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NON-ELECTROSTATIC METHOD FOR PRODUCING ELECTROGRAPHIC IMAGE

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ABSTRACT OF THE DISCLOSURE

A method for producing an electrographic image from an original provided with a conductivity pattern ranging from a portion having a greater conductivity to a portion having a lesser conductivity, comprising the steps of placing a thin layer of electrically chargeable particles in electrical contact with said conductivity pattern, disposing said original and said layer of electrically chargeable particles between a first and second electrode so that said original is interposed between said layer of electrically chargeable particles and said second electrode and generating an alternating electric field between said first and second electrodes of sufficient strength so as to charge said electrically chargeable particles whereby said particles receive electric charges having different maximum values according to the different conductivities of said portions of said conductivity pattern whereby the said electrically charged particles are attracted toward and away from said original whereby a portion of said electrically charged particles are removed and the remainder of said particles form an electrographic image on said original.

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

This invention relates to the production of electrographic images from an original provided with a conductivity pattern.

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^{-11} mho/cm. and the term "non-insulating" as defining the quality of having an electric conductivity superior to 10^{-11} mho/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 charged 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 causing 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 the optic image of a document to reproduce; 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

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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. Now in accordance with the present invention, it has been found 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.

In its simplest form, the present invention pertains to the production of electrographic images from a thin uniform layer of developer powder placed in contact with the conductivity pattern of an original. An electric field is generated across the powder layer to electrically charge the powder from the conductivity pattern of the original. According to this invention the different parts of the layer of powder receive from said pattern electric charges having different maximum values in accordance with the different conductivities of said conductivity pattern. Consequently, the most charged powder is electrically removed by the electric field while the remaining powder never holds sufficient maximum charges to be removed and thus it develops a stable electrographic image.

According to one embodiment of the present invention, a stable electrographic image is produced by generating an alternating electric field charging a thin layer of developer powder from the conductivity pattern of the original and thus applying 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 attracted away from the layer of powder while the remaining powder is never sufficiently charged to be electrically removed. This remaining part of the powder develops a stable electrographic image in substantial configuration with the conductivity pattern of the original and the satisfactory quality of the obtained image is irrespective of the duration of its development. This method is well adapted to produce the dense large areas as well as the half-shadow areas of the electrographic image.

According to another embodiment of the invention, the thin layer of developer powder is placed against and interposed between the conductivity pattern of the original and an image carrier having an electric conductivity between the maximum and the minimum conductivities of said pattern, 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 powder is electrically charged and 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. This method is well adapted to simultaneously produce two stable electrographic images from any kind of original provided with a pattern of conductive and low conductive parts.

According to a further embodiment of this invention, an original is used which is provided with a pattern of conductive and low conductive parts on an insulating backing material, the conductivity pattern of the original 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 said conductivity pattern and thus to apply to this powder electric charges having values in proportion to the conductivities of said pattern. Under the influence of the electric field, the charged powder is electrically attracted away from the most conductive parts of said pattern,

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while, because of the insulation of the coated conductivity pattern between the insulating backing and the insulating layer, the remaining powder is never sufficiently charged to be removed and thus it develops a stable electrographic image on the least conductive parts of said pattern.

According to a further embodiment of this invention, an original is used which is provided with a conductivity pattern on an insulating backing, a metallic image carrier is coated with a thin layer of developer powder, the conductivity pattern of the original is placed against the coating powder and a variable electric field is generated to charge the layer of powder from said conductivity pattern and said image carrier. By using an insulating electrostatically chargeable developer powder, the latter is electrically attracted towards the most conductive parts of said pattern to form a first stable electrographic image thereon, while another part of the powder is attracted away from the least conductive parts of said pattern to form a second stable electrographic image on said image carrier. On the contrary, by using a non-insulating developer powder, a stable electrographic image facing the most conductive parts of said pattern is formed on said image carrier, while a second electrographic image is formed on the least conductive parts of said pattern. Furthermore, according to this embodiment of the invention using a non-insulating developer, a sheet of copy material is placed against the electrographic image of non-insulating powder carried by said image carrier, and an electric field is generated charging the powder and thus electrically transferring the electrographic image from the metallic image carrier on to the sheet of copy material.

