United States Patent [19]

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[11] **3,890,621**

[45] **June 17, 1975**

[54] **ELECTROGRAPHIC DEVICES FOR THE NON-ELECTROSTATIC DUPLICATION OF ORIGINALS PROVIDED WITH A CONDUCTIVITY PATTERN FORMED FROM INDICIA AND BLANK AREAS**

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[22] Filed: **Jan. 7, 1974**

[21] Appl. No.: **431,961**

Related U.S. Application Data

[60] Division of Ser. No. 151,489, June 9, 1971, Pat. No. 3,849,126, which is a continuation-in-part of Ser. No. 631,792, April 18, 1967, abandoned.

[52] **U.S. Cl.** ..... **346/74 ES;** 346/74 J

[51] **Int. Cl.** **G01d 15/06**

[58] **Field of Search** ..... 346/74 ES, 74 EW, 74 E, 346/74 J; 178/6.6 A

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[57] **ABSTRACT**

Device and apparatus for electrographic reproduction comprising an original provided with a conductivity pattern including at least an area formed from a first material and at least an area formed from a second material having an electric conductivity different from the conductivity of said first material, means for coating said conductivity pattern with electrically chargeable particles, and means for generating an electric field to charge and remove away from the conductivity pattern a part of the particles leaving an electrographic image on the original.

