United States Patent

Morse

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[54] **APPARATUS FOR CONTROL OF BIAS POTENTIAL IN AN ELECTROPHOTOGRAPHIC COPIER**

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[21] Appl. No.: **17,394**

[52] **U.S. Cl.** ....**355/10,** 96/1 A, 117/37 LE, 355/16

[51] **Int. Cl.** **G03g 13/10**

[58] **Field of Search** ....355/3, 10, 16, 17; 96/1 R; 117/37 LE; 250/49.52 C; 96/1 A, 1 C

[56] **References Cited**

UNITED STATES PATENTS

3,456,109	7/1969	Gawron	250/49.5
3,368,894	2/1968	Matkan et al.	117/37 LE

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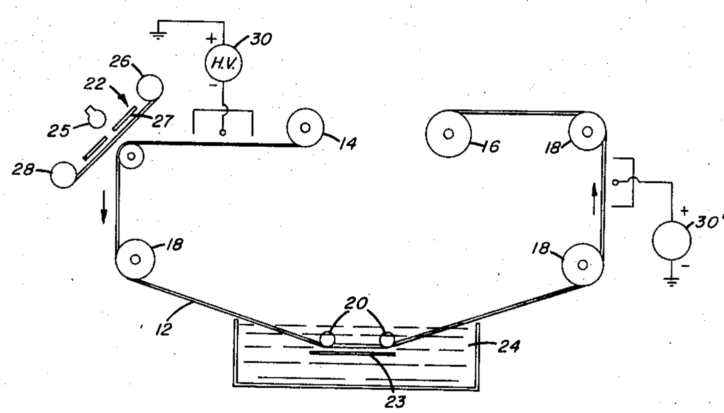
[57] **ABSTRACT**

An apparatus and method are disclosed for adjusting the potential difference between the conducting layer and ground at any preselected position on a photoconductive element that is continuous from exposure through development stations.

2 Claims, 3 Drawing Figures



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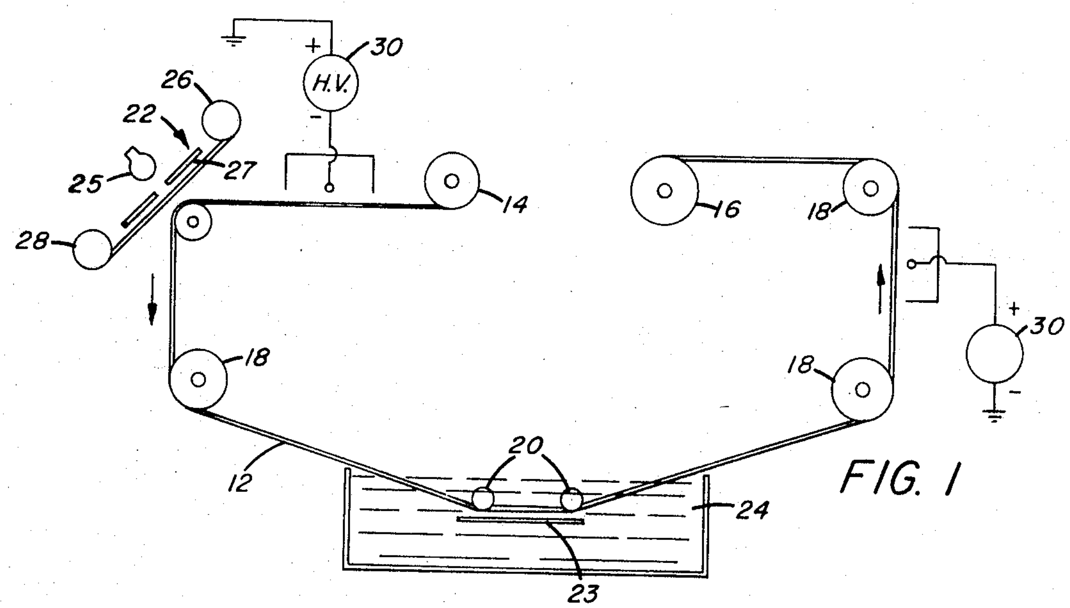