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

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

Several embodiments of the invention will now be described by way of example and with reference to the accompanying drawing, in which;

FIG. 1 is a sectional view showing an original and a sheet serving as an image carrier, arranged between two electrodes;

FIG. 2 is a schematic representation of the electric charges between the original and the image carrier;

FIG. 3 is another schematic representation of the electric charges between the original and the image carrier;

FIG. 4 is a schematic representation of the arrangement of an original between a grid-shaped first electrode and a second electrode;

FIG. 5 is a schematic representation of a device with a drum-shaped electrode; and

FIG. 6 is a schematic representation of another embodiment of the device according to the invention.

In the arrangement shown in FIGS. 1 to 3, for producing an electrographic image an original, provided with indicia 2 having an electric conductivity other than the surface 3 of the backing material 1, is disposed between two electrodes 6 and 7. Owing to the differences of electric conductivity between the materials of the parts 1 and 2 of the original, the latter is provided with a conductivity pattern formed by the areas 2 of the indicia and by the blank surface 3 of the backing 1. Also arranged between the electrodes 6 and 7 is an image carrier 4 placed against a thin uniform layer of developer powder 5 facing the conductivity pattern 2, 3 of the original. Alternatively, the developer powder 5 may be applied to the conductivity pattern 2, 3 or to the image carrier 4; such coating of the powder onto either the image carrier 4 or the original can be accomplished in the well known manner by the use of rotating brushes by spraying or cascading the powder. A dielectric 8 may be disposed between the electrodes 6 and 7 to avoid a useless consumption of heating electric

current passing through the device. In the arrangement shown in FIG. 1, the electrodes 6 and 7 are provided with terminals 9 and 10, respectively, and the dielectric 8, which is disposed between the original and the electrode 7, may consist of a sheet of Mylar (registered trade mark) of a thickness of about 150 microns; furthermore, a second similar dielectric sheet may be arranged between the image carrier 4 and the electrode 6. Indicia 2 may be of different types such as typewriting or pencil traces. On the other hand, if continuous tone electrographic images are to be produced, any original may be used which is provided with a conductivity pattern comprising differently conductive indicia 2 forming dense areas and half-shadow areas, as like a photographic print.

Since it is not important as far as this invention is concerned just how the conductivity pattern of the original is formed, but instead it is important as regards this invention that the layer of powder is placed in electric contact with the conductivity pattern to reproduce.

An electric high voltage is applied to the terminals 9 and 10 to generate an electric field between the electrodes 6 and 7. For example, a direct voltage of 25 kv. may be applied to the terminals for a period of a few milliseconds. However, it is more advantageous to generate an alternating voltage, for example, of 50 Hz. and 5 kv. Instead of this, an attenuated or an alternatively modulated voltage may be applied to terminals 9 and 10. Under the influence of the electric field, the powder 5 receives electric charges having different maximum values according to the different conductivities of the pattern 2, 3 and thus the grains of powder 5, according to the different maximum values of their charges, are differently attracted towards the original and towards the image carrier 4. When, subsequently, the electrodes 6 and 7 are separated and the image carrier 4 is detached from the original, a part of the layer of powder 5 will be found forming an electrographic image on the image carrier 4, while the remaining part of the powder forms another electrographic image on the original; according to the experience, the two electrographic images are obtained in substantial configuration with the indicia 2 and the blank surface 3 of the original.