10 Claims, 6 Drawing Figures

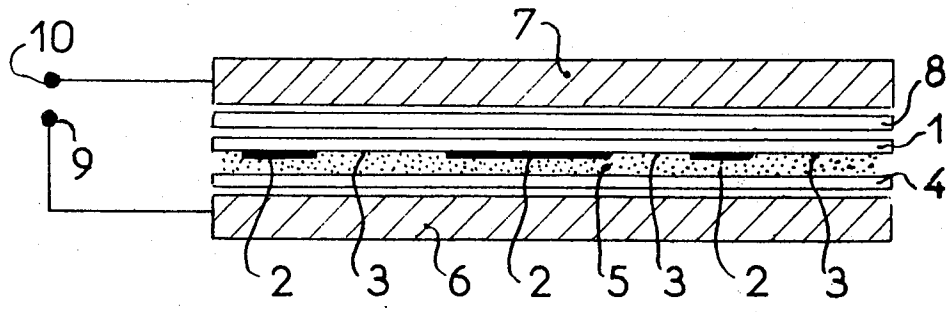


FIG. 1

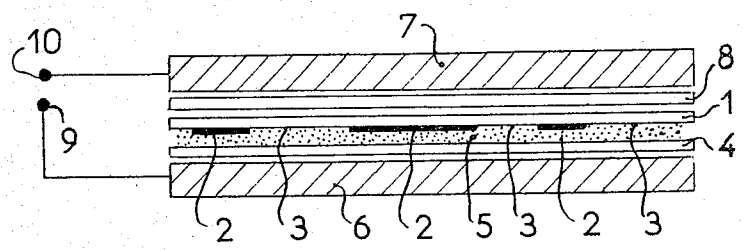


FIG. 2

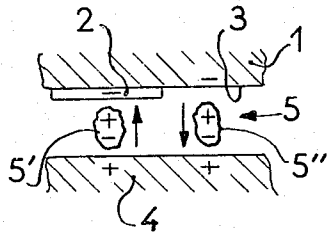


FIG. 3

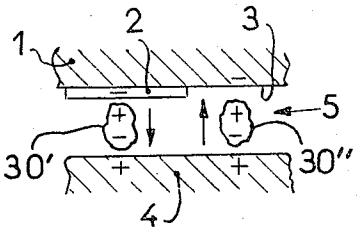


FIG. 4

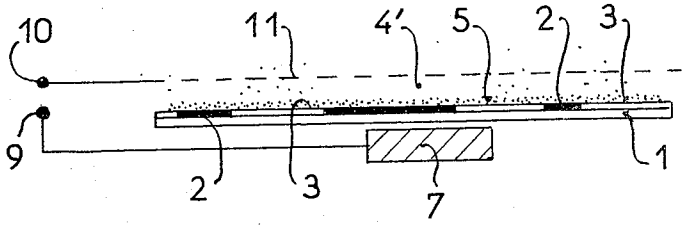


FIG. 5

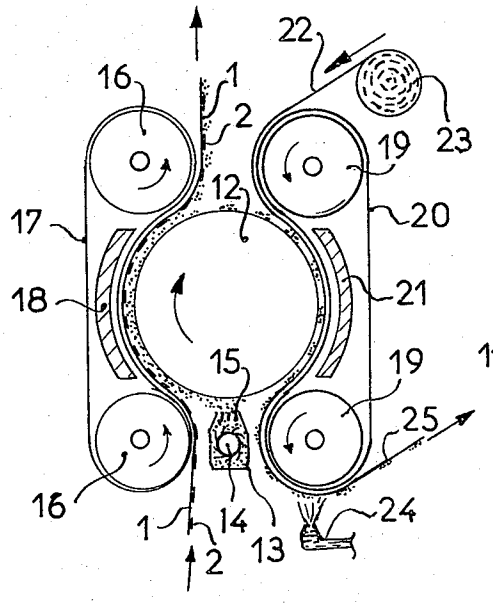
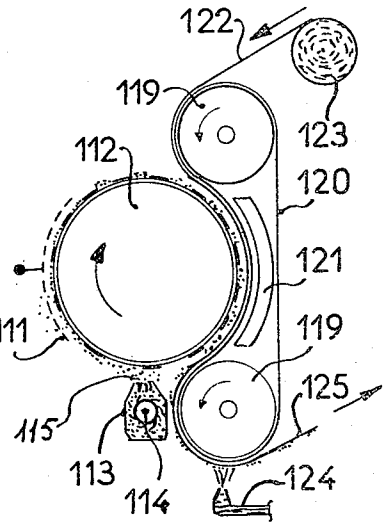


FIG. 6



ELECTROGRAPHIC DEVICES FOR THE NON-ELECTROSTATIC DUPLICATION OF ORIGINALS PROVIDED WITH A CONDUCTIVITY PATTERN FORMED FROM INDICIA AND BLANK AREAS

This application is a division of application Ser. No. 151,489, filed June 9, 1971 now U.S. Pat. No. 3,849,126 which application in turn is a continuation-in-part of application Ser. No. 631,792, filed Apr. 8, 1967, now abandoned.

This invention relates to the duplicating of an original without using optical means.

It is known in the art to form a light image on a photoconductive layer, thereafter this image is developed by electrographic means. In addition, in accordance with many known methods, an electrographic image is developed with a powdered or liquid developer agent by using a latent electrostatic image. This latent image consists in a pattern of electric charges usually generated on the insulating indicia of a printing block, the term "printing" being intended to denote the orientation of the developer agent in an electric field. The electrographic image is developed by electrically orienting a developer agent in conformity with the indicia of the printing block. The developed image may be obtained on the printing block which acts as an image carrier. In addition, an electrographic image may be developed on a second image carrier that is in the form of a sheet carrying a layer of developer powder, this coated sheet being placed against the latent image of the printing block to orient the powder and thereby developing the visible image.

The printing block may be of a different nature although it is usually constituted by a photoconductive layer onto which the latent electrostatic image is produced with the aid of optical means by radiation. The use of such a latent electrostatic image, however, limits the working speed of the process and often requires the use of complicated devices. These disadvantages become particularly important where a liquid developer is used. Nevertheless, even when a powder is used, the carrying out of existing methods necessitates the insulating character of the indicia of the printing block in order to maintain the latent electrostatic image during the development of the visible image. Hence the working of actual electrography is limited by the use of a few specially prepared printing blocks and in particular the use essentially of only a few photoconductive insulating materials.

Now in accordance with the instant invention an electrographic image is formed and simultaneously developed without focussing a light image on a photoconductive layer and in the absence of a latent electrostatic image on a particular insulating printing block. The developed image is now produced by using an original provided with areas on its surface including at least an indicia area having an electric conductivity different from that of the remaining area of said surface. Such a surface original is termed a "conductivity pattern". Accordingly, in addition to the usual printing blocks, also traces of conductive inks, letter-press printing, photographs and any other conductivity pattern may be used to produce developed images according to this invention. In the following specification the term "original" is intended to denote any backing support carrying on its surface a conductivity pattern adapted to the production of electrographic images.

In its simplest form, the present invention pertains to the production of electrographic images from a thin layer of developer powder placed in contact with the conductivity pattern of an original. An electric field is generated across the powder to orient and distribute it in accordance with the indicia of the original and thus to produce and simultaneously develop an electrographic image. A developed image may be obtained on the original and eventually on the image carrier sheet which is placed against the layer of developer powder during the application of the electric field. A copy may be obtained by fixing the developed image on the original or on the image carrier. In addition, the electrographic image may be transferred from the original and from the image carrier onto support materials to provide copies of the original in the upright form.

More specifically, according to a first embodiment of the present invention a thin uniform layer of developer powder is interposed between an image carrier and the conductivity pattern of an original; the original and the image carrier are interposed between two electrodes with the original electrically insulated from its adjacent electrode; an electric field is generated between the electrodes to orient the powder in conformity with the pattern on the original; and either the image carrier or the original is used for producing a copy after the image carrier is separated from the original.

In carrying out the present invention an insulating, as well as a conductive, image carrier may be used. If a conductive image carrier is used, a dielectric layer may be interposed between the image carrier and its adjacent electrode to advantageously insulate the image carrier from the electrode.

