Aug. 25, 1964 C. F. CARLSON 3,146,385

XEROGRAPHIC PLATE CHARGING METHOD AND APPARATUS

Filed Dec. 9, 1960 2 Sheets-Sheet 1

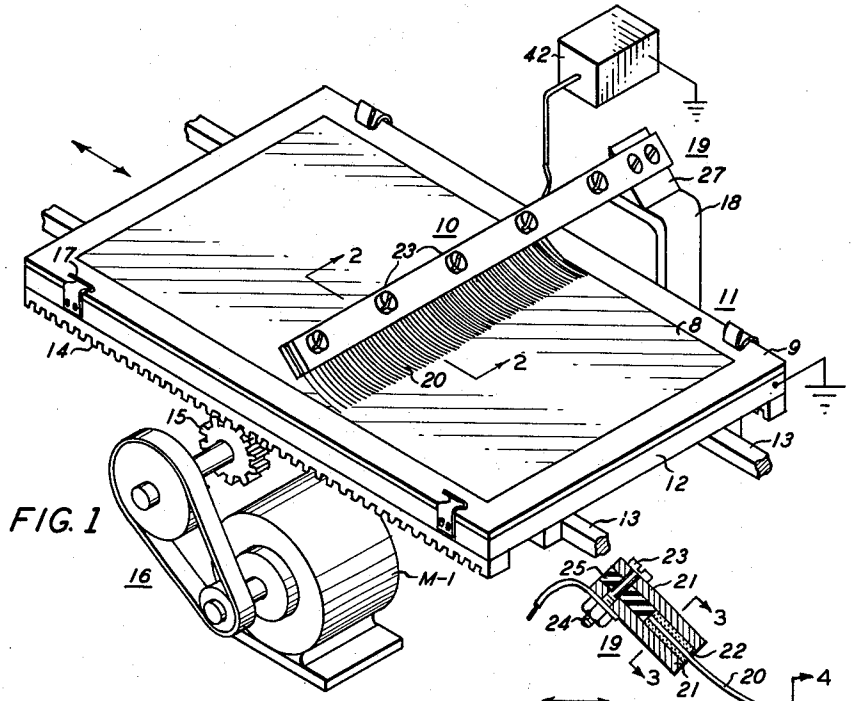


FIG. 1

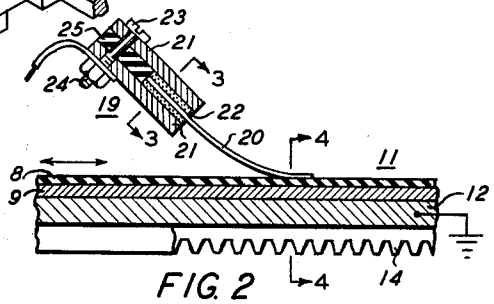


FIG. 2

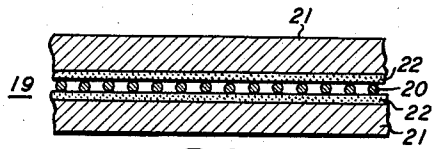


FIG. 3

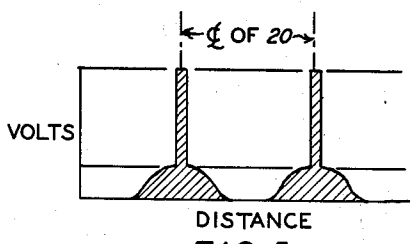


FIG. 5

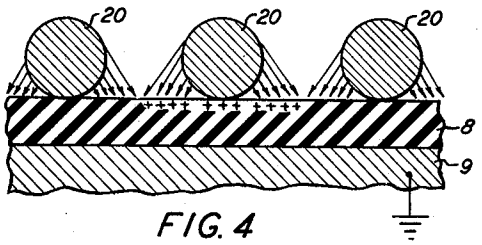


FIG. 4

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Aug. 25, 1964 C. F. CARLSON 3,146,385