According to one embodiment of this invention, an image carrier 4 is used which has an electric conductivity between the maximum and the minimum conductivities of the pattern 2, 3 or the original; for example, a sheet of conductive paper having this intermediate uniform conductivity may be used as image carrier 4; moreover, the image carrier 4 may also consist in a thin uniform metallic layer deposited on a sheet of insulating material. Referring to this embodiment of the invention, FIG. 2 schematically shows two grains 5' and 5'' of the layer of powder 5, a part of the original provided with a conductive backing 1 and low conductive indicia 2, and a part of the image carrier 4 having said conductivity between the conductivities of the indicia 2 and of the backing 1 of the original. It will be appreciated however that the powder is in the form of a layer and that numerous particles will form the thickness of the layer of powder 5. Depending on the relative conductivities of the parts 2, 3 and 4, the contact conductance between the grains 5', 3 and 4, the contact conductance between the grains 5'' and the image carrier 4 is higher than the contact conductance between the grains 5' and the indicia 2. Under the influence of the electric field each grain of powder 5 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 5'' will electrically migrate from the conductive surface 3 towards the image carrier 4 while the powder 5' migrates from the image carrier 4 towards the low conductive indicia 2, as shown by the arrows in FIG. 2. The electrographic image thus formed

by the powder 5' on the indicia 2 will be termed positive upright image, and negative reversed image is called the electrographic image formed on the image carrier 4 by the powder facing the blank surface 3 of the original. On the other hand, the FIG. 3 shows two grains 30' and 30'' of the layer of powder 5 interposed between the image carrier 4 and an original having conductive indicia 2 and a low conductive backing 1. Under the influence of the electric field and irrespectively of the direction of this field, the powder 30' will electrically migrate from the conductive indicia 2 towards the image carrier 4 while the powder 30'' migrates from the image carrier 4 towards the low conductive backing 1, as shown by the arrows in the FIG. 3. The electrographic image thus formed on the surface 3 will be termed negative upright image, and positive reversed image is called the electrographic image formed on the image carrier 4 by the powder facing the indicia 2 of the original.

From the foregoing explanations it becomes apparent that the formation of the electrographic images depends only on the relative conductivities of the parts 2, 3 and 4; consequently, according to the proposal of the present invention, images of satisfactory quality will be obtained irrespectively of a critical conductivity of the pattern of the original and of a critical duration of the electric field serving to their development.

The best quality of the electrographic images is obtained by applying to the terminals 9 and 10 an alternating or an alternatively modulated electric field.

Under the action of the alternating field, the powder 5 facing the most conductive parts of the original will form the dense areas of the stable electrographic image on the image carrier 4, the powder 5 facing the intermediate conductive parts of the pattern 2, 3 will be distributed between the original and the image carrier 4 to form the half-shadow areas of the two electrographic images, while the remaining part of the powder 5 will form the dense areas of the second electrographic image on the least conductive parts of the original.

It may be stated in general that, under the action of the electric field, a conductive powder between the image carrier 4 and the conductivity pattern 2, 3 is more strongly attracted toward the least conductive parts of the pattern 2, 3 than toward its most conductive parts. In addition, by using an image carrier having said intermediate conductivity, a conductive powder between the surface 2, 3 of the original and the surface of image carrier 4 is applied to that surface having the lower electric conductivity.

Consequently, if an image carrier 4 is used having a uniform conductivity lower than the minimum conductivity of the pattern 2, 3 of the original, under the influence of the electric field the powder 5 will be more strongly attracted by the image carrier 4 than by the original; moreover, if an image carrier 4 is used having a uniform conductivity higher than the maximum conductivity of the pattern 2, 3 of the original, under the influence of the electric field the powder 5 will be more strongly attracted by the original than by the image carrier 4.

Because of this effect, if an insulating image carrier is used, the powder 5 will be applied loosely adhering to the original before the application of the electric field; on the contrary, if a metallic image carrier 4 is used, the powder 5 will be applied loosely-adhering to the image carrier 4. For example, this adherence of the powder 5 may be obtained by gravity as well as by coating with a thin slightly adhesive uniform layer of zinc or aluminum stearate the image carrier 4 or alternatively the conductivity pattern 2, 3 of the original. Moreover, any other means having similar adherent qualities as those mentioned above of holding the uniform layer of powder 5 may be used.