According to another embodiment of the present invention an image carrier is used with an electric conductivity which is between the maximum and the minimum conductivities of the conductivity pattern of the original. For example, where the indicia of said pattern have a high electric conducticity and the remaining pattern has low electric conductivity, the image carrier will have an electric conductivity greater than said low conductive areas of the original but lower than the indicia. According to this embodiment a thin uniform layer of powder is sandwiched between said image carrier and the conductivity pattern of the original, and an electric field is generated between two electrodes to electrically orient the powder in conformity with the conductivity pattern of the original.

Similar to the aforementioned first emebodiment of the invention, the original or alternatively the image carrier, or both, may be insulated from their respective adjacent electrode.

When the image carrier is separated from the original, the developer powder forms a first electrographic image on the original and a second one on the image carrier. The two images constitute, respectively, a positive and a negative image of the conductivity pattern of the original.

Alternatively, said first or second electrographic image may be transferred onto a copy material by repeating the aforedescribed method of the invention.

For example, the powder of the images may be fixed on the copy material by means of a fixing varnish or, if fusible powders are used, by heat fusing the powder.

On the other hand, when only one electrographic image is to be produced on the surface of the original, instead of said image carrier, a dielectric fluid layer of air may be interposed between the conductivity pattern of the original and its facing electrode, the latter being advantageously shaped in the form of a grid.

Although said electric field may be generated for producing developed images, it is particularly advantageous to alternatively change the direction of the electric field for developing electrographic images in accordance with the instant invention.

An appropriate apparatus for practicing the method includes two electrodes connected to a voltage source. One of the electrodes may take the form of a rotatable drum. The original is placed between the drum and a second electrode, and the image thereby formed on either the original or the drum is subsequently transferred to a copy material.

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

Another object of this invention is to provide non-electrostatic printing means not necessiting the formation of a light image on a photoconductive layer.

Further 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 diagrammatic sectional view of an electrographic arrangement showing an original with a conductivity pattern thereon and a sheet serving as image carrier, with the sheet and the original disposed between two electrodes;

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

FIG. 3 is a second schematic representation of the electric charges on particles between the original and the image carrier;

FIG. 4 is a schematic represantation of an arrangement showing an original disposed between a first grid-shaped electrode and a second electrode;

FIG. 5 is a diagrammatic representation in side elevation of an electrographic copying device having a drum shaped electrode; and

FIG. 6 is a diagrammatic view in side elevation of another embodiment of an electrographic device in which the orignal is carried by a drum.

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 conductivity pattern 2, 3 of the original is disposed between two electrodes 6 and 7. Also arranged between the electrode 6 and 7 is an image carrier 4 coated with a uniformly distributed powder 5 on its surface facing the conductivity pattern 2, 3.

Where the original is provided with a conductive backing material 1, a dielectric 8 may be disposed between the backing 1 and the electrode 7. If the image carrier 4 is made of a conductive material, a dielectric layer may be interposed between the image carrier 4 and electrode 6. The electrodes 6 and 7 are provided with terminals 9 and 10, respectively.

Any kind of original may be used in the device of FIGS. 1 to 4. According to embodiments of the invention, if a specially prepared printing block is used as an original, it is not used as an electrode. Rather, the conductive areas of the pattern 2, 3 are separated from the electrode 7 by the interposition of the dielectric 8, FIG. 1, or alternatively by the backing material 1, FIG. 4, when the latter is made of an insulating material.

More generally, in carrying out the instant invention, an original may be used which is provided with an electrically conductive or an insulating material and the indicia may consist of an electrically conductive or insulating material. The indicia need not even be visible as are, for example, graphic records. In this conjunction it is also essential to note that between the maximum and the minimum conductivities of the pattern 2, 3 intermediate conductivities may be found, it being also possible that the conductivity of either the indicia 2 or the surface 3 is equal to zero. Accordingly, when sharp-contrast and very accurate reproduction of the half-tone (grey-tone values) of the image is to be achieved, a further embodiment of the invention utilizes a conductivity pattern 2, 3 provided with said intermediate conductivities together with the use of an image carrier having a uniform electric conductivity between the maximum and the minimum conductivities of the pattern 2, 3 of the original.

According to another embodiment of the invention, a metallic conductive image carrier 4 is used, as for example a sheet of steel or aluminium. In this case the sheet 4 is preferably coated with a loosely sticky layer of, for example, zinc stearate, in order to coat said metallic image carrier 4 with a loosely-adhering layer of developer powder. In this embodiment, due to the presence of the metallic sheet 4, the electric resistance between the electrodes 6 and 7 is diminished, and thus a dielectric layer 8 is interposed preferably between the backing 1 of the original and the electrode 7. This arrangement avoids a useless intense electric current through the device. The dielectric 8 consists, for example, of a sheet of MYLAR (registered trade mark) of a thickness of 150 microns.

Instead of coating the powder 5 onto the surface of the image carrier 4 according to the above described method, the powder can, alternatively, be coated onto the surface of the original so that a thin uniform layer coats the entire conductivity pattern 2, 3. Such a coating of the powder onto either the image carrier 4 or the original can be accomplished in a well known manner by the use of rotating brushes, by spraying or cascading the powder.

