United States Patent

Benson

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[54] **XEROGRAPHIC DEVELOPMENT APPARATUS**

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[52] **U.S. Cl.** **118/637,** 117/17.5, 355/3

[51] **Int. Cl.** **G03g 13/00**

[58] **Field of Search** 118/637; 117/17.5; 355/3

[56] **References Cited**

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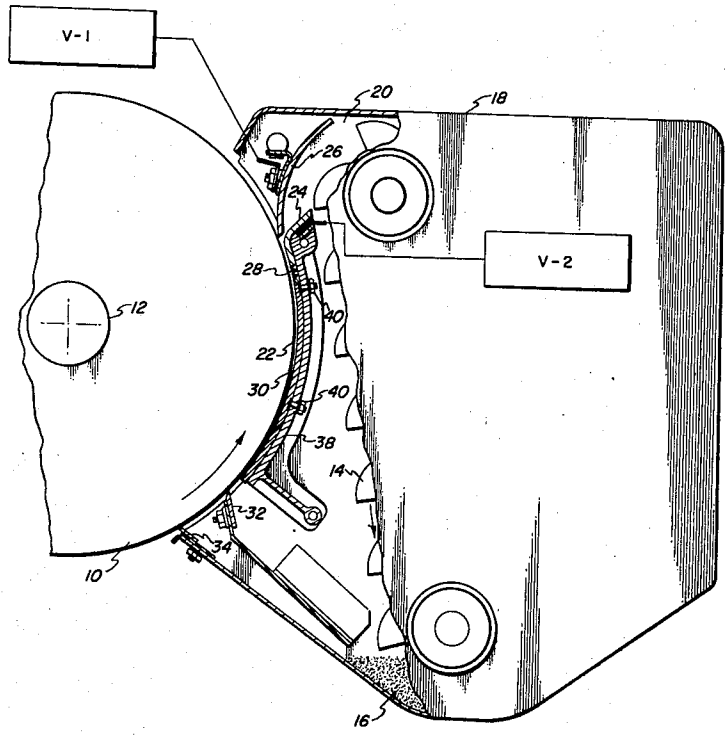
[57] **ABSTRACT**

This invention relates to an electroded cascade development system wherein an extended electrically conductive electrode plate is closely spaced from a xerographic surface being developed. The xerographic surface is moved in an uphill direction against the direction flow of the cascading developer. The electrode is completely insulated electrically from its surrounding whereby it is electrically floating with respect to ground and the image bearing surface for improved development of latent electrostatic images developed under its influence.