FIG. 1

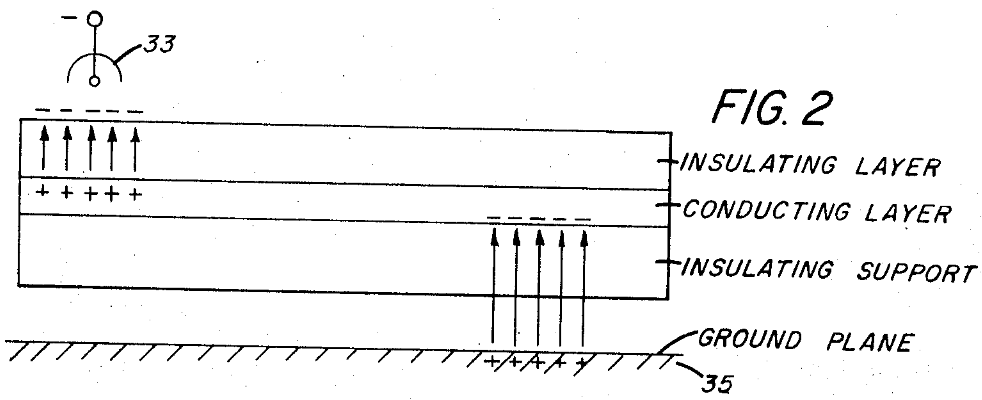

FIG. 2

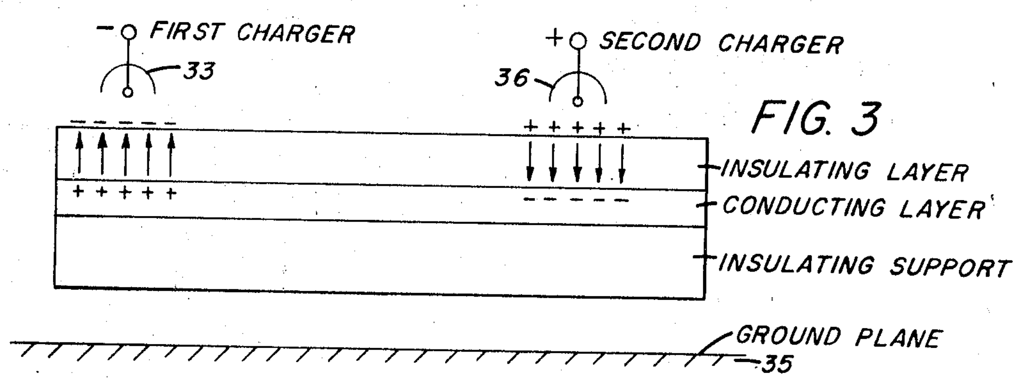

FIG. 3

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APPARATUS FOR CONTROL OF BIAS POTENTIAL IN AN ELECTROPHOTOGRAPHIC COPIER

This invention relates to the predetermined control and adjustment of the potential of a conducting layer in a photoconductor element.

It is desirable in electrophotographic imaging processes that the charging and developing operation be carried out under optimum electrical conditions. That is, the state of charge achieved on the surface of a photoconductor element as well as the performance of the element during development and transfer operations depends upon the potential difference between the conducting layer contained within the photoconductor element and ground. In most photoconductive elements the conducting layer is simply grounded to the apparatus or other convenient ground. In xerographic operations such as disclosed in L. E. Walkup U.S. Pat. No. 2,934,649 where a selenium photoconductive insulating layer is used on a conducting metal drum, the drums potential is not normally adjustable between the operations of charging, exposing, development and transfer.

Normally, adjustment of the bias of the conducting layer of a photoconductor-containing continuous web has been limited to altering the value of the ground potential. Since the conducting layer continuously underlies the photoconductive layer, adjusting the bias of the conducting layer to optimum values at more than one point simultaneously, has not hitherto been possible.