Referring to FIGS. 1 to 4, an high voltage may be applied to the terminals 9 and 10 of the electrodes 6 and 7. For example, a direct voltage of the order of 25 KV may be applied to the terminals for a period of a fraction of one millisecond although, the satisfactory quality of the electrographic image is independent of a longer duration of the developing electric field. The voltage may be alternatively applied for a period of one second, for example. However, the best quality of the developed image is obtained if an alternating voltage is applied to the terminals 9 and 10. For example, alternating voltages of 5 KV, 50 cycles/sec, 3.5 KV, 250 cycles/sec may be applied. Instead of this, it is also possible to apply to terminals 9 and 10 an impulsion of attenuated or oscillating modulated voltage.

When, subsequently, the electrodes 6 and 7, FIG. 1, are separated and the image carrier 4 is detached from the original, the powder 5 is distributed according to

the indicia 2 both on the original and on the image carrier 4 and in this distributed form it may be used for producing a copy. During the image development an external pressure, for example of about 100 g/cm^2, may be exerted on the electrodes 6 and 7.

The manner in which the powder 5 is distributed on the image carrier 4, as well as on the surface 2, 3 of the original, depends upon the electric properties of the powder 5. An electrically insulating powder is attracted to the several surfaces in a manner different from an electrically conductive powder.

FIG. 2 shows two grains 5′ and 5″ of a powder which is electrically insulating, the grains 5′ and 5″ being disposed between the image carrier 4 and the conductivity pattern 2, 3 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. For example, an original may be used in which the electric conductivity of the indicia 2 is greater than the conductivity of the areas 3. Under the action of a very intense electric field across the original 1 and the image carrier 4, the greater mobility of the electric charges in the better electrical conductor provides a higher concentration of charges in the grains of powder 5 against the indicia 2. Consequently, when the original is separated from the image carrier 4 after the application of the electric field, the grains of the insulating powder 5 opposite the more conductive indicia 2 will be attracted away from the image carrier 4, as shown by the arrow for the particles 5′, and the insulating powder 5 opposite the less conductive areas 3 remains applied on the image carrier 4, as shown by the arrow for the particle 5″. It may be stated that, depending on the direction of the electric field, the grains of an insulating powder may be attracted toward the better electric conductive area of the conductivity pattern 2, 3. It will thereafter appreciated that, by using an original having more conductive areas 3 and less conductive indicia 2, the grains of insulating powder 5 move opposite to the direction of the arrows of FIG. 2.

FIG. 3 shows two grains 30′ and 30″ of an electrically conductive powder 5 which are placed against the indicia 2 and the surface 3 of an original, respectively. Where the electric conductivity of the indicia 2 is greater than the conductivity of the surface 3, under the action of an electric field generated between the electrodes 6 and 7, the grains of the conductive powder 5 opposite the less conductive surface 3 will electrically overcome their adherence to the image carrier 4 and will be attracted toward the surface 3, as shown by the arrow for the particle 30″. At the same time, the grains of the conductive powder 5 opposite to the more conductive indicia 2 remain on the coated image carrier 4, as shown by the arrow for the particle 30′. By using an original provided with surfaces 3 having a conductivity greater than that of the indicia 2, the particles of powder 5 move opposite to the directions shown by the arrows in FIG. 3. Hence, it may be stated that a conductive powder 5 is more strongly attracted toward the less conductive parts of the conductivity pattern 2, 3 of the original. In carrying out the present invention it is expedient to use an image carrier having an electric conductivity between the maximum and the minimum conductivities of the pattern 2, 3 of the original. Such an image carrier may be in the form of a sheet, as for example a sheet of conductive paper. As shown in FIG. 3, an original may be used which is provided with indicia 2 having an electric conductivity higher than that of the surface 3. In this example, the electric conductivity of the image carrier 4 is higher than the electric conductivity of the surface 3. The conductivity of the indicia 2 is higher than the electric conductivity of the image carrier 4. By virtue of these relative conductivities of the indicia 2, surface 3 and sheet 4, the contact conductance between the grains 30″ and the surface 3 is lower than the contact conductance between the grains 30″ and the image carrier 4. Similarly, the contact conductance between the grains 30′ and the image carrier 4 is lower than the contact conductance between the grains 30′ and the indicia 2. When a voltage is applied to the terminals 9 and 10 so that electrodes 6 and 7 create an electric field, each grain of the powder 5 is electrically charged to the polarity of that surface to which the contact conductance is higher and will be attracted to the other surface to which it has a lower contact conductance. Hence it may be stated that an electrically conductive powder will migrate from the surface of higher electric conductivity to the surface of lower conductivity. This effect depends only on the relative conductivities of the indicia 2, the surface 3 and the image carrier 4. The development of the image is independent of the direction of the electric field, of a critical duration of the field and of a particular conductivity of the areas 2 and 3 of the original. Advantageously, an alternating electric field may be generated between the electrodes 6 and 7 to develop electrographic images by the device of FIG. 1 and particularly sharp contrast and a very accurate reproduction of the half-tones are achieved by using said image carrier having an electric conductivity between the electric conductivity of areas 3 and that of the indicia 2.

After separating the original 1 from the image carrier 4, a reversed or mirror-like image of the indicia 2 will be formed on the image carrier 4. At the same time that the reversed image is formed on the image carrier 4, a non-reversed or upright image develops on the original. These reversed or alternatively upright images are termed "positive" if the half-tone scale of the indicia is retained unchanged, so that the areas with powder on the developed image correspond to the indicia of the original, and the clean areas of the powder image correspond to the areas 3 of the original. On the other hand, the electrographic image is termed "negative" if its areas with powder correspond to the areas 3 of the original, and the clean areas correspond to the indicia 2.

Where the original to be reproduced is provided with indicia 2 having an electric conductivity higher than that of the surface 3, by using a conductive powder a positive reversed image is formed on the image carrier 4 and a negative upright image on the original. By using an insulating powder, a negative reversed image may be formed on the image carrier 4 and a positive upright on the original. On the other hand, when the original is provided with indicia 2 having an electric conductivity lower than that of the surface 3, by using an insulating powder a positive reversed image may be formed on the image carrier 4 and a negative upright image on the original 2, 3; by using a conductive powder, a negative reversed image is formed on the image carrier 4 and a positive upright on the original.

After the positive or alternatively negative reversed image is formed on the image carrier 4 by using a conductive powder, this image can be transferred, for ex-

ample, to a sheet of copy paper in order to obtain an upright image. Such transfer may be effected by known methods. Alternatively, it is expedient to develop said image on a metallic image carrier **4** and to effect the transfer of the image onto the copy paper by using the apparatus described below with reference to the FIG. **5.**

After separating the image carrier **4** from the copy sheet, the powder which forms the image on the copy paper needs only to be fixed to obtain the desired permanent copy. The powder may be fixed, for example, by spraying a fixing varnish onto the powder on the copy, or, if the powder used is a synthetic resin having a low melting point, it is sufficient to heat the copy paper to melt the powder so that the powder adheres to the paper. Such melting may be advantageously accomplished by infra-red radiation.

FIG. **4** shows another embodiment of a device for producing electrographic images in which a powder coated original having a backing **1** and a conductivity pattern **2, 3** is disposed under an electrode in the form of a grid **11.** A second electrode **7** is disposed beneath the backing **1.** In this embodiment the indicia **2** is electrically insulated from the electrode **7** by forming the backing **1** from an electrically insulating material. Alternatively, if the backing **1** is of electrically conductive material, an insulating layer is disposed between the backing **1** and the electrode **7.** The conductivity pattern **2, 3** and the coating powder **5** are electrically insulated from the grid **11** by a dielectric fluid such as the air layer **4'** in the space between grid **11** and the powder **5.** The spacing between the grid **11** and the backing **1** is not critical although it depends on the voltage applied to the terminals **9** and **10** so that, by applying the above mentioned voltages between 25 KV and 3.5 KV, the thickness of the layer **4'** is advantageously of about 10 mm.

When a voltage source is connected to the terminals **9** and **10** an electric field is generated between the electrode **7** and grid electrode **11.** Because of this electric field the electrically chargeable powder **5** becomes charged. The coated conductivity pattern **2, 3** being insulated from the electrodes **7** and **11,** the different portions of the layer of powder **5** receive electric charges depending only on the different electric conductivities of the corrisponding portions of the pattern **2, 3.** Hence the differently charged grains of powder **5** are urged toward the grid **11** by different electric forces which depends only on the conductivities of the pattern **2, 3.** Accordingly, where this force is smaller than the adherence of the grain to the original, the grain remains on the original no matter what the duration of the electric field is. A grain above an electrically low conductive spot of the original is urged toward the grid **11** by an electric force smaller than its adherence to the pattern **2, 3** and it remains stably thereon. On the other hand if the grain is above an electrically conductive spot of the pattern **2, 3,** the grain is highly charged and it is acted on by an electric force which overcomes the adherence of the grain to the original, and therefore this grain is attracted away from the conductivity pattern **2,** 3 through the layer **4'** and the grid **11.** Hence grains of powder **5** are electrically removed away from the more conductive areas of the original and the powder on the lower conductive areas of the pattern **2, 3** remains stably thereon developing an electrographic image. It will be appreciated that when the removed grains of powder are electrically charged from the pattern **2, 3,** this removed part of the powder leaves on the original opposite electric charges tending to annul the existing electric field. In this conjunction it has been found expedient to alternatively change the direction of the electric field between the electrodes **7** and **11** so that grains having successive opposite polarities are successively attracted away from the more conductive areas of the pattern **2, 3** in order to develop the electrographic image. On the other hand, by using an original provided with a conductivity pattern affixed to a conductive backing material **1,** an alternating electric field is generated between the electrodes **7** an **11.**

The quality of the obtained images may also be improved by providing the electrode **7** in the form of a bar or thin wires so that the lines of force of the electric field strongly converge toward the electrode **7,** this convergence having the effect of improving the adherence of the powder image onto the the original during the development of this image.

In the embodiment of FIG. **4,** the best results are obtained where the indicia **2** are electrically conductive and the backing material **1** is electrically insulating. In addition, an insulating material may be disposed between the backing **1** and the electrode **7.**

For carrying out the method of the invention an apparatus illustrated in FIG. **5** may be used. This apparatus serves to reproduce originals of any kind on any type of paper by developing the electrographic image on a metallic image carrier and to transfer the obtained image onto the copy paper. Hence, the apparatus comprises, preferably, a metallic rotatable drum **12,** which fonctions both as the electrode **6** and the metallic image carrier of the FIG. **1** embodiment. A spraying device **13** includes a rotatable brush **14** for spraying the 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** is continuously driven by an endless belt **17** guided over two cylindrical rollers **16.** The original **1** is thus placed against the powder layer on the rotating drum **12.** The endless belt **17** is made of an insulating material. Arranged between the two rollers **16** and adjacent to the endless belt **17** is an electrode **18** which functions as the electrode **7** of FIG. **1;** the original **1** will travel upwardly out of 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.** For example, where an original is used which is provided with conductive indicia **2** and low conductive surfaces **3,** a conductive powder **5** will be attracted by the surface **3** and then brushed off, whereas in the areas that correspond to the indicia **2** the rotating drum **12** will carry along the powder and thus present a positive reversed image.

As shown in the right-hand part of FIG. **5,** the apparatus comprises a second pair of rollers **19** guiding an endless belt of dielectric material which is similar to the endless belt **17.** The belt **20** is likewise adapted to be placed against the drum **12** by the rollers **19** and an electrode **21** is similarly arranged between the rollers **16** and adjacent to the endless belt **20.** The two rollers **19,** moreover, serve to guide a web of paper **22** which is unwound from a supply roller **23.** The paper **22** will

travel as shown by the arrow in FIG. 5. Similarly at the left-hand part of the apparatus, the electrodes 21 serves to create an electric field between the drum-electrode 12 and electrode 21, this field charging the conductive powder of the image from the metallic drum 12 and thereby electrically transferring this powder onto the paper 22 while the belt 20 urges the paper 22 against the drum 12. An upright positive image is thus produced on the sheet of paper 22. At the outlet of the apparatus this upright positive image will be fixed, for example, by an atomizer 24 adapted to spray an appropriate solvent onto the web of paper 22. The copy of the conductivity pattern of the original will then be obtained at 25 after drying paper 22.

The embodiment of FIG. 6 serves to produce copies not requiring the separate steps of first developing the image and then transferring it to the copy material. An original is secured to the periphery of a rotatable drum 112. Similar to the FIG. 1 embodiment, a spraying device 113 is arranged for uniformly distributing the powder on the surface of the original. When the drum 112 is rotating, the powder coated original passes below the grid 111 which functions in a manner essentially the same as the grid 11 of FIG. 4. It will however be appreciated that in the arrangement of FIG. 6 the grid 111, the layer of powder 5 and original 2, 3 are disposed parallel to a vertical plane on the periphery of the drum 112. When a voltage is applied between the rotatable drum 112 and the grid 111, which is equivalent to the grid 11 of FIG. 4, the powder 5 is electrically removed from the conductive areas of the conductivity pattern of the original 2, 3, leaving an electrographic image on the less conductive areas of the original on the rotatable drum 112. Thus, in order to produce a copy, conductive indicia 2 are affixed on the backing 1 forming a negative reversed image of the copy to be produced.

In the arrangement at the right-hand part of FIG. 6, the pair of rollers 119 and the endless belt 120 correspond in FIG. 5 to the rollers 19 and the belt 20, respectively. This arrangement serves to effect the transfer of the image from the original 2, 3 to the web of paper 122 while the latter is continuously placed against the rotating drum 112 so that an upright image is produced on the web of paper 122. At the outlet of the apparatus this upright image will be fixed by an atomizer 124 adapted to spray an appropriate solvent onto the web of paper 122.

Another embodiment of the apparatus shown in FIG. 5 consists in the arrangement where the original is secured to the rotatable drum 12. An intermediate image carrier may be used as the original, whereby a first negative reversed copy is first formed on a sheet of paper by the method described above with reference to FIG. 5, and then the thus prepared image bearing sheet of paper is secured to the periphery of the drum 12 as an original. A second spraying device is arranged on the upstream side of the two rollers 19 so that two electrographic images will be formed on each revolution of the drum 12. One of the two images on the web of copy paper driven by the rollers 12 and the other one is produced under the rollers 16 which are likwise associated with identical supply rollers 23 and a second atomizer 24. It will be appreciated that, by using this embodient of FIG. 5, each one of the two electrographic images is produced and simultaneously transferred onto its corresponding copy paper.