According to another embodiment of the present invention, an image carrier 4 is used which has a uniform electric conductivity higher than the maximum conduc-

tivity of the pattern 3, 2 of the original. Referring to this embodiment, the FIGS. 1, 2 and 3 show the high conductive image carrier 4 which may consist, for instance, in a metallic sheet of steel or aluminum. Alternatively, a thin layer of non-insulating or high insulating electrostatically chargeable developer powder 5 may be used; the layer of powder 5 is interposed between the image carrier 4 and an original provided with a pattern of conductive indicia 2 and a low conductive backing 1. By applying a high voltage to the terminals 9 and 10 in connection with the use of a high insulating developer powder 5, the latter electrically migrates according to the directions shown by the arrows in FIG. 2; hence a positive upright image is formed on the original and a negative reversed image is formed on the image carrier 4.

On the other hand, by using a thin layer of non-insulating developer powder 5, the latter will be applied loosely-adhering to the high conductive image carrier 4 before the application of the electric field forming the electrographic images; under the influence of this electric field, as it is shown by the arrows in FIG. 3, the non-insulating powder 5 will form a positive reversed image on the image carrier 4 and a negative upright image on the original. According to this embodiment of the invention, the electrographic images may be obtained by applying to the terminals 9 and 10 a variable high voltage of sufficient value to ionize the gap of air interposed between the original and the image carrier 4; however, the best electrographic images are obtained by generating an alternating or an alternatively modulated electric field. The electrographic images are obtained in a stable way and thus their satisfactory quality is irrespective of the duration of the electric field.

In the arrangement shown in FIG. 4, a powder-coated original provided with a pattern of conductive indicia 2 and low conductive parts 3 is disposed under an electrode in the form of a grid 11. The thin layer of developer powder 5 is insulated from the grid 11 by a fluid dielectric consisting, for example, of an air layer 4'. As for example, the grid 11 may be made of brass and have a mesh width of 0.5 mm. The layer of powder 5 is applied loosely-adhering to the conductivity pattern 2, 3; in accordance with the experience the powder will better adhere to the original by providing an electrode 7 in the form of wires onto which strongly converge the lines of force of the electric field which is generated between the electrodes 7 and 11. Under the influence of this field the powder is electrically charged and removed from the conductive indicia 2, while the powder coating the low conductive parts 3 is never sufficiently charged to electrically overcome its adherence to the parts 3 and thus it develops a stable electrographic image thereon. The space between electrode 11 and the powder 5 must be sufficiently thick so that the intensity of the electric field does not exceed 3 v./mm. in the layer of air 4' to avoid an electric discharge between the electrode 11 and the powder 5. Instead of the air 4', any other insulating gas as well as an insulating liquid, may be used as fluid dielectric 4'. What matters is that powder is insulated from the electrode 11 and that the layer 4' permits the passage of the grains of powder 5 attracted away from the original during the development; these grains thus migrate through the openings of the grid 11 and they are definitively removed from the electric field. Furthermore, in accordance with the present invention, when a direct field is generated between the electrodes 7 and 11, the conductivity pattern 2, 3 will be insulated from the electrode 7 to prevent any direct electric currents filtering through the low conductive parts 3 from electrically charging and removing even the part of the powder which coats the parts 3 and which serves to develop the stable image. Such insulation of the pattern 2, 3 is generally constituted by the insulating backing 1 of the original. If, on the contrary, the backing 1 is made of a low insulating mate-

rial, a dielectric has to be arranged between the latter and the electrode 7.

In the device of FIG. 4, an alternating voltage may be applied to the terminals 9 and 10. The powder 5 thus receives from the pattern 2, 3 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 11. Under the influence of the alternating voltage the powder is electrically removed from the conductive indicia 2 while the powder coating the low conductive parts 3 is never sufficiently charged to overcome its adherence to the parts 3 and thus it forms a stable electrographic image thereon.

