

[54] ELECTROPHOTOGRAPHIC METHOD OF
IMAGEWISE PARTICLE TRANSFER
EMPLOYING ALTERNATING MODULATED
FIELD

[76] Inventor: Marcus Cantarano, No. 47, av. F.
Roosevelt, Bat. B. Thiais 94, France

[22] Filed: June 14, 1971

[21] Appl. No.: 152,962

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 715,313, March 22,
1968, abandoned, which is a continuation-in-part of
Ser. No. 613,792, April 18, 1967, abandoned.

[52] U.S. Cl. 96/1 R, 96/1.3, 96/1.4,
117/17.5 LE, 355/3

[51] Int. Cl. G03g 13/14, G03g 13/16

[58] Field of Search..... 96/1, 1.3, 1.4;
117/17.5 LE

[56]

References Cited

UNITED STATES PATENTS

2,901,348	8/1959	Dessauer et al.....	96/1 R
2,758,525	8/1956	Moncrieff-Yeates	96/1.3
2,758,524	8/1956	Sugarman, Jr.....	96/1.3
2,901,374	8/1959	Gundlach.....	96/1.4

Primary Examiner—George F. Lesmes

Assistant Examiner—M. B. Wittenberg

Attorney—John W. Malley et al.

[57]

ABSTRACT

A process and a device for electrophotographic repro-
duction using a photoconductive layer placed in
contact with a uniform layer of developer between
two electrodes. An alternatively modulated voltage is
applied to the electrodes.

14 Claims, 5 Drawing Figures

Fig. 1

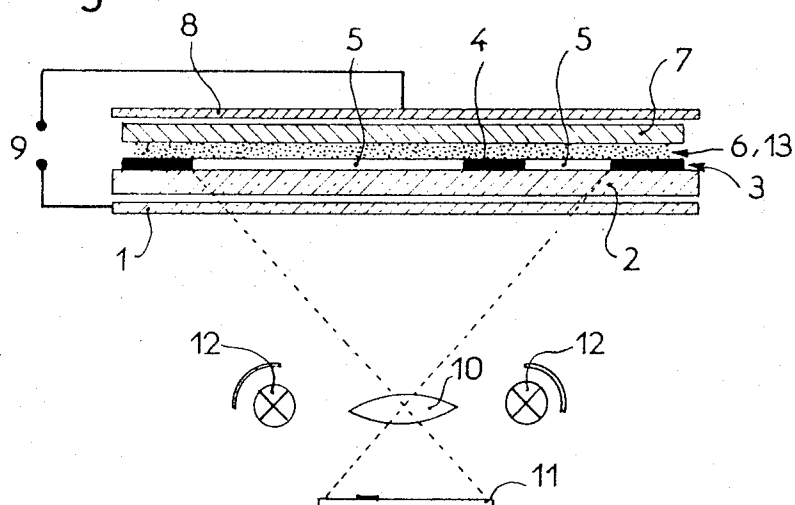
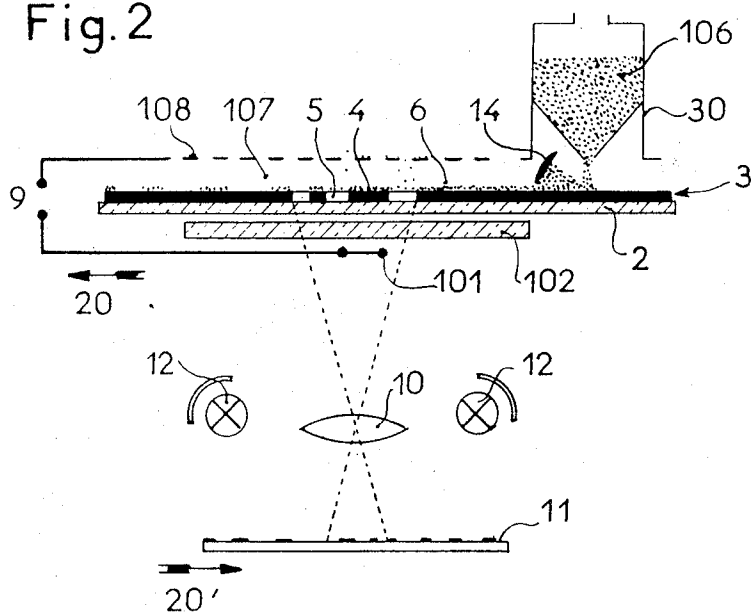


