

[54] **APPARATUS FOR PRINTING OF CHARGE IMAGES**

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Related U.S. Application Data

[63] Continuation of Ser. No. 135,294, April 19, 1971, abandoned.

[52] U.S. Cl. **101/1, 101/DIG. 13, 118/637**

[51] Int. Cl. **B41j 27/16**

[58] Field of Search **101/DIG. 13, 1; 118/637**

[56] **References Cited**

UNITED STATES PATENTS

2,633,796	4/1953	Pethick	101/DIG. 13
2,725,304	11/1955	Landrigan et al.	101/DIG. 13
2,885,955	5/1959	Vyverberg	101/DIG. 13
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[57] **ABSTRACT**

An electrically isolated development electrode is disposed immediately adjacent a charge image bearing surface of a charge image bearing structure having a conductive backing. The charge image induces a second charge image in the development electrode and produces an image electric field in the development gap between the first and second charge images. The second charge image further induces a background charge distribution in the backing member of opposite sign to that of the first charge image. An insulative web is disposed in the development gap to receive electroscopic pigment particles for printing either a positive or a negative print of the first charge image. Additional copies may be printed on successively introduced insulative webs without dissipating the first charge image.

1 Claim, 7 Drawing Figures

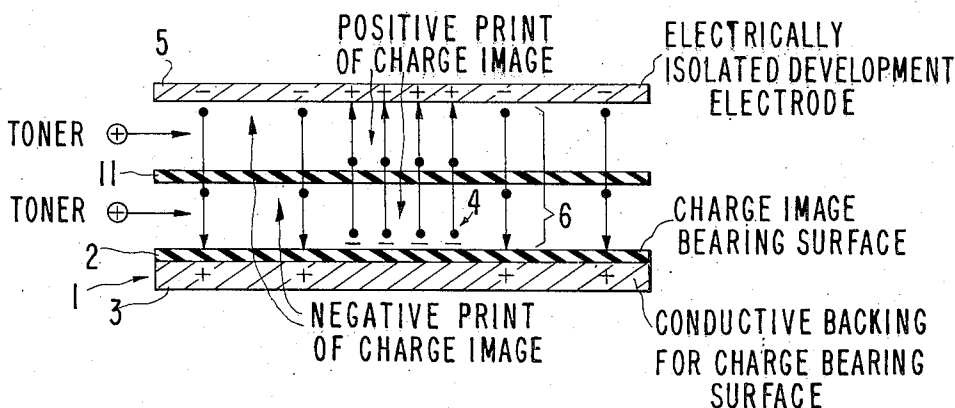


FIG. 1

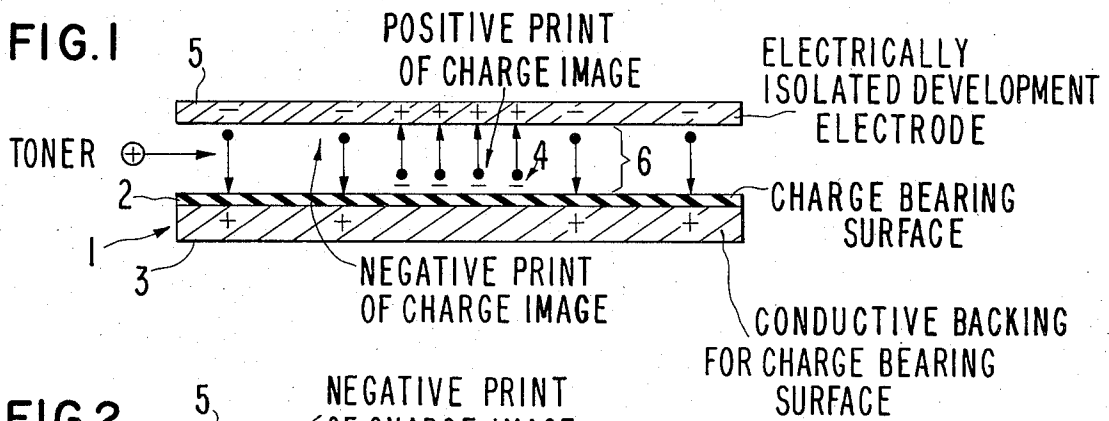


FIG. 2

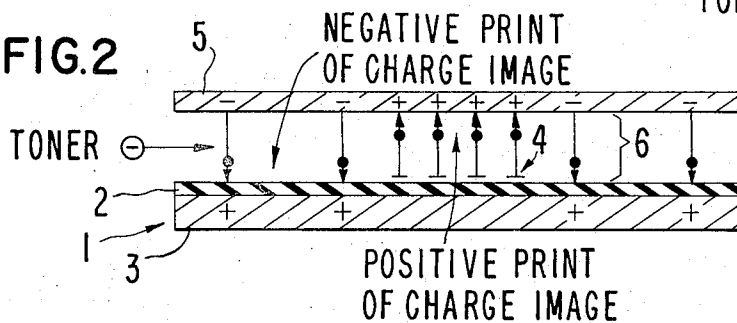


FIG. 3

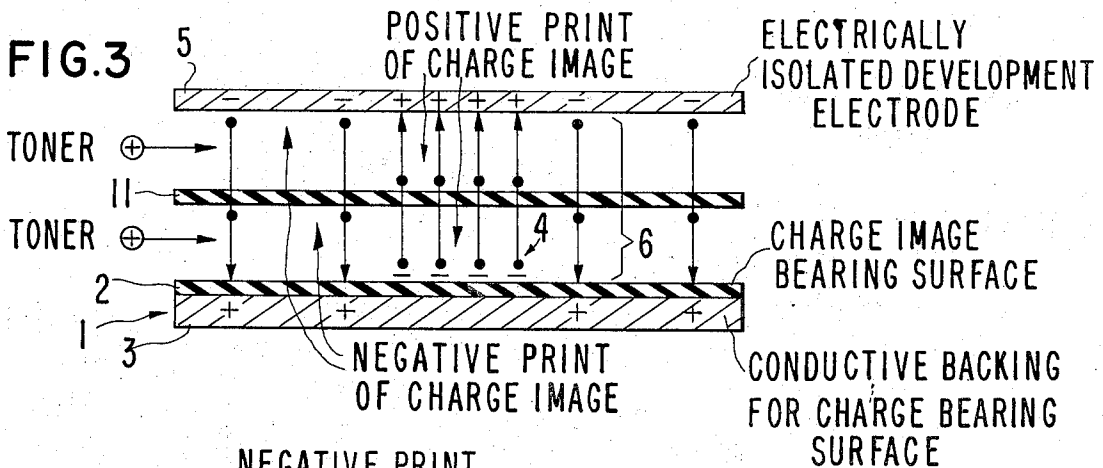
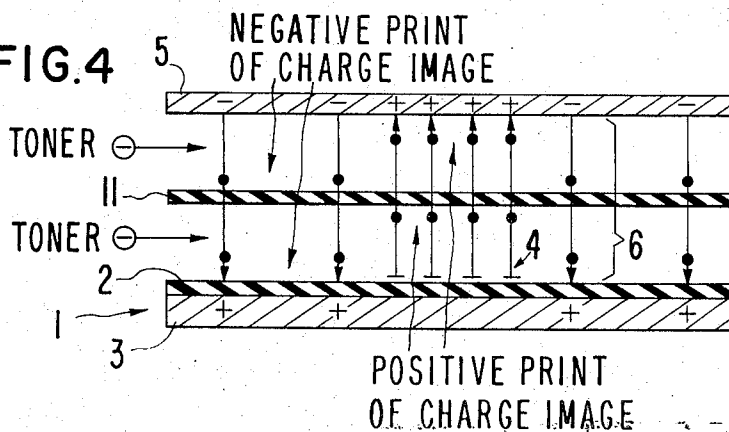