In addition, in the device of FIG. 4, an original may be used which is provided with a pattern 2, 3 affixed to an insulating backing 1. By applying an alternating or an alternatively modulated electric voltage the coating powder 5 receives from the pattern 2, 3 alternating electric charges having maximum values in proportion to the conductivities of said pattern 2, 3; under the influence of alternatively modulated voltage the powder is electrically attracted from the conductive indicia 2 while the remaining powder develops a stable electrographic image on the low conductive parts 3.

On the other hand the original, electrode 7 and electrode 11 may be disposed parallel to a vertical plane, such a vertical arrangement of parts is shown in the left-hand part of FIG. 6, in which figure the grid 111 corresponds to the grid electrode 11 of FIG. 4.

The device used in FIG. 4 can also be used to produce two stable electrographic images simultaneously from the same original by placing against the layer of powder 5 an insulating paper of copy intercepting the powder electrically removed from the indicia 2 during the application of the electric field. Such a disposition of parts is shown in FIG. 1, the insulating paper or copy constituting the image carrier 4 placed against the thin layer of powder 5.

If in the device of FIG. 1 an image carrier 4 is used which has a uniform electric conductivity between the maximum and the minimum conductivities of the pattern 2, 3 of the original, it will be advantageous to use a developer powder 5 having an electric conductivity between the maximum and the minimum conductivities of parts forming the pattern 2, 3. Furthermore, in the device of FIG. 4 it will be expedient to use a developer powder having an electric conductivity about equal to that of the least conductive parts of pattern 2, 3 of the original.

In carrying out this invention a developer powder of charcoal has been found useful; alternatively, other developer powders, such as metallic or thermoplastic powder may be used. By way of example, a suitable developer can be produced by oxidizing at a temperature of about 700° C. a commercial bronze to obtain a black powder containing copper dioxide as well as other metallic oxides the powder is then passed through sieves to reduce the grain size between 2 and 25 microns. The resulting powder can advantageously be coated with stearic acid or zinc stearate or aluminum 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 5 during the application of the electric field. Furthermore, after the formation of the images in the device of FIG. 1 the grains of powder 5 conserve intense residual electric charges because of their thin insulating coat and thus the obtained electrographic images will firmly adhere to the non-insulating parts of the original and to the image carrier 4.

The conductivity of the copper dioxide powders is generally between about 10^{-7} and 10^{-5} mho/cm. It is moreover possible to use a commercial colored powder; such powder has a conductivity between 10^{-5} and 10^{-4} mho/cm.

Other high insulating electrostatically chargeable powders of thermo-plastic matters can be used as, for example, powders of polystyrene resins; if required, these plastic materials can be made conductive by mixing them with pure carbon and then they may be used in the form of a developer powder, as it is well known in the art.

For carrying out the invention as described with reference to FIGS. 1 to 3 an apparatus of the type illustrated in FIG. 5 may be used. This apparatus serves to reproduce originals of any kind on any type of paper. The apparatus comprises a preferably metallic rotatable drum 12 taking over the task and the function of the electrode and the image carrier 4 of the FIG. 1 embodiment. A spraying device 13 including a rotatable brush 14 is arranged for spraying powder through a grid 15 to uniformly coat the surface of the rotating drum 12 with the powder. Thereby a potential difference may be produced between the spraying device 13 and the rotatable drum 12. In operation, the original 1, 2 is continuously driven by an endless belt 17 guided over two cylindrical rollers 16 and placing the original 1, 2 against the powder layer on the rotating drum 12. The endless belt 17 is made of a dielectric material. Arranged between the two rollers 16 and adjacent to the endless belt 17 is an arcuate electrode 18 taking over the function of the electrode 7 of FIG. 1. The original 1, 2 will travel upwardly out the apparatus, as shown in FIG. 5.