5 Claims, 2 Drawing Figures



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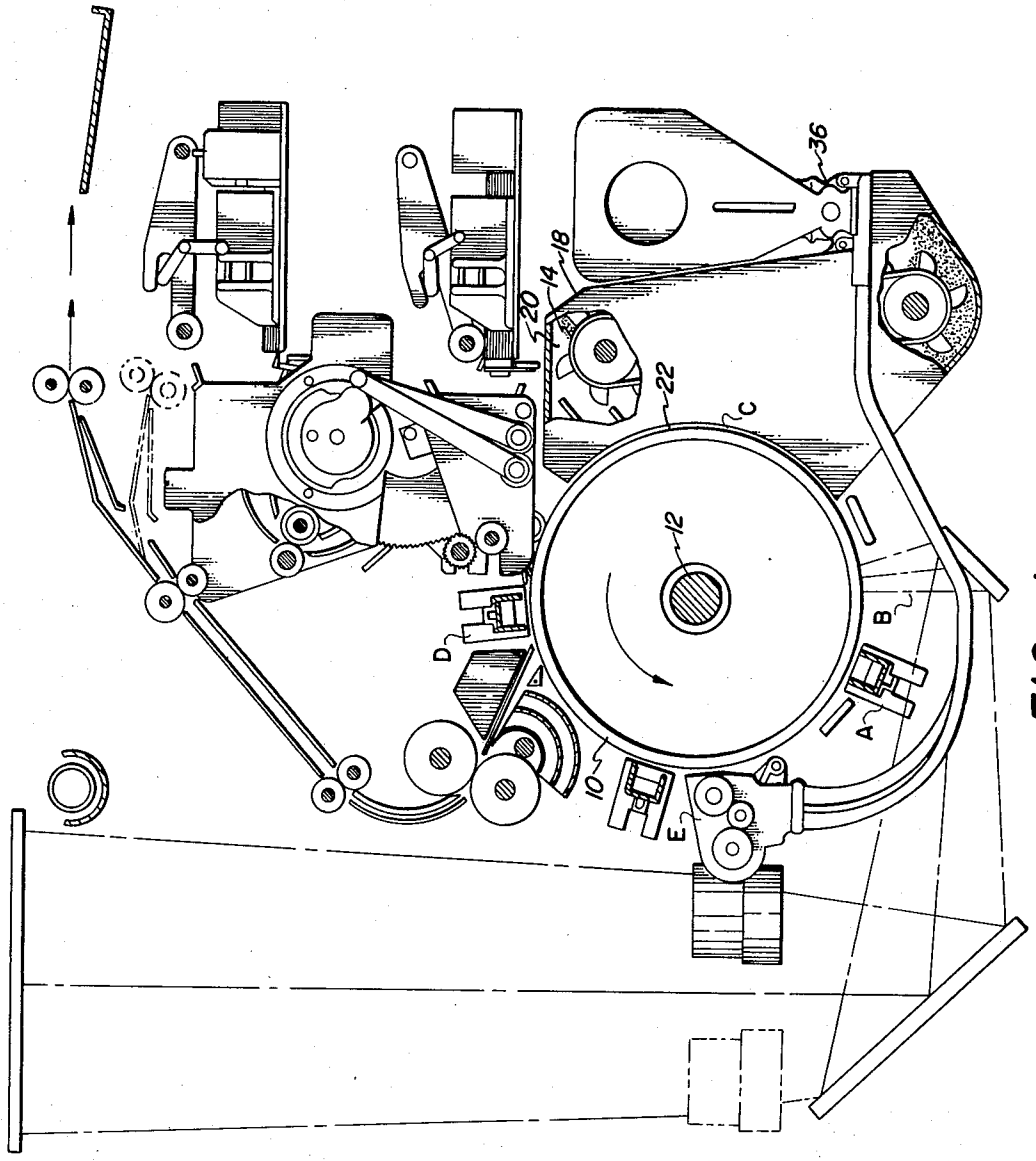

FIG. 1

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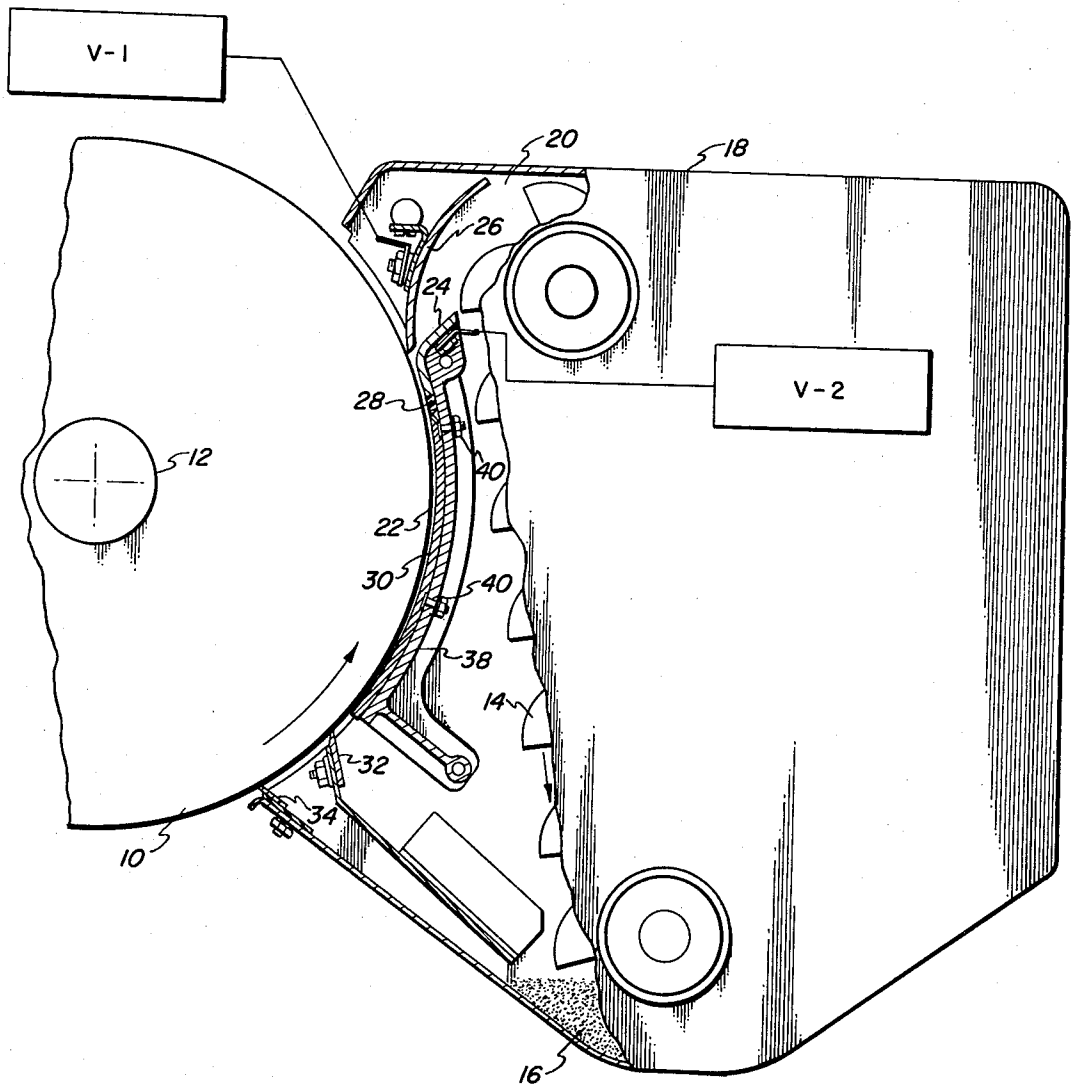

