

[54] **COPIER PHOTORECEPTOR CHARGE CONTROL**

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[51] Int. Cl. **G03g 15/02**

[58] Field of Search **317/262 A; 355/3 R**

[56] **References Cited**

UNITED STATES PATENTS

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Primary Examiner—L. T. Hix

[57] **ABSTRACT**

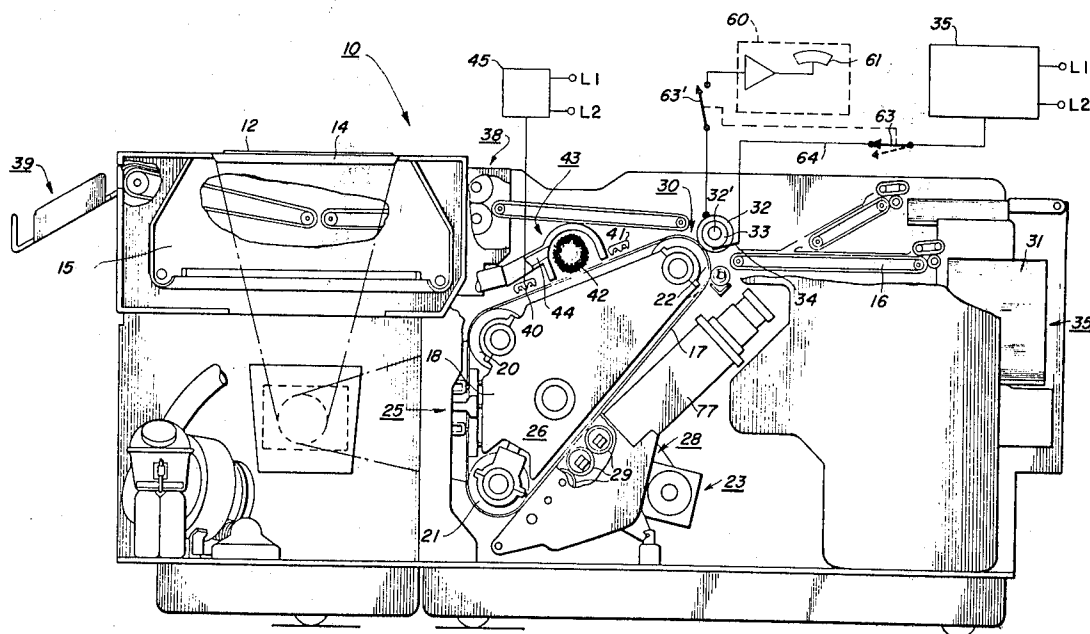
A charge control arrangement for a reproduction machine. The machine has a photoconductive member,

the surface of which has been uniformly charged to permit the creation of a latent electrostatic image of the original being copied thereon. The latent image is then developed and thereafter transferred to a copy sheet. Following transfer, the photoconductive member is cleaned in preparation for another cycle.

To monitor the charge on the photoconductive member, voltage across the copy machine transfer roll is sensed. From this, the corotron power supply is adjusted to provide a desired photoconductor charge level. Alternately, a control may be provided to automatically regulate the corotron power supply in response to the transfer roll voltage sensed. In this latter instance, sensor means to accomodate the presence of a copy sheet in the transfer roll nip is provided to obviate any erroneous readings due to the interposition of the copy sheet between the transfer roll and the photoconductive member.

As a further embodiment, a separate conductive roller probe may be used instead of the transfer roller or in machines not having a transfer roller, the roller probe being disposed in physical contact with the photoconductive member.