The voltage applied to the rotatable drum 12 and the electrode 18 is so chosen as to realize the conditions heretofore described with reference to FIGS. 1 to 3. A conductive powder 5 will be attracted by the parts of the pattern 2, 3 having the lesser conductivity and then brushed off, whereas in the areas that correspond to the parts of the pattern 2, 3 having the greater conductivity the rotating drum 12 will carry along the powder and thus represent a reversed image.

As shown in the right-hand of FIG. 5, the apparatus comprises a second pair of rollers 19 guiding an endless belt 20 of dielectric material which is similar to the endless belt 17. The belt 20 is likewise adapted to be placed towards the drum 12 by an arcuate electrode 21. The two rollers 19, moreover, serve to guide a sheet of paper 22 which is unwound from a supply roller 23. The transfer of grains of powder 5, that have remained on the surface of the rotating drum 12, to the sheet of paper 22 is effected while the latter is continuously placed against the rotating drum 12 so that an upright image is produced on the sheet of paper 22. At the outlet of the apparatus this upright image will be fixed by an atomizer 24 adapted to spray an appropriate solvent on to the sheet of paper 22. A replica of the original 1, 2 will then be obtained at 25 after the drying of the sheet of paper 22.

A drum 12 may be used which has a high electric conductivity on its surface coated with a non-insulating developer powder, the drum 12 then taking over the task and the function of the metallic image carrier 4 of the FIG. 1 embodiment. Because of the high conductivity of the drum 12, the apparatus of FIG. 5 is well adapted to the satisfactory transfer of electrographic images on to slightly, conductive sheets or webs of copy material 22, which is usually difficult to obtain in electrography. Thus, according to the invention, replica of good quality may be produced on sheets or webs of ordinary commercial paper, which paper is generally a low insulating material of copy.

For carrying out the invention as described with reference to FIG. 4, an apparatus of the type illustrated in FIG. 6 may be used. In this case, for simplifying the operation an inverted original may be used. The original is secured to the periphery of a rotatable drum 112. Similar to the FIG. 5 embodiment a spraying device 113 is arranged for uniformly distributing the powder on the surface of the rotatable drum 112. When the drum 112 is rotating the powder-coated original passes below a

grid 111 which is equivalent to the grid 11 of FIG. 4. When the voltage is applied between the grid 111 and the rotatable drum 112, the conditions described with reference to FIG. 4 are obtained.

The arrangement in the right-hand part of FIG. 6 is equivalent to the arrangement in the right-hand part of FIG. 5, those parts in FIG. 6 which correspond to equivalent parts in FIG. 5 plus 100. This arrangement is adapted to effect the transfer and the reversal of the image as well as the fixing thereof in a manner similar to that described with reference to FIG. 5. If, as hereinbefore mentioned, a reversed image of the original is used for the reproduction an upright image will be obtained on every revolution of the drum 112. This method can be adapted successfully for the high speed production of a large number of printed matters by using an original provided with a pattern having high differences in conductivity.

Another possibility of application of the apparatus shown in FIG. 5 consists in that the original is secured to the rotatable drum 12. A second spraying device is arranged on the upstream side of the two rollers 19 so that two replicas will be obtained on each revolution of the drum. One of the two replicas is produced on the web of copy paper of the rollers 19 and the other one is produced between the rollers 16 which are likewise associated with an identical copy paper supply roller 23 and a second atomizer 24. By this embodiment of the apparatus of FIG. 5, each electrographic image is formed and simultaneously transferred on a web of copy paper which takes over the task and the function of the image carrier 4 hereinbefore mentioned with reference to FIGS. 1 and 4.

The apparatus may be constructed also in such a manner that when an original is continuously advanced and simultaneously coated with a powder or a liquid, respectively, the original coated with the powder or the liquid travels on a plane surface instead of the cylindrical surface of the drum 12, 112. In this manner it is avoided that parts of the powder or liquid, respectively, are centrifuged off.

While the method herein described, and the apparatus used for carrying out the 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 that changes may be made in either without departing from the scope of the invention which is defined in the appended claims.