FIG. 2

XEROGRAPHIC DEVELOPMENT APPARATUS

This invention relates to development electrodes employed in cascade development systems and in particular to an electrically floating extended development electrode closely spaced from a latent electrostatic image bearing surface which is being developed by cascading two-component developer.

In the process of xerography as described in U.S. Pat No. 2,297,691 to Chester F. Carlson, a xerographic surface comprising a layer of photoconductive insulating material affixed to a conductive backing is used to support latent electrostatic images. In the usual manner of carrying out the process, the xerographic surface is electrostatically charged uniformly over its surface and then exposed to a light pattern of the image being reproduced to thereby discharge the charge to the areas where light strikes the layer. The undischarged areas of the layer thus form an electrostatic charge pattern in conformity with the configuration of the original light pattern.

The latent electrostatic image can then be developed by contacting it with a finely divided electrostatically attractable material, such as, a powder. The powder is held in image areas by the electrostatic charges on the layer. Where the charge field is greatest, the greatest amount of material is deposited. Where the charge field is least, little or no material is deposited. Thus, a powder image is produced in conformity with a light image of copy being reproduced. The powder is subsequently transferred to a sheet of paper or other surface and suitably affixed thereto to form a permanent print.

It has been known for many years that the development of latent electrostatic images, particularly in cascade systems, can be improved by the utilization of a development electrode. Such a system is disclosed, for example, in U.S. Pat. No. 2,952,241 issued to H. E. Clark et al. on Sept. 13, 1960.

According to that disclosure it is suggested that a conductive member be positioned closely spaced from the latent electrostatic image being developed. When the conductive member or electrode is held at ground potential it will cause the electrical field lines in extended solid area portions of the latent image to extend at right angles from the image supporting surface whereby the charged toner particles of the developer mixture may have an affinity for the central portions of the large solid image areas which would otherwise not have been developed due to the lack of electrical field between such central portions and adjacent portions. This type of assembly effectively reduces the halo effect which would otherwise occur by charged toner particles merely developing out the edges of large solid areas where the charge gradients are the most pronounced.

The aforementioned patent to Clark et al. patent further discloses the concept of electrically biasing the electrode to a polarity the same as that initially impressed upon the xerographic surface and to a potential slightly higher than that in the non-image or background areas. By this technique the advantages of the grounded electrode are maintained in permitting the development of large solid areas. But with the biased electrode, an additional advantage may be obtained in that toner particles, charged oppositely from

the image and background areas will have a greater affinity for the electrode than the background portions of the latent image to thereby minimize toner deposition in such background areas. This results in cleaner images and xerographic copy.