10 Claims, 3 Drawing Figures



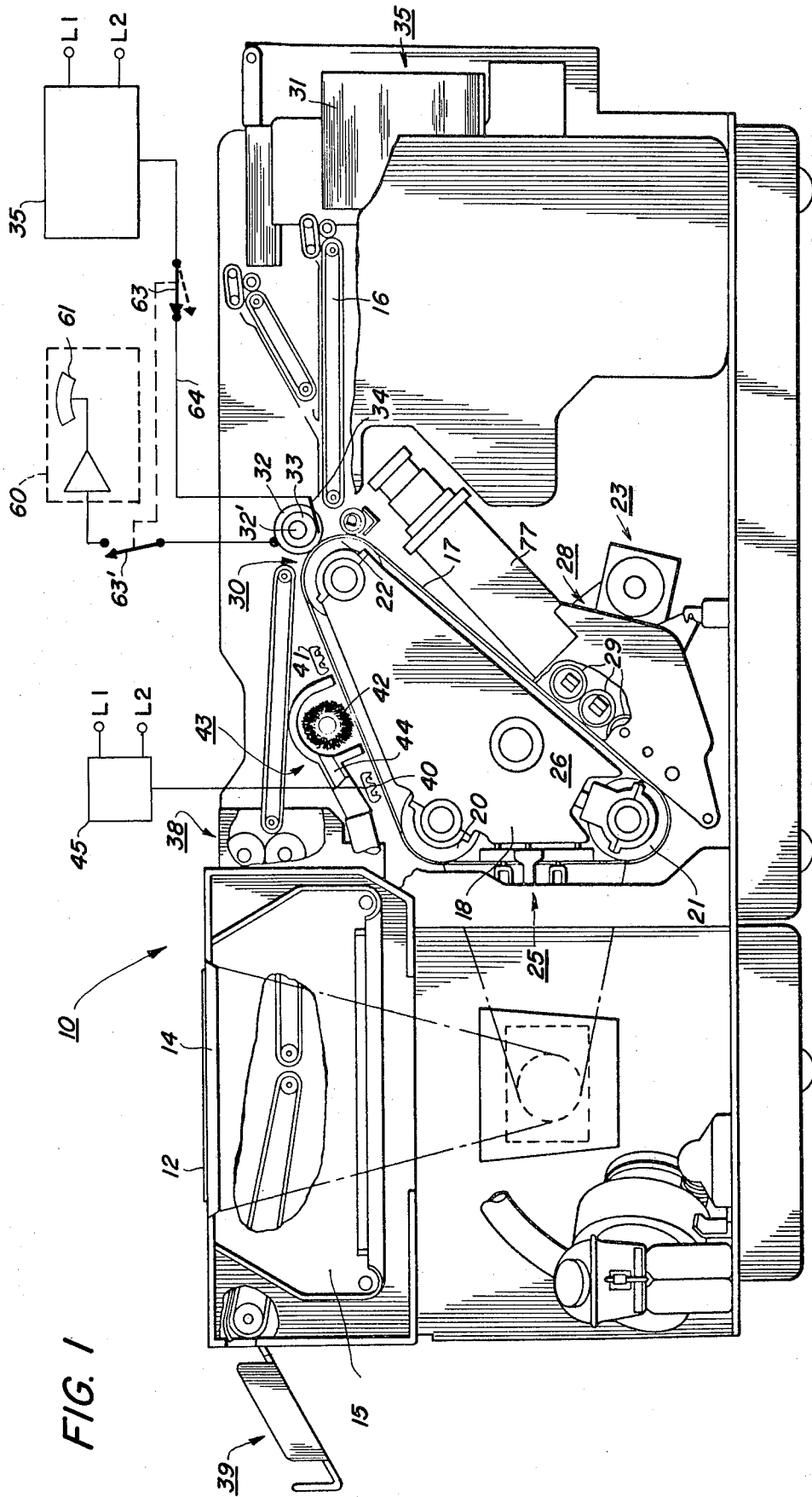


FIG. 2

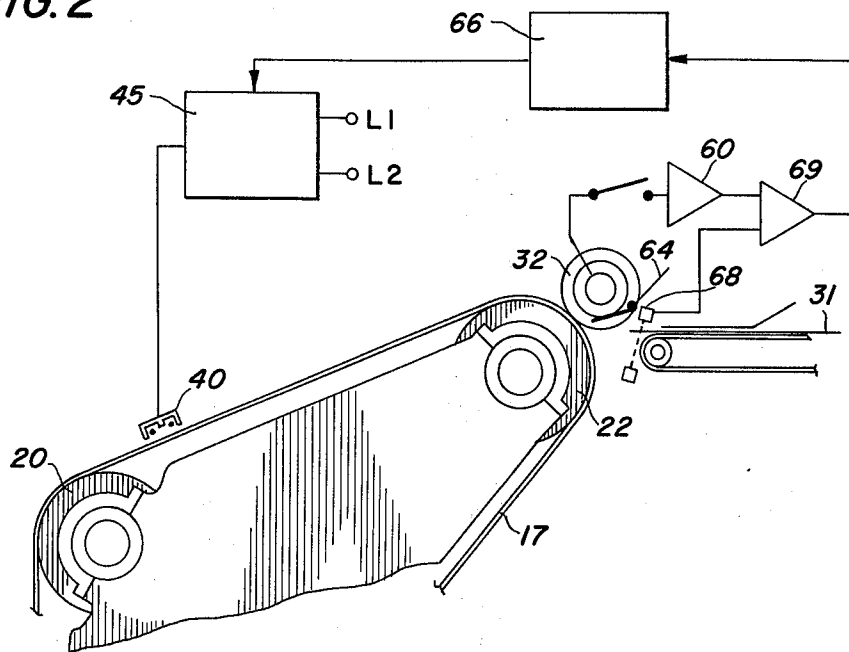
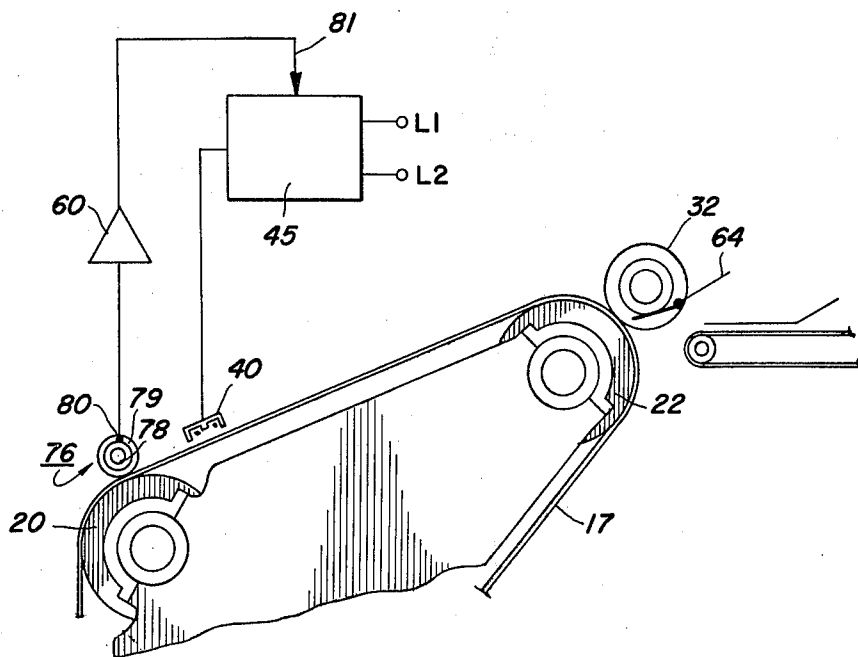


FIG. 3



COPIER PHOTORECEPTOR CHARGE CONTROL

This invention relates to a charge control system for reproduction machines and, more particularly, to improved charge control systems wherein the sensing probe is in physical contact with the photoconductive surface whose charge is being controlled.

In reproduction or copying machines, a predetermined charge is normally placed on the surface of the machine photoconductor in preparation for imaging. The charged photoconductor is then exposed and a latent electrostatic image is formed. This latent image is next developed by an electrostatically attractable marking medium conventionally called toner, and the image so developed is then transferred to a copy sheet. Following transfer, the image bearing sheet is exposed to heat to permanently fix or fuse the image.

The charge placed on the photoconductor of the machine is critical to the production of good quality copies. And while the charging device, normally a corotron, may be factory set to an optimum design condition, subsequent operation and aging of the copying machine and the components thereof may require a change or adjustment in the level to which the machine photoconductor is charged.