Having thus set forth and disclosed the nature of this invention, what is claimed is:

1. A method for producing an electrographic image from an original provided with a conductivity pattern ranging from a portion having a greater conductivity to a portion having a lesser conductivity, comprising the steps of:

- (a) placing a thin layer of electrically chargeable particles in electrical contact with said conductivity pattern,
- (b) disposing said original and said layer of electrically chargeable particles between a first and a second electrode so that said original is interposed between said layer of electrically chargeable particles and said second electrode, and
- (c) generating an alternating electric field between said first electrode and said second electrode of sufficient strength so as to transfer electric charges from said conductivity pattern to said electrically chargeable particles whereby said particles receive electric charges having different maximum values according to the different conductivities of said portions of said conductivity pattern whereby a portion of said particles are sufficiently charged and removed from said layer of electrically chargeable particles and the remainder of said particles are insufficiently charged

so that they continue to remain in said particles layer thereby producing a stable electrographic image.

2. A method as defined in claim 1 wherein the conductivity pattern is insulated from said first electrode.

3. A method as claimed in claim 2 wherein said conductivity pattern is insulated from said first electrode by an insulating image carrier interposed between said layer of electrically chargeable particles and said first electrode whereby a second stable electrographic image facing said portion of said conductivity pattern having said greater conductivity is presented on said image carrier.

4. A method as claimed in claim 2 wherein said conductivity pattern is insulated from said first electrode by an insulating fluid layer interposed between said layer of electrically chargeable particles and said first electrode shaped in the form of a grid whereby the portion of the electrically charged particles removed from said conductivity pattern is attracted through said fluid layer and said grid-electrode under the action of said alternating field.

5. A method as defined in claim 1 wherein the conductivity pattern is insulated from both said electrodes.

6. A method as defined in claim 1 wherein the conductivity pattern is insulated from said second electrode.

7. A method as claimed in claim 6 wherein said layer of electrically chargeable particles is sandwiched between said conductivity pattern and a conductive image carrier whereby a second stable electrographic image is presented on said conductive image carrier.

8. A method as claimed in claim 7 wherein said layer of electrically chargeable particles is formed from an insulating material whereby said second stable electrographic image facing said portion of said conductivity pattern having said lesser conductivity is presented on said conductive image carrier.

9. A method as claimed in claim 7 wherein said layer of electrically chargeable particles is formed from a conductive material whereby said second stable electrographic image facing said portion of said conductivity pattern having said greater conductivity is presented on said conductive image carrier.

10. A method as claimed in claim 7 wherein said layer of electrically chargeable particles, said conductivity pattern and said conductive image carrier are electrically insulated from both said first and second electrodes.

11. A method for producing an electrographic image on a copy material from an original provided with a conductivity pattern ranging from a portion having a greater conductivity to a portion having a lesser conductivity, comprising the steps of:

- (a) coating a conductive image carrier with a thin layer of non-insulating electrically chargeable particles,
- (b) placing said conductivity pattern in electrical contact with said layer of electrically chargeable particles so that said layer of electrically chargeable particles is sandwiched between said conductive image carrier and said conductivity pattern,
- (c) disposing said conductivity pattern, said layer of electrically chargeable particles and said conductive image carrier between a first electrode and a second electrode,
- (d) generating a first electric field between said electrodes of sufficient strength so as to transfer electric charges from said conductivity pattern and from said conductive image carrier to said non-insulating electrically chargeable particles whereby a portion of said electrically charged particles are removed and an electrographic image is formed on said conductive image carrier from the remainder of said particles,
- (e) removing said conductive image carrier bearing said electrographic image thereon from said first electric field,

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- (f) placing a copy material against the non-insulating electrically chargeable particles of said electrographic image, and
- (g) generating a second electric field across said copy material and said conductive image carrier of sufficient strength so as to charge the non-insulating particles forming said electrographic image on said conductive image carrier from said conductive image carrier whereby said electrographic image is electrically transferred onto said copy material.

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