A developer agent other than a powder may be used as for example a liquid and then the apparatus may be constructed also in a manner that when an original or, alternatively, an image carrier is coated with the developer agent and simultaneously advanced, the coated original travels with the image carrier in a straight way. This arrangement avoids centrifugating off portions of the powder or liquid respectively.

While the devices herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited by these precise devices and apparatus, and 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. An electrographic device comprising an original provided with a conductivity pattern ranging from a portion formed from a first material having a greater electric conductivity to a portion formed from a second material having a lesser conductivity, means for placing a thin layer of electrically chargeable particles in contact with said conductivity pattern, means for generating an alternatively modulated electric field of sufficient strength across said conductivity pattern and said layer of electrically chargeable particles so as to transfer electric charges from said conductivity pattern to said electrically chargeable particles whereby a portion of said particles is sufficiently charged and removed from said layer of electrically chargeable particles and the remainder of said particles is insufficiently charged so that it remains in said particles layer thereby forming a stable electrographic image.

2. An electrographic device comprising an original provided with a conductivity pattern ranging from a portion formed from a conductive first material to a portion formed from an insulating second material, means for coating said conductivity pattern with a thin layer of electrically chargeable particles, two electrodes between which said conductivity pattern is interposed, at least one of said electrodes being a grid electrode, means for maintaining said grid electrode in spaced relationship with said conductivity pattern so that said coating particles layer is interposed between said conductivity pattern and said grid electrode and is electrically insulated from said grid electrode, means for generating an electric field of sufficient strength between said electrodes so as to transfer electric charges from said conductivity pattern to said electrically chargeable particles whereby a portion of said particles is sufficiently charged and removed from said conductivity pattern and the remainder of said particles is insufficiently charged so that it remains on said conductivity pattern thereby forming a stable electrographic image on said conductivity pattern said portion of said particles removed from said conductivity pattern migrating through the openings in said grid electrode and being removed from said electric field.

3. An electrographic device comprising an original provided with a conductivity pattern ranging from a portion formed from a conductive first material to a portion formed from an insulating second material, an insulating backing member onto which said conductivity pattern is affixed, means for coating said conductivity pattern with a thin layer of electrically chargeable particles, an insulating layer in contact with said layer of electrically chargeable particles so that said coated

conductivity pattern is electrically insulated between said insulating backing member and said insulating layer, means for generating an electric field of sufficient strength across said insulating backing member and said insulating layer so as to transfer electric charges from said conductivity pattern to said electrically chargeable particles whreby a portion of said particles is sufficiently charged and removed from said conductivity pattern and the remainder of said particles is insufficiently charged so that it remains on said conductivity pattern thereby forminig a stable electrographic image.

4. An electrographic device comprising an original provided with a conductivity pattern ranging from a aportion formed from a conductive first material to a portion formed from an insulating second material, an insulating backing member onto which said conductivity pattern is affixed, means for coating said conductivity pattern with a thin layer of electrically chargeable particles, a first electrode placed against said insulating backing member so that said insulating member is disposed between said first electrode and said coated conductivity pattern, a grid-shaped second electrode in spaced relationship with said conductivity pattern so that said layer of electrically chargeable particles is disposed between said conductivity pattern and said grid electrode and is electrically insulated from said grid electrode, means for generating an electric field of sufficient strength between said electrodes so as to transfer electric charges from said conductivity pattern to said electrically chargeable particles whereby a portion of said particles is sufficiently charged and removed from said conductivity pattern and the remainder of said particles is insufficiently charged so that it remains on said conductivity pattern thereby forming a stable electrographic image on said conductivity pattern said portion of said particles removed from said conductivity pattern migrating through the openings in said grid electrode and being removed from said electric field.

5. An electrographic device comprising an original provided with a conductivity pattern ranging from a portion formed from a conductive first material to a portion from an insulating second material, an insulating backing member onto which said conductivity pattern is affixed, an image carrier, means for interposing a thin layer of electrically chargeable particles between said image carrier and said conductivity pattern so that said conductivity pattern is disposed between said insulating backing member and said layer of particles and said layer of particles is placed in contact with said conductivity pattern, means for generating an electric field of sufficient strength across said insulating backing member and said image carrier so as to transfer electric charges from said conductivity pattern to said electrically chargeable particles whereby a portion of said particles is sufficiently charged and removed from said layer of electrically chargeable particles and the remainder of said particles is insufficiently charged so that it remains in said particles layer thereby forming a first stable electrographic image on said image carrier and a second stable electrographic image on said conductivity pattern.

6. An electrographic device comprising an original provided with a conductivity pattern ranging from a portion formed from a conductive first material to a portion formed from an insulating second material, a conductive backing member onto which said conductivity pattern is affixed, an image carrier, means for interposing a thin layer of electrically chargeable particles between said image carrier and said conductivity pattern so that said conductivity pattern is disposed between said conductive backing member and said layer of particles and said layer of particles is placed in contact with said conductivity pattern, means for generating an electric field of sufficient strength across said conductive backing member and said image carrier so as to transfer electric charges from said conductivity pattern to said electrically chargeable particles whereby a portion of said particles is sufficiently charged and removed from said layer of electrically chargeable particles and the remainder of said particles is insufficiently charged so that it remains in said particles layer thereby forming a first stable electrographic image on said image carrier and a second stable electrographic image on said conductivity pattern.

7. An electrographic device comprising an original provided with a conductivity pattern ranging from a portion formed from a conductive first material to a portion formed from an insulating second material, a conductive image carrier, means for coating said conductive image carrier with a thin layer of electrically chargeable particles, means for placing said conductive image carrier against said conductivity pattern so that said layer of electrically chargeable particles is placed in contact with said conductivity pattern, means for generating an electric field of sufficient strength across said conductivity pattern and said conductive image carrier so as to transfer electric charges from said conductivity pattern and said conductive image carrier to said electrically chargeable particles whereby a portion of said particles is sufficiently charged and removed from said conductive image carrier and the remainder of said particles is insufficiently charged so that it remains on said conductive image carrier thereby forming a stable electrographic image on said conductive image carrier.

8. An electrographic apparatus comprising

an original provided with a conductivity pattern ranging from a portion formed from a conductive first material to a portion form an insulating second material,

a development station including two electrodes, means for disposing said conductivity pattern between said electrodes, at least one of said electrodes being a grid electrode, means for placing said grid electrode in spaced relationship with said conductivity pattern so that said conductivity pattern is electrically insulated from said grid electrode, means for coating said conductivity pattern with a thin layer of electrically chargeable particles so that said layer of coating particles is disposed between said conductivity pattern and said grid electrode, means for generating a first electric field between said electrodes whereby a portion of said particles is sufficiently charged and removed from said conductivity pattern and the remainder of said particles is insufficiently charged so that it remains in said conductivity pattern thereby forming a stable electrographic image on said conductivity pattern,

means for transporting said electrographic image bearing conductivity pattern from said development station to a transfer station,

said transfer station including means for placing a copy material against the particles of said electrographic image on said conductivity pattern, means for generating a second electric field of sufficient strength across said conductivity pattern and said copy material to electrically remove said particles from said conductivity pattern thereby transferring said electrographic image from said conductivity pattern onto said copy material.

9. An electrographic apparatus comprising

an original provided with a conductivity pattern ranging from a portion formed from a conductive first material to a portion formed from an insulating second material, said conductivity pattern being coated with a thin layer of electrically chargeable particles,

a development station including means for placing an image carrier against said conductivity pattern so that said layer of coating particles is interposed between said image carrier and said conductivity pattern, means for generating an electric field across said coated conductivity pattern and said image carrier whereby a portion of said particles is sufficiently charged and removed from said conductivity pattern thereby forming a first stable electrographic image on said image carrier from said removed particles and the remainder of said particles is insufficiently charged so that it remains on said conductivity pattern thereby forming a second stable electrographic image on said conductivity pattern,

means for transporting said conductivity pattern bearing said second electrographic image from said dvelopment station to a transfer station,

said transfer station including means for placing a copy material against the particles of said electrographic image on said conductivity pattern, means for generating an electric field of sufficient strength across said conductivity pattern and said copy material to electrically remove said particles from said conductivity pattern thereby transferring said second electrographic image from said conductivity pattern onto said copy material.

10. An electrographic apparatus comprising.

an original provided with a conductivity pattern ranging from a portion formed from a conductive first material to a portion formed from an insulating second material, a conductive image carrier, said conductive image carrier being coated with a thin layer of electrically chargeable particles,

a development station including means for placing said conductive image carrier against said conductivity pattern so that said layer of coating particles is interposed between said conductive image carrier and said conductivity pattern and is placed in contact with said conductivity pattern, means for generating an electric field across said conductivity pattern and said conductive image carrier whereby a portion of said particles is sufficiently charged and removed from said conductive image carrier thereby forming a first stable electrographic image on said conductivity pattern and the remainder of said particles is insufficiently charged so that it remains on said conductivity pattern thereby forming a second stable electrographic image on said conductive image carrier,

means for transporting said conductive image carrier bearing said second electrographic image from said development station to a transfer station,

said transfer station including means for placing a copy material against the particles of said second electrographic image on said conductive image carrier, means for generating an electric field of sufficient strength across said conductive image carrier and said copy material to electrically remove said particles from said conductive image carrier thereby transferring said second electrographic image from said conductivity pattern onto said copy material.

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