In this regard, the charge conditions of the photoconductor may be checked, either intermittently or continuously and adjustments made either manually or automatically to the corotron power supply. One device which may be used to measure the charge on a photoconductor comprises an electrometer. Since it is generally considered desirable to avoid placing an element in physical contact with the moving copying machine photoconductor except where absolutely necessary for fear of damaging or scratching the fragile surface of the photoconductor, most electrometers employ a rather sophisticated and expensive capacitance type probe which permits probe disposition adjacent to but out of physical contact with the photoconductive surface.

It is therefore a principle object of the present invention to provide a new and improved reproduction machine.

It is a further object of the present invention to provide an improved method and apparatus for monitoring photoconductive charge conditions.

Another object of the present invention is to provide an arrangement to permit adjustment of the charge on the photoconductive surface of an electrostatic type copier in response to actual charge conditions.

It is an object of the present invention to provide method and apparatus for sensing operating conditions in an electrostatic type copier by using the copier transfer roller itself as the probe.

It is an object of the present invention to provide apparatus and method for sensing charge conditions on the photoconductor of a copier utilizing a direct contact probe.

It is an object of the present invention to provide a photoconductor charge controlling system wherein the charge level on the surface of the photoconductor is measured by means of a probe element in physical contact with the photoconductor surface, the signal of such probe working through a controller to regulate the charge corotron power source.

It is a further object of the present invention to provide an improved roller probe for use in detecting

charge conditions on the surface of the photoconductor of an electrostatic type copier.

This invention relates to a method of adjusting the charge level on the photoconductor of an electrostatic reproduction machine which uses a corona charging device to charge the photoconductor in preparation for creating an electrostatic image thereon, the machine incorporating a transfer roller cooperable with the photoconductor to transfer images developed from the photoreceptor to copy material, the steps which consist of: measuring the electrical output of the transfer roller, and adjusting the power input to the corona charging device to provide a predetermined transfer roll electrical output representing optimum photoconductor charge conditions.

The invention further relates to an electrostatic type reproduction machine, comprising, in combination: corona charging means for generating a charge on the machine photoconductor in preparation for imaging thereof; means to measure charges on the photoconductor, the charge measuring means including a probe member in physical and electrical contact with the surface of the photoconductor; an adjustable source of power for the corona charging means; and control means responsive to the charge measuring means for adjusting the charging means power source whereby to provide a predetermined charge on the photoconductor.

Other objects and advantages will be apparent from the drawings in which:

FIG. 1 is a schematic of an exemplary reproduction machine incorporating the charge control system of the present invention wherein the transfer roller functions as the charge sensor;

FIG. 2 is a partial schematic showing a second embodiment of the invention wherein automatic charge control is provided; and

FIG. 3 is a partial schematic of a third embodiment of the invention, utilizing an electrometer and contacting roller probe.

Referring particularly to FIG. 1 of the drawings, an exemplary copier/reproduction machine, designated generally by the numeral 10 and incorporating the charge control system of the present invention, is there shown. As in all electrostatic systems such as the xerographic type machine illustrated, a light image of a document to be reproduced is projected onto the sensitized surface of a xerographic plate to form an electrostatic latent image thereon. Thereafter, the latent image is developed with an oppositely charged developing material to form a xerographic powder or toner image, corresponding to the latent image on the plate surface. The toner image is then electrostatically transferred to a support surface where it is fused by a fusing device so that the toner image is permanently adhered to the support surface.

In machine 10, an original document 12 to be copied is placed upon a transparent support platen 14 fixedly arranged in an illumination assembly generally indicated by the reference numeral 15 and disposed at the left end of the machine. While upon the platen, the document 12 is illuminated, thereby producing image rays corresponding to the informational areas on the original. The image rays are projected by means of an optical system onto the photosensitive surface of a xerographic plate. In the exemplary copier/reproduction machine 10, the xerographic plate is in the form of a

flexible photoconductive belt 17 supported in a belt assembly 18.

