of an electric field between the photoconductive layer of light-sensitive paper 1 and that of light-sensitive paper 3 as an insulator for electric field regulating and in fogging throughout. In order to compensate for this and thus to prevent fogging, the photoconductive insulating layer of light-sensitive paper 3 for electric field regulating may uniformly be exposed somewhat.

Another embodiment of the invention will become apparent referring to FIG. 2. As in the first embodiment, electrophotographic light-sensitive paper 11 having a latent electrostatic image and uniformly charged light-sensitive paper 13 of the same kind are faced at a very small, constant interval. Both of said light-sensitive papers are carried by conductive, perforated suction plates 12, 14 mounted on casings 17, 18 and pressure-reduced by suction pump (not shown) via pipes 15, 16. Suction plates 12, 14 may be insulating or conducting, or both may be electrically connected. When the assembly in vessel 20 is immersed in liquid developer 21, for instance, a dispersion of charged developing particles in an insulating liquid such as kerosene, the developing particles in liquid developing agent 21 adhere to light-sensitive paper 11. The lower the charge density of light-sensitive paper 11, the more is adhered. The state of electric field in the developing space between light-sensitive papers 11, 13 is similar to that of FIG. 1 and the latent electrostatic image of light-sensitive paper 11. Dark attenuation of the surface potential of the photoconduc-

tive insulator in liquid developer 21 is larger than in the air, which is therefore suitable for the invention.

Although a latent electrostatic image is formed on a photoconductive insulator by the projection method in the foregoing two examples, not only photoconductive insulators but also mere insulators may be used as the insulator on which the latent electrostatic image is formed. As a method of forming a latent electrostatic image, it has been well-known to form a latent electrostatic image on a uniformly charged photoconductive insulator according to the quantity of irradiation, to utilize discharge, induction or polarization on an insulator, to transfer a latent electrostatic image formed on an insulator to another insulator by ionization of air, to charge directly an insulator by electron beam, etc. Our developing process is available for all latent electrostatic images formed by these methods.

It is not always necessary to use a photoconductive insulator as an insulator for electric field regulating, but any insulator may be employed so far as it has a dark attenuation character similar to an insulator on which a latent electrostatic image is formed. Since, if a photoconductive insulator used as an insulator for electric field regulating is repeatedly used, its characteristics fluctuate, it is preferred to make it exchangeable in the case of continuously carrying out developing. In the case of using a light-sensitive paper as a photoconductive insulator, for example, a long light-sensitive paper, held in a developing apparatus, is used in turn, the used part is subjected to dark adaptation to stabilize the characteristic and rolled up, in particular, after drying adequately when using a liquid developer, followed by reusing, after a constant time. When it is desired to use repeatedly the same insulator for electric field regulating, an insulator having no photoconductive properties is preferably used. In this case, of course, its dark attenuation characteristic must be made similar to that of an insulator to be developed by adjusting its insulating property suitably. When using a liquid developer, it is required to adjust to the dark attenuation characteristic in the liquid developer, of course. In order to adjust to the characteristic in a liquid developer in the case of using a photoconductive insulator consisting essentially of a photoconductive powder and insulating resin, for example, the same resin is used as a main component of the insulating material and the resistance is controlled with a suitable low resistance component and filler. It is thereby made easy to use the insulator repeatedly as an insulator for electric field regulating. Thus, a good development can be expected even if taking no notice of a small difference between the characteristics of an insulator having a latent electrostatic image and insulator for electric field regulating. If the dark attenuation characteristics of an insulator having a latent electrostatic image and insulator for electric field regulating are different but similar, the best developing can be carried out always by suitably varying the quantity of charge on one of the insulators.

In the process of the invention, a fog-free, complete development of a latent electrostatic image can be accomplished by the use of an insulator for electric field regulating, having the same action as the conventional developing electrode to which an external voltage is applied and capable of denying influences of the attenuation of a latent electrostatic image to be developed in place of such developing electrode. In particular, the use of an insulator for electric field regulating and an insulator having suitable characteristics results in marked advantages, such as, reducing the influence of temperature, humidity, etc.

What is claimed is:

1. A process of reversely developing a latent electrostatic image, which comprises facing across a small clearance a photoconductive insulator having a latent electrostatic image and another insulator for electric field regulating, said another insulator having (1) the same polarity as said photoconductive insulator, (2) uniform charges such as that the electric field emanating therefrom is substantially equal to or less than the electric field emanating from the area of maximum charge density of said latent electrostatic image and (3) dark attenuation characteristics substantially similar to the dark attenuation characteristics of said photoconductive insulator under the developing condition, and feeding developing particles having the same polarity as that of said latent electrostatic image to the clearance, whereby to reversely develop said latent electrostatic image.

2. A process as in claim 1 where said another insulator is photoconductive and including the step of uniformly exposing said another insulator to light so that said electric field emanating from the uniform charges of said another insulator is substantially equal to or less than said electric field emanating from the area of maximum charge density of said latent electrostatic image of said photoconductive insulator.

3. A process as in claim 1 including the step of first transferring said latent electrostatic image to a further insulator having dark attenuation characteristics substantially similar to those of said another insulator and then reversely developing said latent electrostatic image in accordance with the remaining steps of claim 1.

4. A process as in claim 1 where said another insulator is photoconductive.

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