It is clear to see why the biased electrode is more desirable than the grounded electrode due to the fact and all of the advantages of the grounded electrode are attained plus an additional feature. Unfortunately, however, biased electrodes have certain shortcomings in that if the charge thereon is less than the charge and background portions of the latent image, this supplemental advantage is lost. If, however, the charge on the development electrode is more than slightly greater than the charge in non-image areas of the photoreceptor, it can have the effect of competing with the image portions for the charged toner.

It is therefore an object of the instant invention to develop electrostatic images in a cascade development in association with a development electrode which will maintain itself slightly above the charge in background areas.

It is a further object of the instant invention to electrically float a development electrode whereby the charge thereon is self regulating as function of the charge on the photoreceptor after exposure.

It is yet a further object of the instant invention to cascade developed latent images on an uphill moving photoreceptor with the assistance of an electrically floating electrode extending over a substantial distance.

These and other objects of the instant invention are attained by an electroded development system wherein an extended electrically conductive electrode is closely spaced from a xerographic surface being developed. The xerographic surface is moved in an uphill zone against the direction of flow of the cascading developer. The electrode is completely electrically insulated from its surrounding whereby it is electrically floating with respect to ground and the image bearing surface.

For a better understanding of the present invention as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in conjunction with the accompanying drawings wherein:

FIG. 1 is a side elevation of a continuous and automatic xerographic reproducing machine utilizing the development electrode of the instant invention and

FIG. 2 is an enlarged side elevation of the development zone and development electrode of FIG. 1.

Referring now to the drawings, there is shown in FIG. 1 an embodiment of the subject invention in a suitable environment such as an automatic xerographic reproducing machine. The automatic xerographic reproducing machine includes a xerographic plate or surface **10** formed in the shape of the drum. The plate has a photoconductive layer or light receiving surface on a conductive backing, journaled in a frame to rotate in the direction indicated by the arrow. The rotation will cause the plate surface to sequentially pass a series of xerographic processing station. For the purposes of the present disclosure, the several xerographic processing stations in the path of movement of the plate surface may be described functionally as follows:

A charging station A, at which a uniform electrostatic charge is deposited on the photoconductive plate;

An exposure station B, at which light or radiation pattern of copy to be reproduced is projected onto the plate surface to dissipate the charge in the exposed areas thereof to thereby form a latent electrostatic image of the copy to be reproduced;

A developing station C at which xerographic developing material, including toner particles having an electrostatic charge opposite to that of the latent electrostatic image, is cascaded over the plate surface whereby the toner particles adhere to the latent electrostatic image to form a toner-powder image in a configuration of the copy being reproduced;

A transfer station D at which the toner-powder image is electrostatically transferred from the plate surface to a transfer material or a support surface; and,

A drum cleaning and discharge station E at which the plate surface is brushed to remove residual toner particles remaining thereon after image transfer and exposed to a relatively bright light source to effect substantially complete discharge of any residual electrostatic charge remaining thereon.

In the development station C, a bucket conveyor assembly **14** is employed to continually transport developer material from a lowermost or sump portion **16** of the developer housing **18** to an elevated location **20** whereat it may be gravity fed toward the development zone **22**.

The developer is guided toward the development zone by developer input chutes **24** and **26** which may be biased by suitable sources of potential, V-1 and V-2. An insulating strip **28** electrically isolates chute **24** from electrode **30**. The developer is then gravity fed in a smooth flowing fashion through the development zone **22** defined by the volume between the photoreceptive drum and the development electrode. In the development zone, the developer is cascaded into contact with the image bearing surface for its development whereafter it is removed from adjacent the drum by pickoff baffles **32** and **34** which guided it toward the sump **16** for being reconveyed and recascaded in a continuing cycle of operation.

In the development zone, the photoreceptive surface moved continually in an uphill direction against the flow of developer to causes its development. A toner dispenser **36** is provided to add additional quantities of toner to the developer mixture to supplement that toner was from the system through the development of images. Further details of the overall manner of operation may be had by reference to copending application Ser. No. 838,778 filed July 3, 1969 in the name of James M. Lyles et al.

The development electrode **30** of the instant application extends the width of the drum and length of the development zone **22** from adjacent the biased input chutes **24** to a point beneath the three o'clock position of the drum as illustrated in FIG. **2**. In this manner the development zone is extended by the shape of the electrode to a point beyond where it would normally drop from the drum surface under the influence of gravity if the electrode were not so extended.