The support assembly 18 for photoconductive belt 17 includes three rollers 20, 21, and 22 located with parallel axes at approximately the apices of a triangle. The upper roller 22 is rotatably driven by suitable motor and drive means 23 to drive belt 17 in the direction shown by the arrow in FIG. 1. During this movement of the belt, the reflected light image of the original document 12 on platen 14 is flashed upon the photoreceptor surface of belt 17 at an exposure station 25 to produce an electrostatic latent image thereon.

The continued movement of photoconductive belt 17 carries the electrostatic image through a developing station 26 in which there is positioned a developer assembly generally indicated by the reference numeral 28. There, the latent electrostatic image is developed by means of toner through the use of a multiple magnetic brush system 29. Developer assembly 28 includes toner supply section 77 whereat a supply of toner is stored, such toner serving to replenish toner depleted during operation of copier 10.

The developed electrostatic image is carried by belt 17 to the transfer station 30 where the developed image is transferred to a support surface, normally a sheet of copy paper 31, brought forward in the nip between transfer roller 32 and belt 17. In order to accomplish transfer of the developed image solely by means of the electrical bias on transfer roller 32, the copy sheet 31 is moved at substantially the same speed as belt 17. A sheet transport mechanism generally indicated at 16 is provided to advance copy sheets 31 from a paper handling mechanism generally indicated by the reference numeral 35 to transfer station 30.

Following transfer, the copy sheet 31 is stripped from belt 17 and conveyed through fuser 38 wherein the toner image is permanently fused or affixed thereto. Following fusing, the finished copy is discharged into output tray 39.

Photoconductive belt 17 comprises a photoconductive layer of selenium, which is the light receiving surface and imaging medium for the apparatus, on a conductive backing. Further details regarding the structure of the belt assembly 12 and its relationship with the machine and support therefor may be found in U.S. Pat. No. 3,730,623, issued May 1, 1973, and assigned to the same assignee.

Transfer roll 32 comprises a rigid hollow cylinder of conductive metal such as aluminum capable of accepting a biasing potential, and upon which one or more sleeve-like coverings of a suitable elastomeric material are placed. The elastomeric covering allows roll 32 to deform inwardly at the point of contact with the surface of belt 17 and provide an extended contact region whereat the toner particles are transferred from belt 17 to the sheets 31 passing therebetween.

Transfer roll 32 is provided with suitable means such as dielectric end caps to electrically isolate roll 32 from the supporting frame of reproduction machine 10. The supporting shaft 32' of transfer roll 32 is journaled for rotation in the machine frame by suitable bearing means (not shown). A drive pulley (not shown) may be provided on roll shaft 32' to enable roll 32 to be rotated in predetermined timed relationship with photoconductor belt 17 from the machine driving source.

To provide desired electrical bias to transfer roll 32, a commutator ring 33 may be provided with one of the

dielectric end caps commutator rings 33 being in electrical contact with the metal core portion of roller 32. Contact brush 34 serves to electrically connect ring 33 and roll 32 through lead 64 with a suitable source 35 of d.c. power, commutator ring 33 and brush 34 cooperating in a manner understood by those skilled in the art to provide an electrical path from d.c. source 35 to the rotating transfer roll 32. By this means, a voltage contrast between belt 17 and transfer roller 32 is established to enhance transfer of the images developed on the surface of belt 32 to the sheets 31 passing through the nip formed by belt 17 and roll 32. A typical bias for transfer roll 32 is 3,500 volts d.c., the polarity of which is opposite to that of the charged toner particles delineating the images on belt 17.

In order to provide a uniform charge on belt 17 in preparation for subsequent exposure, a charge corotron 40 is provided, corotron 40 being arranged downstream from transfer roll 32 and before exposure station 25. In the exemplary machine 10, to assure removal of leftover toner from belt 17 prior to charging thereof, a pre-clean corotron 41 and vacuum assisted cleaning brush 42 are provided before charge corotron 40. As will be understood by those skilled in the art, pre-clean corotron 41 aids in neutralizing the electrostatic charge tending to retain leftover toner particles on belt 17, while brush 42 serves through physical contact with the surface of belt 17, to scrub or wipe the leftover toner particles therefrom. Cleaning brush 42 is supported within a suitable evacuated housing 43, with discharge vacuum line 44 being provided to convey the toner particles removed by brush 43 away.