FIG. 4



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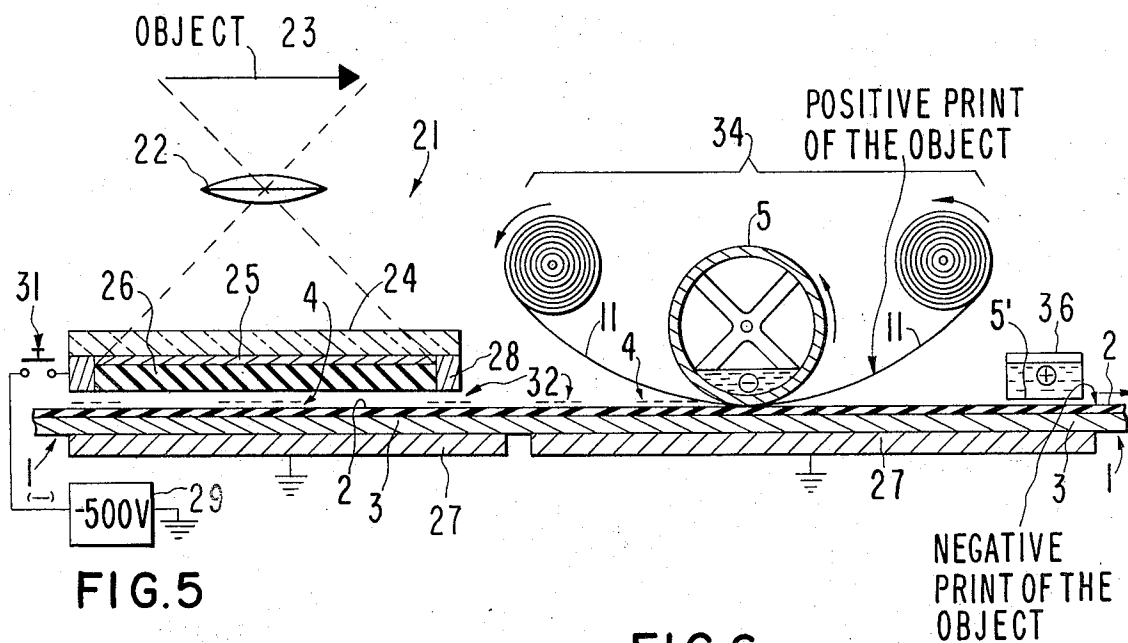


FIG. 6

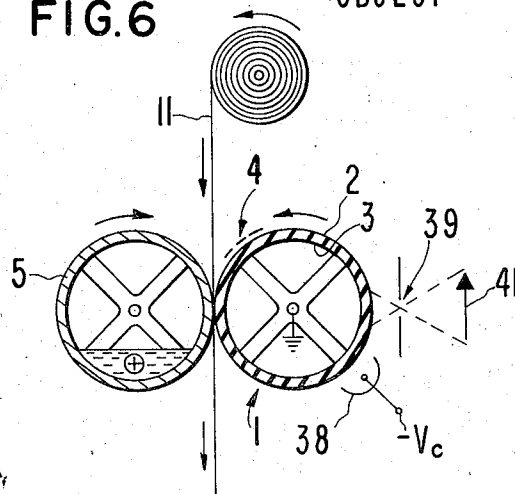
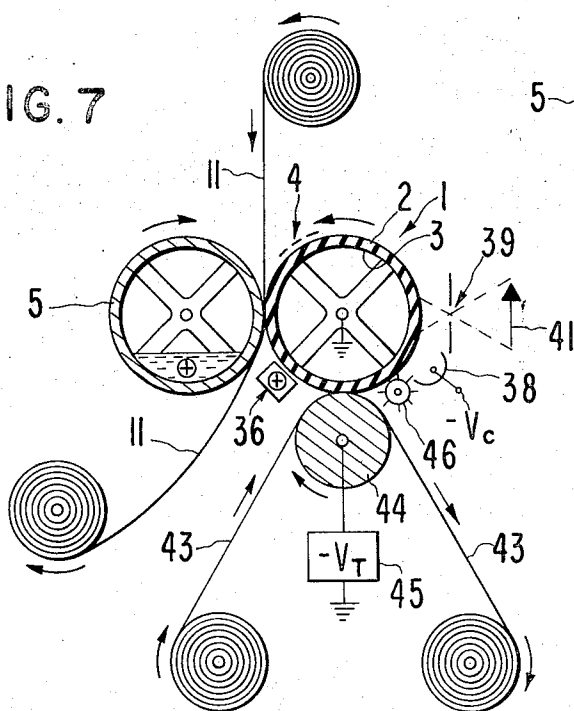


FIG. 7



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APPARATUS FOR PRINTING OF CHARGE IMAGES

This is a continuation of application Ser. No. 135,294 filed 4/19/71 now abandoned.

DESCRIPTION OF THE PRIOR ART

Heretofore, electrically conductive development electrodes have been disposed over a charge image bearing surface backed by a conductive member for improving the development of relatively large area charge images. In the prior art the development electrode was electrically connected for operation at the same potential as the conductive backing member underlying the charge image. In some prior embodiments, such as that disclosed in U.S. Pat. No. 2,573,881 issued Nov. 6, 1951, a relatively high potential, as of 1,500 to 6,000 volts was supplied to the development electrode relative to the backing electrode to prevent undesired printing of the background of the charge image being developed.