Fig. 2



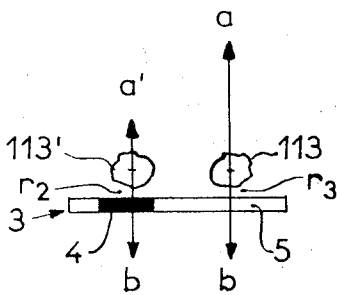


Fig. 3

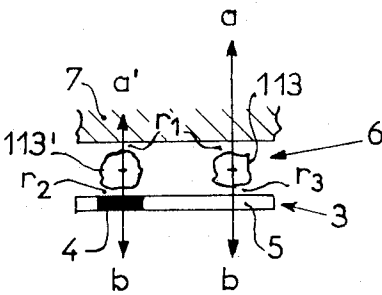


Fig. 4

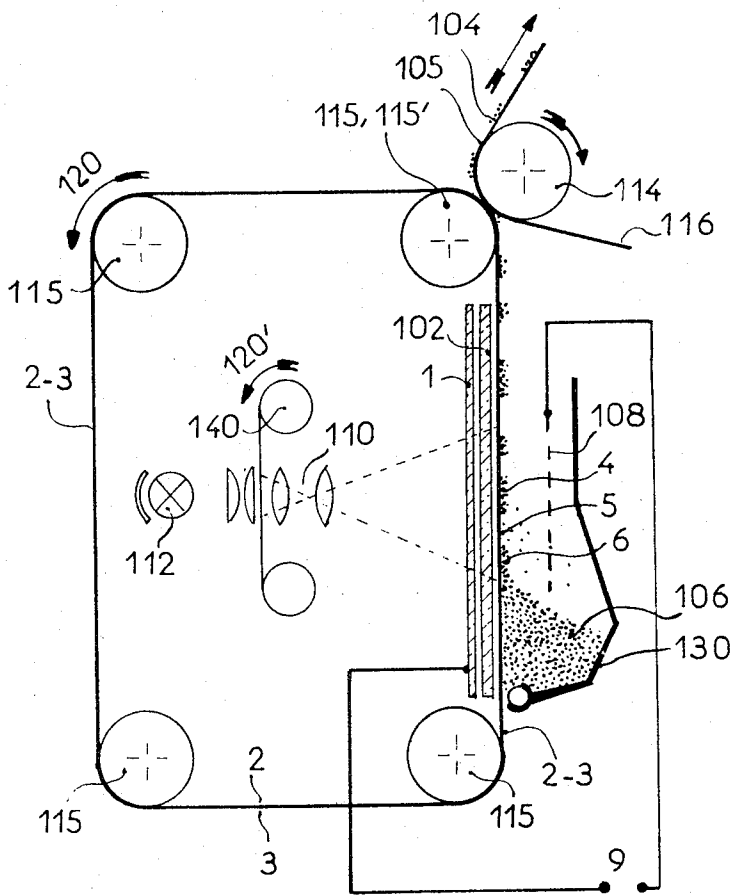


Fig. 5

ELECTROPHOTOGRAPHIC METHOD OF IMAGEWISE PARTICLE TRANSFER EMPLOYING ALTERNATING MODULATED FIELD

This application is a continuation-in-part of my application Ser. No. 715,313, filed Mar. 22, 1968 now abandoned which in turn is a continuation-in-part of my application Ser. No. 613,792, filed Apr. 18, 1967 now abandoned.

This invention relates to the production of electrographic images from a light image forming a conductivity pattern in a layer of a photoconductive material.

As used herein, the term "conductivity pattern" is to be understood as including any virtually plane surface formed by parts having different electric conductivities.

In accordance with prior art, the term "insulating" is to be understood as defining the quality of having an electric conductivity lower than 10^{-12} Siemens/cm and the term "non-insulating" as defining the quality of having an electric conductivity superior to 10^{-12} Siemens/cm.

In the actual art, a feature of electrographic methods resides in the use of an original provided with a conductivity pattern including high insulating parts which will selectively hold electric charges to form a latent electrostatic image; thus an electrographic image may be developed by an electrically responsive powder which adheres to the charges parts of the latent image. This electrographic image will not be obtained in a stable way because of the passage of electric charges even through the high insulating parts of the original, which would cause the effacement of at least a part of the latent image during the step of the development. A typical original of actual electrography consists in a photoconductive insulating layer provided with a conductivity pattern resulting from an exposure to a light image; such a photoconductive layer will be a high insulator in the dark in order to obtain a conductivity pattern including the non-illuminated high insulating parts serving to develop an electrographic image according to existing methods. These photoconductive insulating layers are slow in their response to successive different exposures to the light and, consequently, they may not be used to afford high speed processes to produce successive different electrographic images. Furthermore, these insulating layers having a very low sensitivity to the light, the enlarging of a document is still difficult to obtain in electrography.