A suitable source of electrical power 45 is provided for operating corotron 40 to provide, through corona emissions, in the manner known to those skilled in the art, a desired electrostatic charge of the photoconductive surface of belt 17 preparatory to imaging thereof. (See FIG. 2).

In the embodiment illustrated in FIG. 1, a suitable voltage measuring device 60 which preferably comprises a high input impedance operational amplifier, is provided to measure electrical output across the transfer roll 32. The voltage across transfer roll 32 as sensed by sensor 60 is a function of the potential on the photoconductive surface of belt 17 at transfer roll 32. To enhance accuracy, both the bias supply to transfer roll 32 and the feeding of copy sheets 31 are interrupted. To effectuate the former, a switch 63 is provided in the transfer roll bias lead 64 adapted when opened to interrupt the bias supplied to roll 32. Switch 63 has a second contact 63' in the lead to detector 60, contact 63' being arranged to close on opening of bias circuit switch contact 63, and vice versa. Thus, when it is desired to monitor the charge effectiveness of corotron 40, switch 63 is opened to interrupt bias to transfer roll 32. At the same time, contact 63' thereof is closed to complete the circuit to detector 60.

As will be understood by those skilled in the art, copy sheets 31, which are normally paper, are to a greater or less degree, electrically insulative. Hence, to ensure an accurate reading by detector 60, any voltage reading is taken only when there is no copy sheet in the nip between belt 17 and transfer roll 32. This may be effected by terminating the feeding of sheets 31 while a reading or series of readings is being taken or taking any reading between successive sheets 31.

Under the above conditions, with the feeding of sheets 31 and the bias supply to transfer roll 32 interrupted, and with the surface of belt 17 charged but not exposed, the voltage reading of detector 60 reflects the undissipated charge on belt 17, ignoring any losses inherent in the system. However, where the portion of belt 17 opposite roll 32 comprises an image area, that is, where exposure has taken place, the voltage reading 60 normally represents a dissipated or partially dissipated charge. Since any reading is normally taken over a time span, a reading can be obtained representing the average charge on the image area which may then be used to adjust the power to corotron 40.

As described above, the charge effectiveness of corotron 40 can be determined by measuring the voltage across the transfer roll 32. In this, transfer roll 32 serves in effect as a probe for detector 60. From the voltage reading taken, the power input from source 45 to corotron 40 may be adjusted to provide a desired charge on belt 17.

Detector 60 includes a meter 61 facilitating read out of detector 60. Based on the indication of meter 61, corotron power supply 45 is adjusted until the voltage reading obtained indicates an optimum charge on belt 17.

In the arrangement illustrated in FIG. 2, an automatic feed back system is provided wherein the signal output of detector 60 is used to regulate or adjust the power supply 45 of corotron 40. In this arrangement, a suitable control circuit 66 is provided for controlling the corotron power supply 45 in response to the signal output from detector 60. To assure an effective reading, a suitable sheet sensor 68 is provided in the paper path proximate transfer roll 32 to sense the presence or absence of sheets 31 in the transfer roll nip. The signal output from sensor 68, reflecting the absence of a sheet 31 from the transfer roll nip, serves to enable gate 69 which in turn permits the signal output of detector 60 to be impressed on control circuit 66. The resulting signal from circuit 66 sets corotron power supply 45.

In the embodiment shown in FIG. 3, the probe unit for detector 60 consists of a conductive roller 76 supported in rolling contact with belt 17 by suitable means (not shown). Roller 76 preferably comprises a metal core 78 bearing a relatively soft elastomeric covering or coating 79. Contact brush 80 rides against core 78 of the roller 76 to conduct the voltage signal therefrom to the input of detector 60.