In another prior art method and apparatus for developing electrostatic images, the development electrode was grounded to the same potential as the conductive backing portion of the charge image bearing structure. An insulative web was disposed in the electric image field between the development electrode and the charge image bearing surface. Electroscopic pigment particles were introduced into the electric field, either between the web and the charge image or between the development electrode and the insulative web, for developing an image on the insulative web corresponding to the charge image to be developed. Since the charge image on the charge bearing structure was not developed, in the latter case, it was recycled for producing multiple copies from a single charge image. Such a method and apparatus is disclosed in U.S. Pat. No. 2,801,374, issued Aug. 25, 1959.

Both of the aforecited prior art references result in prints which are a positive print of the charge image disposed on the image bearing surface. In some instances, it is desirable to obtain a negative print of the charge image being developed. In other instances, it may be desirable to obtain both a negative and a positive print of the charge image.

SUMMARY OF THE PRESENT INVENTION

The principal object of the present invention is the provision of improved method and apparatus for printing charge images.

In one feature of the present invention, an electrically isolated conductive development electrode is disposed adjacent a charge image bearing surface overlaying an electrically conductive backing member, whereby the charge image on the charge bearing surface induces a charge image pattern of opposite sign in the isolated development electrode which in-turn induces a background charge image in the conductive backing member of opposite sign to the charge image on the charge bearing surface. Either a positive or negative print of the charge image pattern may be developed by introducing electroscopic pigment particles of the proper sign into the development gap between the charge bearing surface and the development electrode.

In another feature of the present invention, an electrically insulative web is interposed in the development gap between the charge bearing surface and the electri-

cally isolated development electrode, such web intercepting the electric field lines of the electric field pattern, whereby either a positive or a negative print may be obtained on the insulative web, of the charge image pattern by introducing charged toner particles of proper sign into the electrical field image pattern.

Other features and advantages of the present invention will become apparent upon perusal of the following specification taken in connection with the accompanying drawings, wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic cross sectional view depicting the method and apparatus for developing charge images according to the present invention,

FIG. 2 is a sketch similar to that of FIG. 1 depicting an alternative embodiment of the present invention,

FIG. 3 is an apparatus similar to that of FIGS. 1 and 2 with the exception of the introduction of an insulative web between the development electrode and the charge image bearing surface,

FIG. 4 is a view similar to that of FIG. 3 depicting an alternative embodiment of the present invention,

FIG. 5 is a schematic diagram, partly in block diagram form, depicting an electrographic camera and development apparatus according to the present invention,

FIG. 6 is a schematic cross sectional view of an electrographic apparatus incorporating features of the present invention, and

FIG. 7 is a view similar to that of FIG. 6 showing an alternative embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is shown method and apparatus for development of charge images and incorporating features of the present invention. More particularly, a charge image bearing structure 1 includes an insulative charge image bearing layer 2 supported upon an electrically conductive backing member 3. A charge image 4, such as a negative charge image, is deposited upon a charge image bearing surface of the insulative layer 2. In a typical example, the charge image bearing structure 1 may comprise, a sheet of dielectric coated conductive paper, a sheet of photoconductive coated paper, an xerographic plate as of selenium with a conductive backing member, or merely an insulative film overlaying an electrically conductive backing plate 3.

A development electrode 5, such as a metallic plate, wire screen, electrically conductive paper, or porous metal plate, is closely disposed adjacent the image bearing layer 2 to define a development gap 6 in the space between the development electrode 5 and the charge bearing structure 1. The development electrode 5 is electrically isolated from the conductive backing member 3. As a negative charge image 4 is brought into close proximity to the development electrode 5, i.e., within 10's of microns to 100's of microns, the negative charge image 4 induces a second charge image of opposite polarity in the adjacent face of the conductive development electrode 5. The induced positive charge image, which is mutually opposed to the negative charge image 4 depletes the background area of the development electrode 5 of positive charge, thereby inducing a negative charged background image in the development electrode. This induced negative back-

ground image in the development electrode induces a background image in the backing member 3 of positive polarity. Thus, in the presence of the electrically isolated development electrode 5, the deposited charge image 4 induces an image electric field pattern in the development gap 6 which has one direction over the deposited charge image and opposite direction over the background areas of the deposited charge image.

When electroscopic pigment particles (toner) of an electrical sign opposite to the sign of the deposited charge image are introduced into the development gap 6 a positive print of the deposited charge image is obtained on the charge bearing structure 1, and a negative print of the charge is developed or printed on the development electrode 5.

Conversely, as shown in FIG. 2, if a toner having an electrical sign which is the same as the electrical sign of the deposited charge image is introduced into the development gap 6, a negative print of the charge image is obtained on the charge bearing structure 1 and a positive print of the deposited charge image is developed or printed on the development electrode 5. The electroscopic pigment may be pigment particles suspended in a dielectric liquid or may comprise a powdered electroscopic pigment suspended in a gas such as air. Alternatively, the toner particles may be carried by a suitable carrier medium, such as glass beads or on an insulative web.

The intensity of the induced background image may be increased by depositing additional charges on the charge bearing layer 2, of the same electrical polarity as the deposited charge image 4, about the marginal edge of the print to be developed. Such additional charge may be deposited in any one of a number of ways, such as by contacting the charge bearing surface 2 with a conductive electrode operated at a potential of the same sign as the charge image 4 and at preferably a higher potential than the potential of the charge image 4 relative to the potential applied to the backing member 3. In the case where the charge image bearing layer 2 is a photoconductor the additional charges to be placed about the marginal edge of the image to be developed, may be deposited at the same time as the charges forming the image 4 and just not drained off through the photoconductive layer 2 when exposed to the radiation utilized to form the image 4. The purpose of the additional charge about the margin of the image to be developed is that it produces additional induced background charge images in the development electrode 5 which in-turn increases the induced background image intensity in the conductive backing electrode 3.

Referring now to FIG. 3, there is shown a method and apparatus for printing both a positive and negative print on a printing medium of the deposited charge image 4. More particularly, the apparatus of FIG. 3 is substantially the same as that of FIGS. 1 and 2 with the exception that an insulative web 11, as of insulative paper, dielectric film, or the like, is interposed in the development gap 6 between the development electrode 5 and the charge image bearing layer 2, such that the charge image electric field pattern passes through the insulative web 11. Toner particles having an electrical sign opposite to the sign of the charge image 4 are introduced into the electric field regions of the development gap 6 on opposite sides of the web 11. Such electroscopic toner particles under the influence of the in-

duced electric fields develop a positive print of the charge image 4 on the charge image bearing structure 1 and on the upper surface of the insulative web 11. Such toner particles also develop negative prints of the charge image on the bottom side of the insulative web 11 and on the bottom side of the development electrode 5.

Conversely, as shown in FIG. 4, the introduction of electroscopic pigment particles (toner) of a sign, which is the same as that of the charge image 4, serves to develop or print a positive print of the charge image 4 on the bottom surface of the insulative web 11 and on the bottom surface of the development electrode 5. A negative print of the charge image 4 is formed on the upper surface of the insulative web 11 and on the upper surface of the charge bearing electrode 1.

The apparatus and method of FIGS. 3 and 4 offers the ability to print multiple copies of the deposited charge image 4 without destroying the image 4. More particularly, if the toner particles are introduced only into that portion of the development gap between the development electrode 5 and the insulative web 11, and the insulative web serves as a barrier to the toner particles such that they do not develop the charge image pattern on the charge image electrode 1, positive prints of the original charge image may be produced utilizing the method of FIG. 4. The cycle may be repeated to obtain multiple copies on successively introduced and toned insulative webs without destroying the original deposited charge image 4.

Referring now to FIG. 5, there is shown an electrographic camera apparatus 21 incorporating features of the present invention. The electrographic camera 21 includes a lens 22 for focusing the image of an object 23 through a transparent support 24, as of glass, and transparent electrode 25, as of tin-oxide, onto a photoconductive plate 26. A charge image bearing structure 1, such as dielectric coated conductive paper with the dielectric coating forming the charge retentive layer 2 overlaying the conductive paper backing 3, is disposed over a ground plate electrode 27.

The insulative charge retentive layer 2 is in nominal contact with the photoconductor 26. A conductive electrode 28 frames the photoconductor plate 26 for depositing a charge image around the marginal edge or frame of the image to be photographed. A potential source 29, of relative high potential as of -500 volts, is connected between ground and the transparent electrode 25 via the intermediary of a timing switch 31.

The object 23 is photographed by illuminating the object and pressing the timing switch 31 for a suitable exposure time to transfer the charge from the transparent electrode 25 through the portions of the photoconductor illuminated by the object and across the gap between the photoconductor and the charge retentive layer 2 to deposit a charge image 4 on the charge retentive layer 2. The charge image 4 is an image of negative charge corresponding to a negative image of the object 23. Image 4 is framed by framing image 32 having the same sign as the charge image 4.

After exposure, the charge image 4 on the image bearing structure 1 is advanced into a printing or developing section 34. In the developing section 34, the charge image bearing structure 1 is fed under a development drum 5 together with an insulative printing web 11, as of paper. The drum 5 is porous and forms the development electrode. Electroscopic pigment particles

5

having the same sign as the charge image 4 are suspended in a suitable dielectric liquid within the porous development drum 5. The drum 5 is electrically isolated from the conductive backing member 3 and from the grounded electrode 27. In the same manner as previously described with regard to FIG. 4, a negative print of the charge image 4 is printed on the upper surface of the paper web 11 to form a positive print of the object 23. A second development station 36 having a second porous development electrode 5' disposed adjacent the upper surface of the charge image 4 and filled with electroscopic pigment particles having a positive charge or a sign opposite to that of the sign of the image 4 serves to develop the charge image 4 on the charge image bearing structure 1, in the same manner as previously described with regard to FIG. 3, to obtain a negative print of the object 23. Thus, in the camera 21 of FIG. 5, both a positive and a negative print of the object 23 is obtained.

Referring now to FIG. 6, there is shown an alternative embodiment of the present invention. In this embodiment, the charge image bearing structure 1 comprises a xerographic drum having a photoconductive charge retentive layer 2 deposited overlying a conductive drum 3. A corona discharge charging station 38 charges the photoconductive layer 2 with a uniform high negative charge. As the drum 1 rotates past a camera aperture 39, light from an object 41 illuminates the photoconductor 2 to selectively discharge the photoconductor in accordance with the object 41 to leave a negative charge image 4 on the drum. The negative charge image 4 corresponds to a positive image of the object 41.

As the drum 1 rotates, the negative charge image 4 to be developed rotates under a development electrode drum 5 of the type previously described with regard to FIG. 5. The drum 5 is loaded with positively charged electroscopic pigment particles. A printing web 11 of insulative material, as of paper, is fed between the development electrode 5 and the charge image 4 on the xerographic drum 1. The positive electroscopic pigment particles are drawn from the development electrode 5 to the web 11, in the manner as previously described with regard to FIG. 3, to produce a positive print of the charge image and thus a positive print of the object 41. The development electrode 5 operates at an independent floating potential relative to the potential of the drum 3.

Referring now to FIG. 7 there is shown an alternative embodiment of the present invention. The apparatus of FIG. 7 is essentially identical to that of FIG. 6 with the exception that the charge image 4 on the xerographic drum 1 is also developed by means of a development

6

station 36, as previously described with regard to FIG. 5 to produce a positive print on the xerographic drum. The print on the drum is then transferred to a second printing web 43, as of paper, which passes around the transfer drum 44 adjacent the developed charge image 4 on the drum.

The transfer drum 44 is operated at a high negative potential relative to the grounded potential of the xerographic drum for transferring the positive toner particles of the image 4 from the xerographic drum 1 to the second printing web 43. Transfer voltage is supplied to the transfer drum 44 from a supply 45. Thus, in the apparatus of FIG. 7 two positive prints of the object 41 are obtained, one on web 11 and the other on web 43. The drum 1 is then cleaned by cleaning station 46 to remove toner particles from the drum prior to recharging the drum at the charging station 38.

What is claimed is:

1. An apparatus for toning an image corresponding to a charge image on an insulative charge retentive layer overlying an electrical conducting backing member, comprising the combination:

an insulative charge retentive layer overlying an electrical conducting backing member;

development electrode means which is electrically conductive and disposed adjacent the charge retentive surface defining a development gap therebetween which is sufficiently narrow to permit the charge image on the charge retentive surface to establish a corresponding electric field across the development gap to induce a charge image on the development electrode, the development electrode means being electrically isolated from the backing member and operating at an independent floating potential with respect thereto;

an insulative web positioned in the development gap in spaced relationship from the charge retentive surface and from the development electrode means and dividing the development gap into two portions, one portion formed by the insulative web and the development electrode and the other portion formed by the insulative web and the charge retentive surface, the web receiving a charge image thereon by induction by means of the electric field extending across the development gap; and

means for applying toner into at least one of the development gap portions, which toner migrates under the influence of the electric field towards at least one of the charge images to establish a toned image corresponding to the charge image on the charge retentive surface.

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