I have found, however, that a stable electrographic image may be formed and simultaneously developed from any original provided with a pattern of conductive and low conductive parts in the absence of a latent electrostatic image; to this end an alternating electric field is generated to charge a thin layer of developer powder from the conductivity pattern of the original and thus to apply to this powder electric charges having different maximum values according to the different conductivities of said pattern. Under the influence of the electric field, the most charged particles are electrically removed from the layer of powder, while a stable electrographic image is developed by the remaining part of the powder which is never sufficiently charged to be removed. One of such form of electrographic method is disclosed in my co-pending application Ser. No. 631,792, filed Apr. 18, 1967, now abandoned. The present invention thus relates to the formation and the

simultaneous development of a stable electrographic image from an original consisting in a photoconductive layer forming a pattern of conductive and low conductive parts as a result of an exposure to a light image.

This application is a continuation-in-part of application Ser. No. 631,792, filed Apr. 18, 1967 now abandoned.

Now in accordance with the present invention, it has been found that a stable electrographic image may be produced from a light image forming a pattern of conductive and low conductive parts in a layer of photoconductive material. In the preferred form of the invention a photoconductive layer is used which is highly conductive when exposed to the light, the dark conductivity of this layer being not critical to obtain a stable electrographic image of satisfactory quality according to the invention. Such a photoconductive layer can be called photoconductive non-insulating layer to distinguish it from the photoconductive insulating layers taught by Carlson in the U.S. Pat. No. 2,297,691. The non-insulating layers of the type of the well known photoconductive layers used in the photoelectric cells, offer the advantage of having a virtually instantaneous response and a high sensitivity to the light and thus they are well adapted for the high speed production of stable images and for the electrographic enlarging of documents.

According to one embodiment of the present invention, a thin photoconductive layer is affixed to an insulating material, the photoconductive layer is exposed to a light image forming a conductivity pattern in this layer, and an alternating electric field is generated to charge a thin layer of developer powder from said conductivity pattern and thus to apply to the powder electric charges having different maximum values according to the different conductivities of said pattern. Under the influence of the alternating field, the charged powder is electrically attracted away from the most conductive parts of said pattern, while the remaining powder is never sufficiently charged to be removed from the least conductive parts of said pattern and it develops a stable electrographic image thereon. The satisfactory quality of the obtained image is irrespective of a critical duration of the electric field. This method is well adapted to exactly reproduce the dense large areas and the half-shadow areas of the light image.

According to another embodiment of this invention, the photoconductive layer is affixed to an insulating backing material and it is coated with a thin layer of developer powder, an insulating layer is placed against the layer of powder, and an electric field is generated to charge the powder from the conductivity pattern of the photoconductive layer; because of the insulation of the coated photoconductive layer between the insulating backing and the insulating layer, the coating powder will receive electric charges having maximum values in proportion to the conductivities of said pattern. Accordingly, the charged powder is electrically attracted away from the most conductive parts of said pattern while the remaining part of the coating powder is never sufficiently charged to be removed from the least conductive parts of said pattern and it develops a stable electrographic image thereon. By using a photoconductive non-insulating layer exposed to a contrastful light image, this method is well adapted for the high speed production of stable electrographic images. In addition, by generating an alternating or an alterna-

tively modulated electric field this method is well adapted to produce stable electrographic images from a photoconductive layer exposed to a low contrastful light image. Accordingly, under the action of the modulated field particles of powder receive electric charges of successive opposite polarities and they are attracted away from the most conductive parts of said pattern. Because of the opposite charges of the powder particles, the removal of the powder may be prosecuted to electrically remove all of the powder coating the most conductive parts of said pattern while the remaining part of the coating powder is never sufficiently charged to be removed from the least conductive parts of the layer and thus it forms a stable electrographic image thereon.

According to a further embodiment of the invention, the thin layer of developer powder is placed against and sandwiched between a photoconductive layer and an image carrier having a uniform electric conductivity between a photoconductive layer and an image carrier having a uniform electric conductivity between the maximum and the minimum conductivities of the pattern in the photoconductive layer, and an electric field is generated to charge the powder from said conductivity pattern and said image carrier. Because of the intermediate conductivity of the image carrier, under the influence of the electric field the particles of powder are electrically charged under the sign of that surface in contact which is the lesser conductive and they are attracted away from the most conductive parts of said pattern to form a first stable electrographic image on said image carrier, while another part of the powder is electrically attracted towards the least conductive parts of said pattern to form a second stable electrographic image thereon. The best quality of the images is obtained by generating an alternating or an alternatively modulated electric field. This method is well adapted to the high speed development of two simultaneous stable electrographic images from the same light image.