The electrode is formed of an electrically conductive material mounted on an insulating members **38** such as commercially available circuit board on each side of the electrode to which it is suitably secured by an insulating adhesive or by bolt members **40** as shown in FIG. **2**.

The entire surface of the electrode is preferably smooth in its entire extend through the development zone to minimize turbulence of the developer which might be increased through irregularities in the surface of the electrode face. It is desirable, as in the case of most electrodes, to place the electrode as close as possible to the surface being developed without interferring with the flow of the developer. According to the instant application, it has been found desirable to make a constant spacing of under 0.200 inches, but preferably about 0.060 inches., between the xerographic drum and development electrode throughout the extent thereof. This preferred spacing is suitable when carrier granules of about 0.010 inches are employed. This constitutes about a six diameter spacing between electrode and xerographic plate for the preferred embodiment.

For the development electrode of the instant application to function properly in accordance with the inventive concept herein the electrode should not be contacted by any electrically grounded member. Neither should it be contacted by a source of electrical potential. Thus, it can be seen that such a development electrode, as described herein, is normally electrically neutral and therefore floats with respect to its surroundings. A degree of charge may, however, leak across the dielectric or insulating strip **28** from biased chute **24** to impress a slight potential on floating electrode **30**.

Due to the nature of the electrically floating development electrode, electrical charge on the photoreceptor passing through the development zone and adjacent to the electrode will induce a like polarity charge to the electrode.

The charge induced onto the development electrode is a function of the total quantity of electrical charge there-adjacent or within the development zone at any given time. And the electrical charge on any one segment of the development electrode will naturally be the same as that on any other area of the electrode.

The entire development zone may be considered as a capacitor wherein a change of charge in one of the elements, namely, the photoreceptor, will cause a change in charge in the other element, namely, the electrode. Thus, it can be seen that the entire system is self-regulating to the degree that a change in the pre-exposure charging current or exposure lamp power will not seriously affect the ability of the electrode to function in its normal manner since the electrode will become charged only to the degree required of it as dictated by the charge on the image being developed.

In normal operation within the parameters as described above, it was found that the development electrode charged up quickly to the optimum potential slightly above background. It thus functioned in the manner of a biased development electrode for developing solid areas and minimizing background toner deposition while having the ability to attain optimum conditions. Within the time that a first latent electrostatic image passed through the development zone at the start of any given run or even at the beginning of a day.

By the way of example only, one successful test employing the invention of the instant application included the charging of the photoreceptor to about 750 volts positive and optically discharging to create a charge pattern of about 700 volts positive in image areas and 200 volts positive in non-image areas. With 1,200 volts positive on chute **24** the electrode floated at about 350 volts positive, plus or minus 100 volts, i.e., between 250 and 450 volts positive.

It is thus clear that the floating development electrode is well suited for commercial use in that it attains the advantages of normal development electrodes while adding the further ability to self-regulate itself as a function of the image being developed. All of this is attained without supplemental biasing means within the system.

While the instant invention as to its objects and advantages has been described as carried out in specific embodiment hereof it is not intended to be so limited but it is intended to cover the invention broadly within the scope of the appended claims.

What is claimed is:

1. Xerographic development apparatus including a latent electrostatic image bearing member adapted to be developed, means to move the latent electrostatic image bearing member upwardly through a development zone,

means to cascade a quantity of two components of developer material down the latent electrostatic image bearing member being developed, and

a normally unbiased, electrically isolated, development electrode formed of a conductive member being spaced less than 0.20 inches from the image bearing member such that a varying bias response to the electrical charge carried on said plate surface is induced in said electrode.

2. A xerographic development apparatus for making visible a latent electrostatic image supported upon a photoconductive member including

means to move the image bearing plate through a development zone,

an unbiased electrically isolated development electrode positioned within the development zone in close parallel relation to said plate at a distance to induce a bias in said electrode that varies in response to the electrical charge carried on said plate, and

means to move a quantity of developer material through the development zone between said electrode and said plate whereby the electrostatic image carried thereon is made visible.

3. The apparatus of claim **2** further including

an electrically biased input chute positioned at the developer entrance to the development zone to control the flow of developer material therein, and

electrical insulating means positioned between said input chute and said electrode whereby a continuous surface is presented to developer material moving through the development zone.

4. The apparatus of claim **2** wherein said electrode is positioned less than 0.20 inches from said plate.

5. The apparatus of claim **4** wherein the plate is moved through the development zone in opposition to the flow of developer material.

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