Various disclosures in the xerographic imaging art are directed toward inductive or noncontract adjustment of potential differences. For example, R. W. Gundlach, U.S. Pat. No. 2,965,481 issued Dec. 20, 1960 discloses a typical dual corona charging setup for providing the requisite potential difference between one side of a photoconductive element and the other. Likewise, Gundlach U.S. Pat. No. 2,885,556 issued May 5, 1969; F. A. Steinhilper U.S. Pat. No. 2,955,938 issued Oct. 11, 1960 and S. Naroff U.S. Pat. No. 3,411,846 issued Nov. 19, 1968 disclose similar apparatus. Likewise, E. C. Giaimo U.S. Pat. Nos. 2,815,449 and 2,922,883 describe charging processes utilizing two chargers mounted on opposite sides of the photoconductive element. These latter two patents describe the use of photoconductive elements which do not contain a conducting layer.

It is an object of the present invention to provide a method and apparatus for biasing the conducting layer of a moving photoconductive belt or web in a manner which enables selection of predetermined potential differences between the conducting layer and ground, which are optimum for the various operations which must take place in the production of electrophotographic images.

The foregoing object and hereinafter described advantages are achieved according to the present invention by providing dual charging means which can be located on the photoconductor-containing side of the element in spaced relation from each other. These charging means are then operated at predetermined potentials at opposite polarities.

A preferred form of the invention is shown in the accompanying drawing wherein;

FIG. 1 shows the schematic of an electrophotographic duplication apparatus embodying the present invention.

FIG. 2 is a cross section of a normal photoconductive element showing charge patterns which occur during electrophotographic use of the element when the conducting layer is not grounded.

FIG. 3 is the same as FIG. 2 with charge patterns produced by the method and apparatus of the present invention.

A typical xerographic processing system with which the present invention may be utilized is shown in FIG. 1 in which the various system components are schematically illustrated. A general understanding of operation of the present invention can be derived from examination of such a system, the teachings of course being applicable to other xerographic systems employing these same principles. As in all xerographic systems based on the concept disclosed in the U.S. Pat. to Carlson, No. 2,297,681, issued Oct. 2, 1942, a pattern of actinic radiation representing the copy to be reproduced is projected onto the charged surface of a photoconductive element to form an electrostatic charge pattern thereon. Typically, the electrostatic charge pattern is developed with an oppositely charged developing material to form a toner image, corresponding to the electrostatic charge pattern, on the surface of the photoconductive element. The developed image is then typically transferred onto a second surface where it may be fused by a variety of fusing devices, such as heaters and the like, whereby the image is caused to adhere to the second surface permanently. Alternatively, the electrostatic charge pattern can be developed by liquid development techniques with or without the necessity of a fusing station. Likewise the toner image can be developed to a permanent or semipermanent form on the surface of the photoconductor element.

Referring now specifically to the drawings, FIG. 1 shows a schematic illustration of an electrophotographic duplicating device utilizing a photoconductor-containing web moved by a roller transport mechanism. The photoconductor containing web **12** is introduced to the mechanism from a supply roll **14** and rewound onto pickup roll **16**. Photoconductor-containing web **12** is transported around the mechanism by means of transport rollers **18** and developing station rollers **20**. A high voltage corona charger **30** is stationed before exposing station **22** and a second high voltage charger **30'** is located after the developing station **24**. Exposing station **22** consists typically of a supply reel **26** containing film to be duplicated and a film takeup reel **28** with a light source **25** and aperture control **27** for control of the exposure of the photoconductor-containing web.

The development station **24** typically comprises a vessel containing small particles of marking material suspended in an insulating liquid and preferably utilizes a development electrode **23**. In operation, the corona chargers when activated, are set to different polarities and, in the configuration shown, establish the proper potential difference between the conducting layer and ground to provide for optimum charging before exposing station **22** and optimum development at station **24**. Adjustment of the voltages employed as well as the location and general configuration of the particular mechanism used will provide a predictable level of potential difference. Such adjustment will not require extensive experimentation and therefore should be within the skill of the operator to perform.