Preferably, the roller probe 76 is disposed between charge corotron 40 and exposure station 25. The voltage on roller probe 76 which is a function of the charge on the photoconductive surface of belt 17, is responded to by detector 60 to regulate power input to corotron 40 from the corotron power supply 45.

While roller probe 76 is disclosed as positioned between charge corotron 40 and exposure station 25, probe 76 may be located after exposure in the area between exposure station 25 and developing station 26. And while an automatic control system for the corotron power supply 45 is shown in FIG. 3, it will be understood that a manual or operator controlled arrangement similar to that of FIG. 1 may be envisioned. In that instance, the line 81 coupling the output of detector 60 to the corotron power supply 45 would be dispensed with and a suitable meter, such as the meter 61 shown in the FIG. 1 embodiment, would be provided with detector 60.

It will be understood that current may instead of voltage be sensed in the various embodiments described. It will further be understood that, while the output of detector 60 has, throughout the several embodiments described above, been used to control power to corotron 40, other devices in the xerographic system, such as the bias applied to developer rolls 29, or the exposure intensity of illumination system 15, may instead be regulated either independently or in conjunction with the power supply to corotron 40.

While the invention has been described with reference to the structure disclosed, it is not confined to the details set forth, but is intended to cover such modifications or changes as may come within the scope of the following claims.

What is claimed is:

1. The method of controlling the charge level on the photoreceptor of an electrostatic reproduction machine of the type having corona charging means for placing a charge on the photoreceptor in preparation for imaging together with means including a biased transfer roller to transfer images developed on said photoreceptor to copying material, the steps consisting of:
 - interrupting bias to the transfer roller while measuring the transfer roller electrical output; and adjusting said corona charging means to provide a predetermined transfer roller output representing optimum charge on said photoreceptor.
2. The means according to claim 1 including the step of measuring voltage across said transfer roller.
3. The method according to claim 1 including the step of measuring current across said transfer roller.
4. The method according to claim 1 including the step of terminating the feeding of copying material while measuring said transfer roller electrical output.
5. In an electrostatic reproduction machine of the type having corona charging means for generating a charge on the photoreceptor in preparation for imaging thereof together with means to transfer the images developed on said photoreceptor surface to copying material, said transfer means including a biased transfer roll, the combination of:
 - means for monitoring voltage across said transfer roll during operation of said machine,
 - means to interrupt bias to said transfer roller while said transfer roller voltage is being monitored, and
 - means to adjust said corona charging means in response to said monitoring means output to provide a predetermined voltage across said transfer roller representing an optimum charge on said photoreceptor surface.
6. In an electrostatic reproduction machine of the type having corona charging means for generating a charge on the photoconductor in preparation for imaging thereof, the combination of:
 - means to measure charges on said photoconductor, said charge measuring means including a probe member in physical and electrical contact with said photoconductor,
 - an adjustable power source for said corona charging means,
 - control means responsive to said charge measuring means for adjusting said charging means power source whereby to provide a predetermined charge on said photoconductor.

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7. The reproduction machine according to claim 7 in which said reproduction machine includes a transfer roller cooperable with said photoconductor to transfer images developed on said photoconductor to copying material, said probe member comprising said transfer roller.

8. The reproduction machine according to claim 7 in which said probe member comprises a roller, and means supporting said roller in rotatable engagement with the surface of said photoconductor member.

9. The reproduction machine according to claim 9 in

which said roller supporting means supports said roller in engagement with said photoconductive member after said photoconductive member is charged but before said photoconductive member is imaged.

10. The reproduction machine according to claim 9 in which said roller supporting means supports said roller in engagement with said photoconductive member after said photoconductive member is imaged but before the photoconductive member image is developed.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,887,845

DATED : June 3, 1975

INVENTOR(S) : Robert J. Michatek

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

Col. 7, line 1, change "7" to -- 6 --.

Col. 7, line 7, change "7" to -- 6 --.

Col. 7, line 11, change "9" to -- 8 --.

Col. 8, line 5, change "9" to -- 8 --.

Signed and Sealed this

sixteenth Day of September 1975

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks