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Hastwell

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[54] **CORONA CHARGER CONFIGURATION**

[75] Inventor: **Peter J. Hastwell,** North Adelaide, Australia

[73] Assignee: **Savin Business Machines Corporation,** Vahalla, N.Y.

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[52] **U.S. Cl.** **250/324,** 250/326

[51] **Int. Cl.** **G03g 15/00**

[58] **Field of Search** ..... 250/49.5 ZC, 49.5 GC, 250/49.5 TC

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Primary Examiner—James W. Lawrence
Assistant Examiner—C. E. Church
Attorney—Henry L. Shenier et al.

[57] **ABSTRACT**

Charging Apparatus for an electrostatic copier wherein a photoconductive surface is electrostatically charged and exposed to a light pattern forming a latent image thereon which is developed by application of a suitable toner. The photoconductive surface is charged by exposure to a corona discharge field which is shielded in a manner to provide uniform charge distribution over the major area of the surface, and shaped so as to modify charge near the borders of the surface in a manner which compensates for variations in the intensity of the light pattern projected thereon.

11 Claims, 4 Drawing Figures

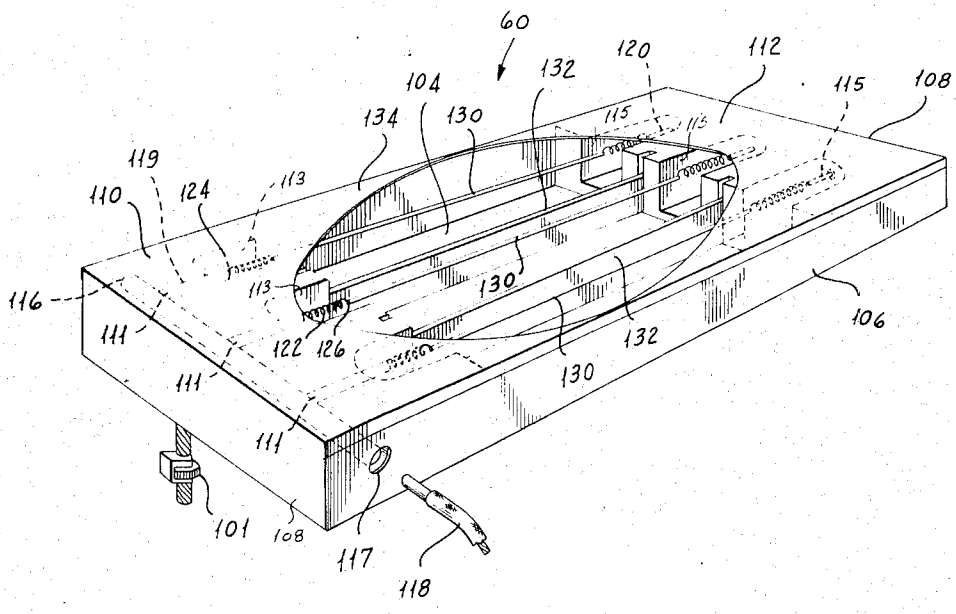
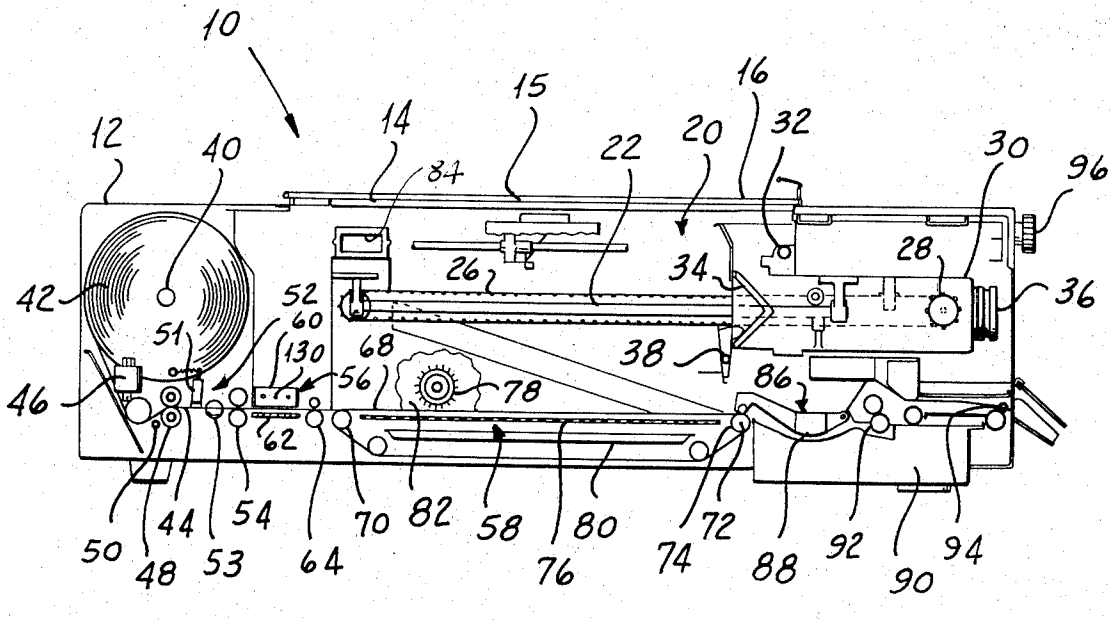


Fig 1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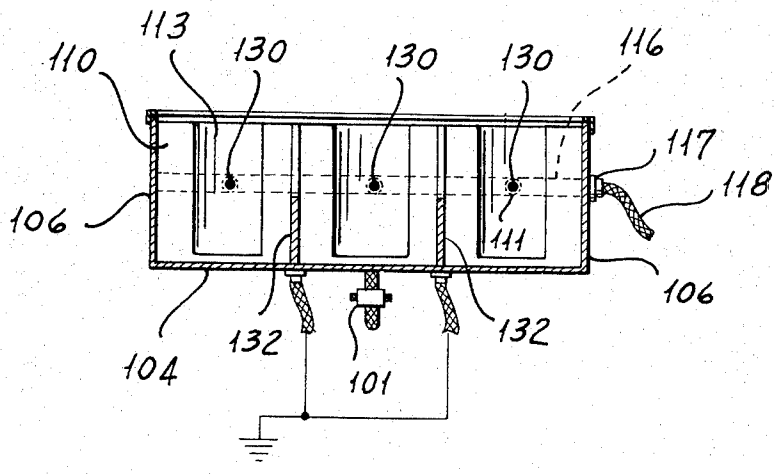
113
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Fig 4

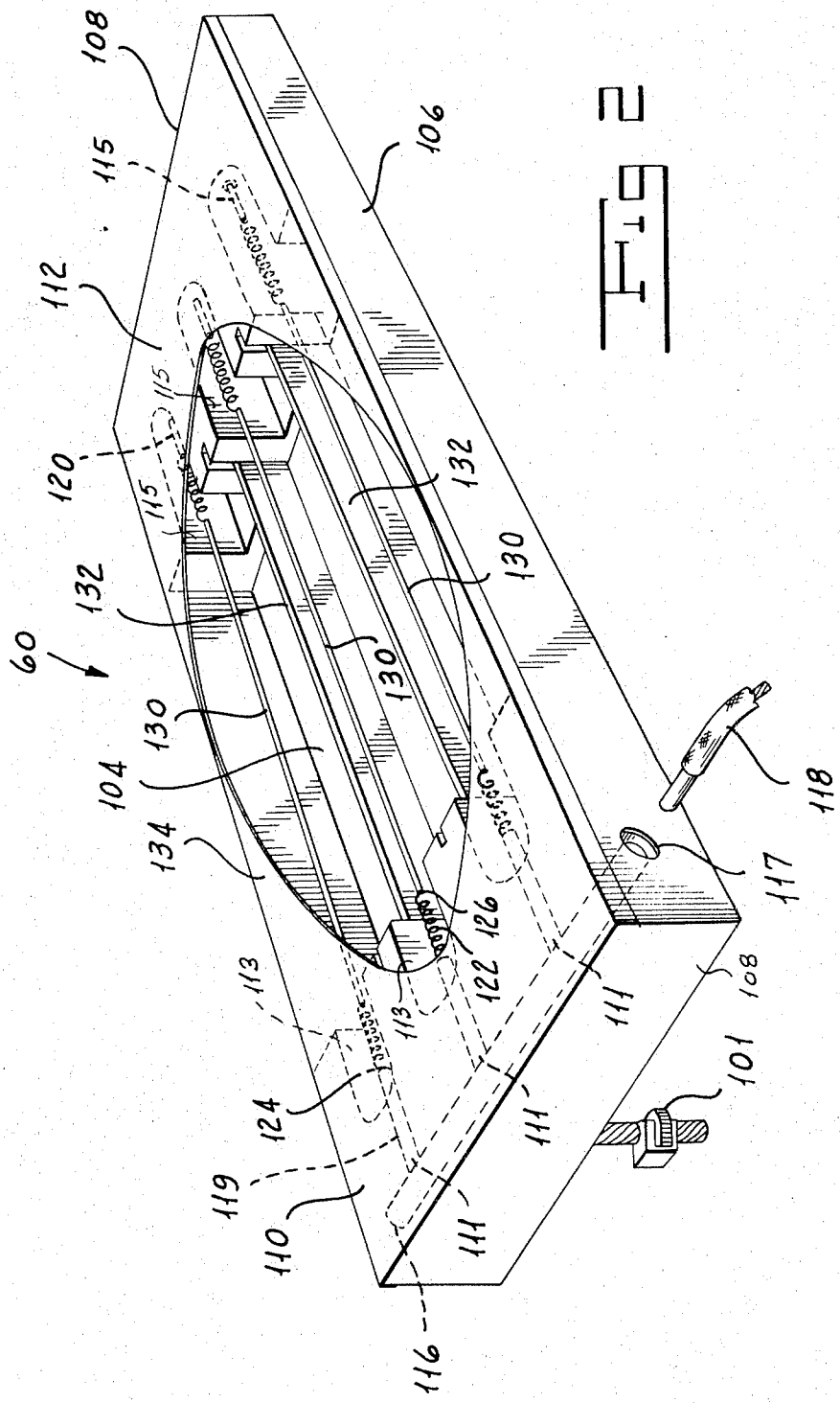
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FIG 2

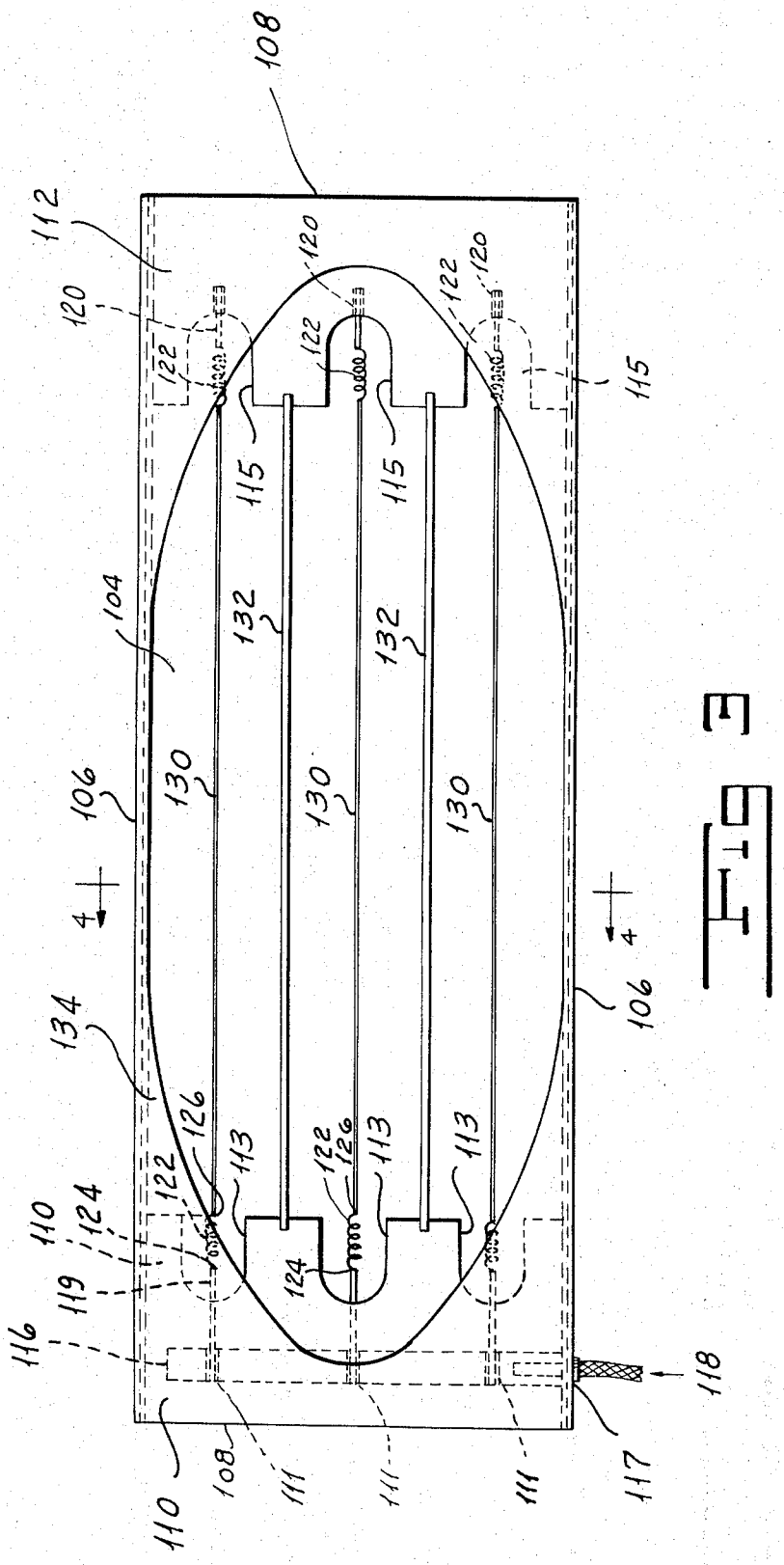
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FIG. 3

CORONA CHARGER CONFIGURATION

BACKGROUND OF THE INVENTION

In the art of electrostatic copying, an electrostatic charge is applied to a photoconductive surface. When the surface is exposed to a pattern of light a latent image is formed thereon which is developed by application of a toner material.

Most electrostatic copying machines of the prior art employ charging systems in which a plurality of generally parallel corona wires are oriented generally perpendicularly to the direction of scanning movement of a photoconductive surface relative to the charging system. Owing to the presence of discharge points along the wires uneven charge distribution and streaking in the developed copy has occurred in use of such systems. Various more or less successful expedients have been proposed in an effort to overcome this problem. In many machines of the prior art the charged photoconductive surface is exposed to an image of the original through a projection system having a rectangular aperture. The projection system may be moved relative to the surface in a linear scanning motion to produce thereon a latent electrostatic image having a generally rectangular border. When the surface is thus exposed to the light source it is found that light is not projected evenly over the rectangular area. The light intensity falls off at the edges and corners of the rectangular border. As a result contrast in the developed copy is not faithfully reproduced from the original.

While attempts have been made in the prior art to distribute the charge over the photoconductor in a uniform manner, no system has been developed to shape the charge distribution in a manner which compensates for the diminution in light intensity at the borders of the copy surface. My system comprises means for shielding a grid of corona discharge wires to provide a more uniform charge pattern in the central portion of the copy surface and means for shaping or limiting the charge distribution near the borders of the surface.

SUMMARY OF THE INVENTION

One object of my invention is to provide an improved charging apparatus for an electrostatic copying machine which produces consistent copies of good clarity and high contrast, free of imperfections.

Another object of my invention is to provide an apparatus which applies a uniform electrostatic charge to central regions of a photoconductive surface and a compensating electrostatic charge at edges and corners of the surface.

A further object of my invention is to provide an electrostatic charger which emits a saturating level of charge, but in which a portion of the charge is shielded and blocked before reaching the photoconductive layer to shape the charge reaching the layer.

Other and further objects of my invention will appear from the following description viewed in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings which form a part of the instant specification and which are to be read in conjunction therewith and in which the reference numerals are used to indicate like parts in various views:

FIG. 1 is a schematic view of an electrostatic copying machine employing my invention.

FIG. 2 is a perspective view of the electrostatic charger of FIG. 1 inverted from the position of FIG. 1 to reveal the charge shaping template.

FIG. 3 is a bottom plan view of the electrostatic charger of FIG. 1.

FIG. 4 is a sectional view of my electrostatic charger taken along the line 4—4 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 I have shown one form of electrostatic copying machine 10 using the invention. Machine 10 has a generally rectangular opaque housing 12 whose upper surface carries an exposure window 14 on which the original 15 to be copied is placed. An opaque cover sheet 16 of rigid or flexible design is hinged adjacent one edge of the exposure window to normally cover the original during transmission of the image contained thereon to the copy surface.

I provide an optical scanning system 20 comprising a pair of horizontally disposed parallel slide rails fixed below the exposure window 14. The rails 22 support a carriage 30 for linear travel thereon. An endless drive chain 26 carried by sprockets 28 is connected to the carriage 30 and is driven by a motor (not shown) to reciprocate the carriage 30 between the limits of the rails 22.

The carriage 30 houses an optical system which exposes the photoconductive surface to a light pattern derived from the original. As the carriage 30 advances along the rails 22, the optical system comprising a set of mirrors 34, a lamp 32, a reflective lens system 36 and a shutter 38, is activated, and the system sweeps across the face of the original, transmitting to the photoconductive surface a reflected light pattern derived from the original.

A shaft 40 carries a roll 42 of coated paper or other flexible sheet material 44 to which the image of the original is to be transferred. Material 44 may comprise a conductive base layer which is coated with a suitable photoconductive material, such as finely divided zinc oxide particles in an insulating resin binder. The roll 42 is mounted on the shaft 40 in such a manner that when a length of the material 44 or "copy paper" is drawn therefrom the photoconductive face of the copy paper is in appropriate orientation for exposure to light from the original.

A copying operation is initiated on energization of a solenoid 46 which causes a pair of feed rollers 48 to draw the copy paper 44 from the roll 42 around guide rollers 50. The feed rollers 48 advance the copy paper 44 past a cutting station, indicated generally by reference numeral 52, comprising rotary cutter 53 and stationary blade 51, to a pair of forwarding rollers 54 which continue to transport the copy paper past a corona charging system, indicated generally by reference numeral 56 to a conveyor belt assembly indicated generally by reference numeral 58.

The corona charging system 56 comprises a charger housing 60 in which a plurality of horizontally disposed parallel corona charging wires 130 oriented normally to the direction of motion of the copy paper 44 is mounted. The corona wires 130 are arranged to line in a plane generally parallel to a horizontally disposed, grounded support plate 62 over which the copy paper 44 moves during the charging stage.

I provide a rotary solenoid which is energized following the charging step to rotate the rotary cutter **53** through a small angle, and into contact with the stationary blade **51** to shear the copy paper **44** to a preselected length.

As the copy paper leaves the corona charging station it is grasped by the forwarding rollers **64** and delivered to the conveyor assembly **58.** The conveyor assembly comprises a plurality of horizontally disposed parallel belts **68** arranged to pass over drive roller **72** and idler roller **70.** The belts **68** are driven by a motor (not shown) through a gear chain (not shown) tracking a pinion **74** securely mounted on the drive roller **72.** Air is drawn downward through a multiplicity of small holes in an exposure bed **76** by the action of a partial vacuum created by a motor driven fan **78.** The exposure bed **76** comprises a perforated surface extending laterally between limits defined by rollers **70** and **72** and secured in a horizontal plane generally below the plane defined by the plurality of belts **68.** The suction created by the fan **78** draws air through the perforations in the exposure bed **76** and through an elongated slot **80** opening into a duct **82,** where the air moves upward to be expelled through an exhaust port **84.** This airflow holds the copy paper onto the upper surfaces of belts **68** while it is being transported and optically scanned on the exposure bed **76.** The charged photoconductive surface remains stationary on the exposure bed **76** during exposure by optical scanning system **20.**

Following exposure, the conveyor assembly **58** transports the image bearing surface to a developing station indicated generally by reference numeral **86** comprising a paper guide arm **88,** a developer trough **90** and squeegee rollers **92** which deliver the developed copy to a discharge slot **94.** I may arrange in trough **90** a set of rollers (not shown) or a similar instrumentality for applying to the exposed photoconductive surface the toner material contained in the trough.

I provide automatic controls (not shown) to execute a programmed sequence of steps comprising drawing copy material **44** from roll **42,** charging the photoconductive surface of the paper, cutting the copy paper to a desired length, exposing the charged surface to a light pattern derived from the original, developing the image bearing surface and discharging the developed copy. I further provide a density control knob **96,** calibrated for light densities ranging from "dark" to "light" which controls the voltage applied to the corona charging wires **130.**

My charger housing **60** and conductive support plate **62** are arranged relative to one another so that the corona wires **130** and the photoconductive surface of the copy paper lie in parallel planes. Forwarding rollers **54** transport the photoconductive surface at constant speed relative to the corona wires, in a direction of motion normal to their orientation.

Referring now to FIGS. **2, 3** and **4,** a form of my electrostatic charging system comprises a rectangular housing **60** with a shielding base plate **104,** approximately 9 inches × 3 inches suitably joined to enclosing side walls **106** approximately 3 inches × 1 inch and closing end walls **108** approximately 9 inches × 1 inch. The bottom of the charger is open when the charger is in the position indicated in FIG. **1.** Adjacent to the end walls **108** and extending across the width of the housing **102,** I mount a pair of insulating blocks **110** and **112,** having generally rectangular configurations into which U-shaped channels **113** and **115** are cut. Blocks **110** and **112** may be fabricated of one of several insulating materials. I have found the acrylic resin of the type known as plexiglas, which is the registered trademark of Rohm and Haas Co., to be suitable.

A brass bus bar **116** embedded in block **110** extends transversely from a cable socket **117,** in one wall of the block **110,** to a series of internal connections **111** to horizontally disposed parallel brass rods **119** oriented normally to the direction of bus bar **116** and extending outwardly from the block **110** into the channels **113.** Similarly several horizontally disposed parallel insulating rods **120** are affixed within block **112** and extend into channels **115** toward block **110.** The corresponding pairs of brass rods **119** and insulating rods **120** lie along parallel, colinear line segments in a common plane above and parallel to the base plate **104.**

I secure in a suitable opening in each one of the rods **119** and **120,** one end **124** of an individual tension spring **122.** The other end **126** of each of the tension springs **122** is connected to and serves to hold an end of a tungsten corona wire **130.** In this manner, the three parallel corona wires **130** are held taut between corresponding sets of the springs **122.** Arrayed between the wires **130** are secured by notches in blocks **110** and **112** are several dividers **132.** The dividers are made of metal and grounded together with the walls **108** and **106** and base plate **104** of the charger housing.

It is well known that the corona current is created when a sufficiently high voltage is applied between the wires and the parallel conducting surface beneath the photoconductive material to be charged. Air near the wires becomes ionized and the ions are swept by the electric field toward the photoconductive surface. The corona discharge threshold voltage for a corona wire is an increasing function of the diameter of the wire. The corona on a negative wire appears as a bluish-white sheath over the surface of the wire connecting bright glowing foci uniformly spaced along the wire. The direction of motion of the photoconductive surface is normal to the orientation of the wires **130.** Absent the dividers **132,** the charge distribution on the photoconductive surface would appear as a pattern of parallel bands of high charge density oriented in the direction of motion of the surface and corresponding to the spacing of the corona foci along the wires **130.** The metal dividers perform a valuable function in obtaining a uniform charge distribution. The dividers attract much of the corona current generated so that the wires may be operated at a potential exceeding the threshold voltage without overcharging the photoconductor. Operation at voltages exceeding the threshold voltage reduces variations in corona current owing to variations in wire diameter or to adherence of contaminants to the wire. The dividers also serve to spread the bands of charge so that they cover the photoconductive surface in a more uniform manner. It has been found that to produce the desired improvement in charge uniformity, the height of the divider must be about one-sixteenth of an inch below the distance of the wires from the base plate **104.** If the dividers extend above the wires the corona current is too severely diminished. If the dividers are too far below the wires, then not enough corona current is attracted and the photoconductor is unevenly charged as previously described.

I place above the corona wires, parallel to and opposite the base plate **104** a cover plate **134** which serves

as a charge shaping template. The plate **134** is attached to the charger housing in any suitable manner. The plate **134** has an opening designed to modify the charge density distributed at edges and corners of the photoconductive surface. This is done because the light projected onto the surface, after charging, falls off in intensity at the borders of the surface, in a manner which yields a border-to-center illumination ratio between 0.8 and 0.9. Since less light is available to remove charge at the borders of the surface, it follows that somewhat less charge should be distributed near border regions so that, on development, proper contrast relative to central regions of the photoconductive surface will be achieved. FIGS. **2** and **3** illustrate the preferred elliptical opening for my charging apparatus. However, any one or more openings of any shape which by experimental determination achieve a desired diminution in charge intensity at any region of the photoconductive surface may be employed. The wires are raised to corona potential by a voltage source connected to the wires through a cable **118.**

My charger **56** is placed in the electrostatic copying machine so that the corona wires are 1 inch above the photoconductive surface as viewed in FIG. **1.** This height was determined by the charge acceptance rate of the paper and the relative speed of traverse of the carriage.

It will be seen that I have provided an apparatus for uniformly charging the central region of a photoconductive surface and simultaneously shaping the distribution pattern so that less charge is deposited on border regions of the surface to compensate for the diminution in light intensity subsequently projected thereto.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of my claims. It is further obvious that various changes may be made in details within the scope of my claims without departing from the spirit of my invention. It is, therefore, to be understood that my invention is not to be limited to the specific details shown and described.

Having thus described my invention, what I claim is:

1. In an electrostatic copying machine having an exposure system for subjecting the surface of a photoconductor to an image of an original to be reproduced over a generally rectangular illuminated area, the light intensity of which falls off at the edges and corners of said area and having means for positioning the photoconductive surface adjacent to a charging station, charging apparatus comprising means at said charging station for producing a generally rectangular corona discharge field pattern, and means for so modifying said field pattern adjacent to the periphery thereof as to compensate for said fall off in light intensity over said illuminated area to cause said machine to produce a copy having contrast throughout corresponding to the contrast in the original.

2. Apparatus as in claim **1** in which said modifying means reduces the effect of said field adjacent to said periphery.

3. Apparatus as in claim **2** in which said modifying means is a conductive plate formed with an opening therein and means mounting said plate between said field pattern producing means and a surface positioned adjacent to said charging station.

4. Apparatus as in claim **3** in which said opening has a generally oval configuration.

5. Apparatus as in claim **4** in which said surface moves relative to said charging apparatus and in which the major axis of said opening extends at right angles to the direction of relative movement between said surface and said apparatus.

6. Apparatus as in claim **1** in which said field producing means comprises a plurality of corona wires, means mounting said wires in spaced parallel relationship and respective grounded conductive plates disposed in the spaces between said wires.

7. Apparatus as in claim **6** in which the upper edges of said plates are slightly below said corona wires.

8. Apparatus as in claim **7** in which said photoconductive surface moves relative to said discharge station and in which said wires and said plates are disposed generally perpendicularly to the direction of relative movement between said surface and said station.

9. Apparatus as in claim **8** in which the upper edges of said plates are about one-sixteenth of an inch below said wires.

10. In an electrostatic copying machine having an exposure system for subjecting the surface of a photoconductor to an image of an original to be reproduced over a generally rectangular illuminated area, the light intensity of which falls off at the edges and corners of said area and having means for moving the photoconductive surface along a path past a charging station, charging apparatus comprising a plurality of corona wires adapted to be energized to produce a charging field, means mounting said wires in spaced relationship at said charging station with the lengths thereof extending across said path, field distributing plates disposed in the spaces between said wires, said plates having upper edges spaced slightly below said wires, a field shaping plate means having a generally centrally located opening therein for modifying said field adjacent to the periphery thereof so as to compensate for said fall off in light intensity to cause said machine to produce a copy having contrast throughout corresponding to the contrast of the original, and means mounting said plate between said wires and said path.

11. Apparatus as in claim **10** in which said opening is generally oval and in which the major axis thereof is generally perpendicular to the path.

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