An object of this invention is to improve electrographic methods and to provide means and devices for use in electrography.

Other objects of this invention will be apparent from the following description and accompanying drawings taken in connection with the appended claims.

In the drawings:

FIG. 1 is a schematic side elevation view of a first embodiment for the carrying out of the invention;

FIG. 2 is a schematic side elevation view of a second embodiment;

FIG. 3 is a diagram of the forces acting on the powder grains coating the photoconductive layer;

FIG. 4 is a second diagram of the forces acting on the powder grains placed against the photoconductive layer and the image carrier;

FIG. 5 is a diagrammatic side elevation view of a mechanical device according to the FIG. 2 embodiment.

In the preferred form of this invention a layer of a photoconductive non-insulating material is used which has a high sensitivity and a virtually instantaneous response to the light. Alternatively, many photoconductive non-insulating materials may be used such as, for example, metallic selenium, thallium sulfide, cadmium sulfide, cadmium selenide, lead sulfide as well as in general all the materials which are used in the well known photoresistive cells. Layers having a high sensitivity to the visible part of the spectrum may be used to

reduce the loss of light transmitted across the lens, mirrors etc serving to form the optical image to be reproduced. Cadmium selenide and sulfide layers are well adapted for the high speed production of copies from successive different light images because of the virtual instantaneous response of these layers to the light and to the dark.

In the arrangement of FIG. 1, a transparent electrode 1 is disposed beneath a transparent backing material 2 to which is applied a photoconductive layer 3. A light image comprising illuminated parts 5 and low illuminated parts 4 is formed on the layer 3. Owing to the differences of light intensity between the parts 4 and 5, the photoconductive layer is provided with a conductivity pattern including conductive parts 5 and low conductive parts 4, respectively. It will be appreciated however that between the maximum and the minimum conductivities in the layer, any intermediate electrical conductivity may be found in the photoconductive layer accordingly to the half-shadows of the light image to reproduce. In order to form the light image, for example, an objective 10 is located in front of the transparent electrode 1, and beneath the objective 10, the document 11 to be reproduced. Light sources 12 illuminate the document 11 that reflects the light toward the objective 10 which projects it across the electrode 1 and the transparent backing 2 on the photoconductive layer 3 over which the optical image to be reproduced is formed. Document 11 may be a sheet of paper carrying printed or typewritten matter, or a photograph, for example, although other things may be photographed such as three-dimensional objects, for example. Alternatively, other radiations than light may be used to form the pattern 4, 5 such as, for example, X- or gamma-rays; furthermore, any other means inducing in the layer 3 a pattern of conductive parts 5 and low conductive parts 4 may be used to produce electrographic images according to the present invention. If a visible light image is formed on layer 3, electrode 1 may consist, for example, in a thin uniform layer of "Nesa," a high conductive transparent varnish sold by Pittsburgh Plate Glass Co, Pittsburgh. The layer of "Nesa" may be affixed to a support of glass, for example. Moreover and for example, a sheet of aluminium may constitute the transparent electrode 1 when a X-rays image is formed on layer 3. As shown in FIG. 1, a thin uniform layer of developer powder 6 is disposed between layer 3 and an image carrier 7. The powder 6 may be applied to coat layer 3 or image carrier 7 or both, alternatively, for the uniform application of the powder, classic spraying or cascading devices may be used, provided that a thin uniform layer of powder 6 is formed rather than a particular amount of grains. In order to develop electrographic images, an electric field is generated between the electrode 1 and a second electrode 8 by applying an electric voltage to terminals 9. Electrode 8 may be placed in contact with the image carrier 7 or, alternatively, an insulating layer (not shown) may be inserted between them. Under the influence of an electric field, the layer of powder 6 is electrically distributed between the conductivity pattern 4, 5 and the image carrier 4. When subsequently, electrodes 1 and 8 are separated and the image carrier 7 is detached from layer 3, a part of powder 6 will be found forming a first electrographic image on the image carrier 7, while the remaining part of the powder forms a second electrographic image on layer 3, the two electrographic

images being obtained in substantial configuration with the optic image 4, 5.

According to one embodiment of the present invention an image carrier 7 is used which has a uniform electric conductivity between the maximum and the minimum conductivities of the pattern 4, 5 of layer 3. A sheet of a conductive paper may be used as image carrier 7. Moreover, the image carrier 7 may also consist in a thin uniform metallic layer on a sheet of insulating material, as, for example, a sheet of mylar. Referring to this embodiment of the invention, FIG. 4 schematically shows two grains 113 and 113' of layer of powder 6, a part of layer 3 and a part of the image carrier 7 having said intermediate conductivity between the conductivities of the parts 4 and 5 of layer 3. Depending on the relative conductivities of the parts 4, 5 and 7, the contact conductance r_3 between grains 113 and the illuminated part 5 of layer 3 is higher than the contact conductance r_1 between grain 113 and image carrier 7; the contact conductance r_1 between grain 113' and image carrier 7 is higher than the contact conductance r_2 between grain 113' and the low illuminated parts 4 of layer 3. Under the influence of the electric field generated between electrodes 1 and 8, each grain of powder 6 is electrically charged under the sign of that surface to which the contact conductance is the more, and thus it will be electrically attracted away from this surface. For this reason, irrespectively of the direction of the electric field, the powder 113 will electrically migrate from the illuminate conductive part 5 towards the image carrier 7, while powder 113' migrates from image carrier 7 towards the low illuminated low conductive part 4. The electrographic image thus formed by powder 6 on the parts 4 of layer 3 will be termed positive upright image, and negative reversed image is called the electrographic image formed on the image carrier 7 by the powder facing the parts 5 of layer 3.

From the foregoing explanations it becomes apparent that, by using an image carrier 7 having said intermediate conductivity, the development of the electrographic images is irrespectively of the minimum conductivity of layer 3; thus, according to the invention, a photoconductive non-insulating layer having a relatively high dark conductivity may be used.

Satisfactory continuous tone electrographic images may be produced by applying an alternating or of an alternatively modulated electric voltage to terminals 9, for example, from 1 to 10 KV. In order to develop electrographic images from the pattern of a photoconductive non-insulating layer, an electric voltage ionizing the gap of air 13 interposed between image carrier 7 and layer 3 may be advantageously applied to terminals 9. To this end also a direct electric field may be generated which is modulated by an alternating signal to produce copies. On the other hand, it will be appreciated that the best quality of continuous tone electrographic images is obtained by using a layer 3 which has a photoelectric linear character as for example a cadmium sulfide layer.

In the arrangement shown in FIG. 2, a powder-coated photoconductive layer 3 provided with a pattern of illuminated conductive parts 5 and low illuminated low conductive parts 4 is disposed under an electrode 108 in the form of a grid. The coating powder 6 is insulated from the grid 108 by a fluid dielectric consisting, for example, of an air layer 107. For example, the grid 108

may be made of brass and have a mesh width of about 0.5 mm; the spacing between the grid 108 and layer 3 may be from 0.5 to 5 mm, for example. A voltage generator (not shown) may be connected to terminals 9 to create an electric field between the grid-electrode 108 and a second electrode 101. The thin layer of powder 6 is applied loosely-adhering to the layer 3. According with the experience, the adherence of the powder may be improved by providing an electrode 101 in the form of parallel wires so that the lines of force of the electric field strongly converge toward the electrode 101.

By generating an electric field between electrodes 101 and 108, the powder is electrically charged and removed from the conductive parts 5, while the powder coating the low conductive parts 4 is never sufficiently charged to electrically overcome its adherence to layer 3 and thus it develops a stable electrographic image thereon. The grains of powder which are electrically attracted away from the parts 5 of the layer 3 will pass through the fluid layer 107 and the grid-electrode 108. The intensity of the electric field cannot exceed 3.3v/micron in the layer of air 107 to avoid a sudden electric discharge between electrode 108 and coating powder 6, which would reduce the electric field serving to the development of the image. Instead of this, the quality of the electrographic images is improved by generating between electrodes 101 and 108 an electric field having, in the air layer 107, a gradient between 2.5 and 3.1 v/micron to obtain a silent ionizing discharge in the air 107 simultaneously with the development of the electrographic image; in this manner powder 6 will be electrically charged from the slight conductive air 107 to adhere to the low conductive parts 4, while the electric field remains sufficiently intense, in the air 107, to electrically charge and remove the coating powder from the conductive parts 5. When a layer 3 affixed to an insulating backing 2 is used a direct electric field may be generated between electrodes 101 and 108.

Devices of FIGS. 1 and 2 serve to electrically photograph a document 11 as well as three-dimensional objects, for example. Furthermore and for example, as shown in FIG. 2, the layer 3 may move in the direction of arrow 20 in the device simultaneously with document 11 in the direction indicated by the arrow, the latter having a synchronous parallel movement beneath objective 10. During the movement of document 11 and of layer 3, the powder 106 drops from a container 30 on the layer 3 and it is uniformly distributed in a thin uniform layer 6 coating the photoconductive layer 3. As shown in FIG. 2, the photoconductive layer 3 may be affixed to a backing sheet 2 separated from the insulating layer 102. Document 11, illuminated by light sources 12, moves in the direction indicated by the arrow whereas the photoconductive layer 3 and its support 2 moves in opposite direction with a synchronous movement capable of immobilizing, in relation to the photoconductive layer, the optic image formed on the latter. An electric field is created between electrodes 101 and 108 and thus the powder 6 is drawn by electrode 108 from the illuminated zones 5 of the photoconductive layer whereas it remains on the layer 3 over the dark zones 4 of the projected image.

According to one embodiment using the device illustrated in FIG. 2, an alternating voltage is applied to terminals. The powder 6 thus receives from the pattern 4, 5 alternating electric charges having different maximum values in proportion to the conductivities of said

pattern and the most charged powder is electrically attracted through the grid-electrode 108. Referring to this method, FIG. 3 schematically shows two grains 113, 113' of the powder 6 coating the photoconductive layer 3; by the letter *b* is indicated the equal force which retains the grains 113, 113' on layer 3, this force *b* may be due to the gravity, for instance. Because of the different illuminations of the parts 5 and 4 of layer 3, the contact conductance r_3 between grains 113 and the illuminated part 5 is higher than the contact conductance r_2 between grain 113' and the low illuminated part 5 of layer 3. By generating an alternating electric field between electrodes 101 and 108 (FIG. 2), grains 113 and 113' receive from layer 3 alternating charges having different maximum values according to the different contact conductances r_3 and r_2 ; under the action of the field the charged grains 113, 113' are attracted away from layer 3 by modulated electric forces having maximum values *a* and *a'* in substantial proportion to the contact conductance r_3 and r_2 , respectively; the amplitude of the alternating voltage is then adjusted to apply to grain 113 the force *a* more intense than its adherence *b* to layer 3 while, because of the alternating character of the charges, the electric force *a'* applied to grain 113' is never sufficiently intense to overcome the adherence of this grain 113' to the low illuminated part 4 of layer 3.

The electrographic image being obtained in a stable way, its good quality is irrespective of a critical duration of the electric field.

According to a further embodiment using the device of FIG. 2, a photoconductive layer 3 is used which is affixed to an insulating backing 2. By applying an alternatively modulated voltage to terminals 9, the coating powder 6 receives from the pattern 4, 5 alternating electric charges having maximum values in proportion to the conductivities of said pattern 4, 5; the amplitude of the alternating modulation of the electric voltage is adjusted to electrically attract powder 6 away from the illuminated parts 5 while the remaining powder develops a stable electrographic image on the low illuminated parts 4. Because of the insulation of the pattern 4, 5 from electrode 101, electric currents filtering through the low conductive parts 4 are avoided and thus a low frequency of the field is not critical in order to produce stable images from a photoconductive non-insulating layer 3. This frequency may be as low as 50 Hz, for example. The amplitude of the modulated field is then adjusted to attract particles of powder having successive opposite polarities away from the most illuminated parts 5 of the layer, while the powder coating the least illuminated parts 4 is never sufficiently charged to be removed; because of the opposite charges of these grains, the removal of the powder may be prosecuted to electrically remove all the powder coating the most illuminated parts 5 of the layer 3 while the remaining part of the coating powder forms a stable electrographic image of high density. This method is well adapted to produce satisfactory electrographic images from a photoconductive layer 3 having low differences in conductivity between its parts 4 and 5. On the other hand, a direct voltage may be applied to terminals 9 to produce stable images from a photoconductive non-insulating layer 3 having high differences in conductivity.

For carrying out the invention as described with reference to FIGS. 2 and 3, an apparatus of the type illus-

trated in FIG. 5 may be used. This apparatus comprises four rollers 115 over which an endless belt 2-3 travels in the direction of arrow 120. This endless belt is constituted by a transparent and flexible support 2 on to which is affixed a photoconductive layer 3. A transparent dielectric plate 102 is made of glass, for example, and it serves to guide the belt 2-3. The transparent electrode 1 and the grid-electrode 108 are connected to the terminals 9 of a voltage generator. A microfilm projector comprises a light source 112, an objective 110 and a film unroller 140 of which the unrolling direction is reversed that the endless belt 2-3, as indicated by arrows 120' and 120, respectively. In operation, the photoconductive layer 3 is affixed to its flexible transparent support 2 is driven by rollers 115 at a constant speed in synchronism with the movement of the projector film 111. The light source 112 being lighted, the image is projected on layer 3 through the transparent electrode 1 and the glass plate 102. Belt 2-3 moving in the direction of arrow 120, the developer powder 106 of the container 130 uniformly coats the photoconductive layer 3 and the thin uniform layer of powder 6 is driven by the upward movement of the latter in the electric field generated between electrodes 1 and 108. In order to insure the adherence of powder 6 to the layer 3, a slight adhesive powder may be used, as for example, a powder 106 the grains of which are coated with zinc stearate. Under the action of the electric field, the powder coating illuminated parts 5 of layer 3 is electrically attracted through the grid-electrode 108 and falls again in the container 130, while the powder coating low illuminated parts 4 forms a stable electrographic image thereon. Thereafter, the powder image 104-105 is transferred on to the layer 3 by rollers 114 and 115'. Web 116 may be a web of copy paper. If an excited photoconductive layer 3 is used which is provided with a pattern 4, 5 having low differences in conductivity, an alternatively modulated voltage is applied to terminals 9.

In the device of FIG. 1 it will be advantageous to use a developer powder having an electric conductivity between the maximum and the minimum conductivities of the parts forming the pattern 4, 5 of layer 3. Furthermore, in the device of FIGS. 2 and 5, it will be expedient the use of a developer powder having an electric conductivity about equal to that of the least conductive parts of the pattern 4, 5. Although the exact conductivity of the powder is not critical in order to obtain electrographic images of satisfactory quality.

In carrying out this invention a developer powder of charcoal has been found useful; alternatively, other developer powders, such as metallic or thermoplastic powders may be used. By way of example, a suitable developer powder can be produced by oxidizing at a temperature of about 700° C a commercial bronze to obtain a black powder containing copper bixide as well as other metallic oxides; the powder is then passed through sieves to reduce the grains size between 2 and 25 microns. The resulting powder can advantageously be coated with stearic acid or zinc stearate or aluminium stearate, alternatively; such a treatment will render the powder somewhat adhesive and give to its grains a very thin insulating coat which prevents electric discharges between contiguous parts of the layer of powder 6 during the application of the electric field. Furthermore, after the formation of the images in the device of FIG. 1, the grains of powder 6 conserve intense

residual electric charges because of their thin insulating coat and thus the obtained electrographic images will electrically adhere to the non-insulating parts of layer 3 and to the uniformly conductive image carrier 4.

The conductivity of copper bixide powder is generally between about 10^{-7} and 10^{-5} Siemens/cm. It is moreover possible to use a commercial bronze coloured powder; such powder has a conductivity from 10^{-5} to 10^{-4} Siemens/cm.

Other types of developers, such as thermoplastic powders may be used as, for example, powders of polystyrene resins; these plastics materials may be rendered conductive by mixing them with pure carbone, as it is well known in the art. Furthermore, an insulating thermoplastic powder may be made conductive by coating its grains with a thin metallic layer, for example.

While the method herein described and the apparatus used for carrying out this method into effect constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to this precise method and apparatus, and changes may be made in either without departing from the scope of the invention which is defined in the appended claims.

What I claim is:

1. A method for producing an electrographic image comprising the steps of placing a layer of electrically chargeable particles against a photoconductive layer, exposing said photoconductive layer to a pattern of radiation to form a conductivity pattern in said photoconductive layer, generating across said layer of electrically chargeable particle and said photoconductive layer an alternatively modulated electric field thereby transferring alternating electric charges from said conductivity pattern to said layer of electrically chargeable particles whereby said layer of particles receives a pattern of greater and lesser alternating charges, said greater alternating charges removing a part of said particles while said lesser alternating charges maintain the remaining particles in said layer of particles thereby developing a stable electrographic image.

2. The method of claim 1 wherein said photoconductive layer is located between an insulating backing and said layer of electrically chargeable particles and said alternatively modulated electric field is generated across said layer of electrically chargeable particles, said photoconductive layer and said insulating backing.

3. The method of claim 1 wherein said layer of electrically chargeable particles is located between said photoconductive layer and an insulating layer, and said alternatively modulated electric field is generated across said insulating layer, said layer of electrically chargeable particles and said photoconductive layer.

4. The method of claim 3 wherein said insulating layer is formed from a fluid layer interposed between said photoconductive layer and a grid-shaped electrode, and said alternatively modulated electric field is generated between said photoconductive layer and said grid-electrode, whereby said removed part of the particles is definitively attracted across said fluid and said grid-electrode away from said electric field.

5. The method of claim 1 wherein said layer of electrically chargeable particles is located between said photoconductive layer and an image carrier whereby a second stable electrographic image is developed on said image carrier by said removed part of said particles.

6. A method for producing an electrographic image comprising the steps of placing a layer of electrically chargeable particles against a photoconductive layer, exposing said photoconductive layer to a pattern of radiation to form in said photoconductive layer a conductivity pattern including maximum and minimum electric conductivities, sandwiching said layer of electrically chargeable particles between said photoconductive layer and an image carrier having a uniform electric conductivity between the maximum and minimum conductivities which are included in said conductivity pattern, generating across said image carrier, said layer of electrically chargeable particles and said photoconductive layer an alternatively modulated electric field charging said layer of electrically chargeable particles from said conductivity pattern and said image carrier simultaneously, said layer of electrically chargeable particles thereby receiving electric charges attracting a part of said particles away from said image carrier to develop a first stable electrographic image on said photoconductive layer and opposite electric charges attracting the remaining particles away from said photoconductive layer to develop a second stable electrographic image on said image carrier.

7. The method of claim 6 wherein said photoconductive layer is located between an insulating backing and said layer of electrically chargeable particles and said electric field is generated across said image carrier, said layer of electrically chargeable particles, said photoconductive layer and said insulating backing.

8. The method of claim 6 wherein said image carrier is located between said layer of electrically chargeable particles and an insulating layer, and said electric field is generated across said insulating layer, said image carrier, said layer of electrically chargeable particles and said photoconductive layer.

9. The method of claim 6 wherein the sandwich, formed by said layer of electrically chargeable particles disposed between said photoconductive layer and said image carrier, is located between two insulating layers, and said electric field is generated across said two insulating layers, said image carrier, said layer of electrically chargeable particles and said photoconductive layer.

10. A method for producing an electrographic image comprising the steps of coating a conductive image carrier with a layer of loosely-adhering electrically chargeable particles, placing said coated image carrier against a photoconductive layer so that said layer of electrically chargeable particles is sandwiched between said photoconductive layer and said conductive image carrier, exposing said photoconductive layer to a pattern of radiation to form a conductivity pattern in said photoconductive layer, generating across said conductive image carrier, said layer of electrically chargeable particles and said photoconductive layer an alternatively modulated electric field so as to charge said layer of electrically chargeable particles from said photoconductive layer and said conductive image carrier simultaneously, said layer of electrically chargeable particles thereby receiving a pattern of greater and lesser alternating charges, said greater alternating charges attracting a part of said particles away from said image carrier to develop a first stable electrographic image on said photoconductive layer while said lesser alternating charges maintain the remaining particles on said image

11

carrier thereby developing thereon second stable electrographic image.

11. The method of claim 10 wherein said photoconductive layer is located between said layer of electrically chargeable particles and an insulating backing, and said alternatively modulated electric field is generated across said conductive image carrier, said layer of electrically chargeable particles, said photoconductive layer and said insulating backing.

12. The method of claim 10, wherein said conductive image carrier is located between said layer of electrically chargeable particles and an insulating layer, and said alternatively modulated electric field is generated across said insulating layer, said conductive image carrier, said layer of electrically chargeable particles and said photoconductive layer.

13. The method of claim 10, wherein the sandwich, formed by said layer of electrically chargeable particles disposed between said image carrier and said photoconductive layer, is located between two insulating layers, and said alternatively modulated electric field is generated across said two insulating layers, said image carrier, said layer of electrically chargeable particles

12

and said photoconductive layer.

14. A method for producing an electrographic image comprising the steps of affixing a photoconductive layer on an insulating backing material, coating said photoconductive layer with a layer of electrically chargeable particles, disposing said layer of electrically chargeable particles between said photoconductive layer and an insulating layer, exposing said photoconductive layer to a pattern of radiation to form a conductivity pattern in said photoconductive layer, generating across said insulating layer, said layer of electrically chargeable particles, said photoconductive layer and said insulating backing material an alternatively modulated electric field thereby transferring alternating electric charges from said conductivity pattern to said layer of electrically chargeable particles whereby said layer of particles receives a pattern of greater and lesser alternating charges, said greater alternating charges removing a part of said particles while said lesser alternating charges maintain the remaining particles in said layer of particles thereby developing a stable electrographic image.

* * * * *

25

30

35

40

45

50

55

60

65