FIG. 2 shows a typical charge pattern distribution in an element having a photoconductive layer and a conducting layer on a support where a single charger **33** is used, and no connection made between the conducting layer and the ground plane **35**. Typically a negative charge is applied to the surface of the photoconductor-containing insulating layer which induces positive charges to move in the conducting layer to a position near the negative surface charge. The resulting negative charge in other areas of the conducting layer induce positive charges in the ground plane **35**, resulting in an undesirable potential difference between the conducting layer and ground **35**.

FIG. 3 shows the charge patterns produced according to the present invention wherein the first charger **33** and the second charger **36** are operated at different polarities. In this manner the conducting layer will achieve electrical neutrality. However, it can be seen that the location of the second charger, being at a specific point on the photoconductor-containing web, will produce a gradation from electrical neutrality to a positive or negative value depending on the position sensed between the two chargers. This is contrary to the phenomenon occurring in the photoconductor-containing web shown in FIG. 2 where the charges will be induced from the ground plane nearest the conducting layer. The following are examples of the operation of the method and apparatus of the present invention.

EXAMPLE 1

A 35 mm. photoconductor-containing web comprising a polyester support having coated thereon a cuprous iodide conducting layer, a barrier layer, and an unsensitized photoconductor-containing insulating layer, was suspended between two insulating posts to provide electrical isolation from ground. Two corona chargers were placed facing the photoconductor-containing surface of the web and a distance of 3 feet from each other. An electrometer probe was positioned above the photoconductor-containing web surface, midway between the corona chargers so that the potential of the conducting layer could be measured. With one corona generator energized negatively and the second charger inoperative the conducting layer could be made to assume a negative polarity of several hundred volts by adjusting the intensity of the first charger. The second charger was then energized positively and its intensity gradually increased. The conducting layer potential was observed to rise steadily form its negative value as the corona intensity was increased. A second-charger setting was reached at which the conducting layer reached zero potential, when the second charger potential was increased further the conducting layer potential could be rendered positive. A maximum positive conducting layer potential of approximately 200 volts was achieved by this method.

EXAMPLE 2

Utilizing the same setup as described in Example 1 the second or positive corona charger was moved so that it faced the edge of the photoconductor-containing web. The edge of the cuprous iodide layer was then exposed to the output of the charger. With this setup the intensity required to produce a conducting layer potential of zero was less than required when the charge was facing the photoconductor-containing surface. It was also possible to achieve a positive conducting layer potential of 400 volts.

Example 3

Using the isolated photoconductor-containing web, electrometer probe, and chargers as described in the previous examples, a chart recorder was connected to record the electrometer readings as a function to time. The two chargers were energized and adjusted to bring the conducting layer potential to zero. The chargers were then allowed to operate for a 5-minute period without adjustment. The chart record indicated a maximum deviation of 20 volts from zero during the 5-minute period. Short term variations in potential can be reduced by introducing the capacitance between the conducting layer and the ground rollers over which the belt passes. Experiments with the belt supported by the use of rollers indicated that a minimum capacitance of 150 picofarads is required to remove short term variations in the conducting layer potential. Capacitance of this value or greater would normally be present in a belt support apparatus between the isolated conducting layer and the grounded rollers over which the belt passes.

EXAMPLE 4

Using a roller transport mechanism as shown in FIG. **1**, the second charger was added over the photoconductive surface at a point following the development station **24**. With the first charger **30** adjusted to apply a 1000-volt potential to the photoconductor surface, the second charger was set to adjust the conducting layer potential to zero at the development station. In operation, the photoconductor-containing belt or web was moved at 1 foot per second while charging, exposure and development were carried out without the second charger energized. The developed elements had a high level of background toning indicating that the conducting layer was rising to a potential of the same polarity as the image charge. Then without stopping the belt, the second charger was energized, bringing the potential of the conducting layer to zero. The developed elements which resulted from this change had greatly reduced background densities compared to the single charger run.

In the practice of the method of the present invention a variety of modifications are possible. Since control of the potential is particularly difficult in the case of an overcoated conducting layer it is important to have control of the potential at both charging and development stations. The present invention permits adjustment of the bias for the development station in addition to facilitating the photoconductive surface charging whether the conducting layer is or is not exposed. Both of these operations can then be performed without physical contact with the conducting layer. For example, it is possible to position one charger next to the edge of the photoconductor-containing web shielding the surface of the photoconductor, if necessary. In this manner the second charger can be located from a position relatively near to the first charger to a point anywhere along the front or rear of the belt or web for example to the position shown after the development station.

Without intending to be bound thereby, the mechanism of the process appears to involve the exchange of charge carriers in the conducting layer between the two charger sites as hereinbefore described. The associated currents which will be produced in a moving web will cause a potential gradient to exist in the conducting layer in the region between the two chargers. The magnitude of the potential gradient is directly proportional to the conducting layer resistivity and the intensities of the corona chargers. If the currents induced by these two sources are balanced, the point on the conducting layer which is midway between the two chargers will be at zero potential. An increase of reduction of either charger output will change the potential distribution along the conducting layer and move the point of zero potential. It can therefore be seen that a change in either the intensity of the chargers or their location can alter, in a predetermined manner, either the point of zero potential, or of a selected potential, along the moving web. This adjustment may be accomplished without undue experimentation on the part of the operator.

In the practice of the method of the present invention the most successful and preferred photoconductor-containing webs or belts or supports are organic photoconductor-containing elements. This description covers a very broad class of materials which are characterized by their ability to act as insulators until exposed to light. The same prerequisite is necessary for organometallic photoconductive materials which are normally dispersed in a resinous material. Useful photoconductors of both types are described in Goldman and Johnson U.S. Patent application Ser. No. 650,664 filed July 3, 1967, U.S. Pat. No. 3,472,839 and Johnson application Ser. No. 755,711 filed Aug. 27, 1968. Especially useful class organic photoconductors are referred to as organic amine photoconductors which are useful photoconductor-containing elements such as used herein. Such compound include aryl amine compounds such as those described in Fox U.S. Pat. No. 3,240,597 issued Mar. 15, 1966 and the like as well as U.S. Pat. No. 3,180,730 issued Apr. 27, 1965 and Fox U.S. Pat. No. 3,265,496 issued Aug. 9, 1966, as well as U.S. No. 3,274,000 and French Pat. No. **1,383,461** likewise U.S. application Ser. No. 627,857, now U.S. Pat. No. 3,542,544 filed Apr. 3, 1967 discloses useful photoconductors. Such photoconductors may, if desired, be used with or without sensitizers depending on the choice of the designer. Typical sensitizing addenda for improving speed and/or spectral response as well as other desired electrophotographic characteristics are disclosed in U.S. Pat. Nos. 3,250,615, 3,141,770 and 2,987,395.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

I claim:

1. In an electrophotographic copier including means for advancing along a predetermined path an electrophotographic recording element having a layer of photoconductive material and an electrically conductive backing which is electrically isolated from ground, a first corona discharge source positioned adjacent such path for impinging ions of a first potential upon the photoconductive layer to uniformly charge such layer, means for selectively dissipation the uniform charge on the photoconductive layer to form a developable charge pattern thereon, and developing means positioned adjacent such path for applying electroscopic pattern visible, the improvement comprising:

means positioned adjacent said path downstream from the

developing means for applying an electrical potential to the conductive backing of the recording element to establish an optimum potential in the backing at any preselected position along said path.

2. The invention according to claim **1** wherein said applying means comprises a second corona discharge source for directing ions of a polarity opposite said first potential at the recording element, and means for varying the discharge intensity of said second corona discharge source.

* * * * *

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(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,650,622 Dated March 21, 1972

Inventor(s) Theodore H. Morse

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In Column 1, line 60, change "duplication" to --duplicating--.

In Column 3, line 19, change "form" to --from--.

In Column 4, line 33, change "of" to --or--.

In Column 5, line 6, change "dissipation" to --dissipating--;

In Column 5, line 9, after "electroscopic", insert --particles to the photoconductive layer to render the charge--.

Signed and sealed this 8th day of August 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

PO-1050
(5/69)

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