XEROGRAPHIC PLATE CHARGING METHOD AND APPARATUS

Filed Dec. 9, 1960 2 Sheets-Sheet 2

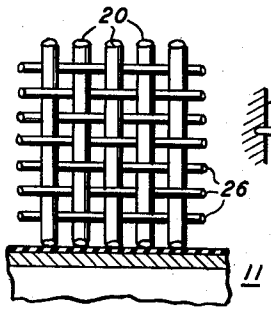


FIG. 6

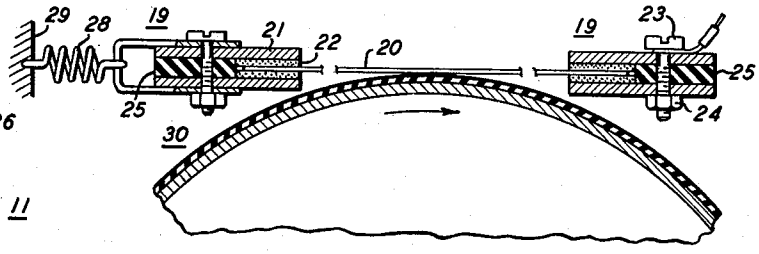


FIG. 7

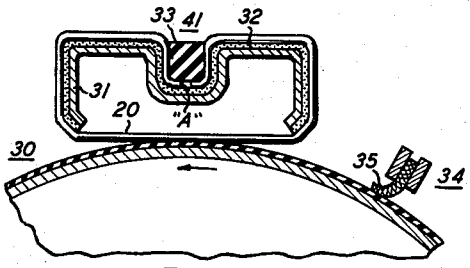


FIG. 8

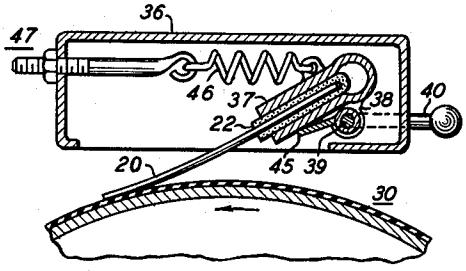


FIG. 9

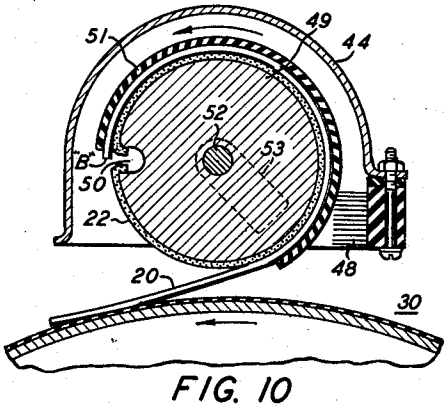


FIG. 10

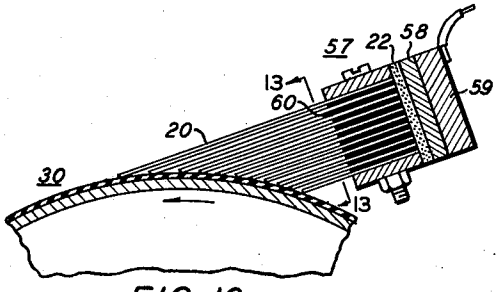


FIG. 12

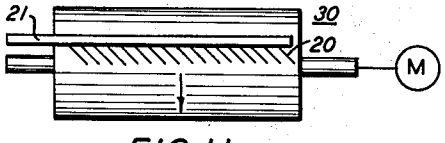


FIG. 11

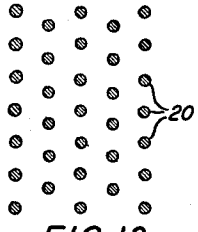


FIG. 13

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3,146,385
XEROGRAPHIC PLATE CHARGING METHOD AND APPARATUS

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Filed Dec. 9, 1960, Ser. No. 74,908
8 Claims. (Cl. 317—262)

This invention relates to xerography and particularly to improved method and apparatus for charging a xerographic plate.

In the process of xerography, for example, as disclosed in Carlson Patent 2,297,691, issued October 6, 1942, a xerographic plate comprising a layer of photoconductive insulating material on a conductive backing is given a uniform electric charge over its surface and is then exposed to the subject matter to be reproduced, usually by conventional projection techniques. This exposure discharges the plate areas in accordance with the radiation intensity that reaches them, and thereby creates an electrostatic latent image on or in the photoconductive layer. Development of the latent image is effected with an electrostatically charged, finely divided material such as an electroscopic powder that is brought into surface contact with the photoconductive layer and is held thereon electrostatically in a pattern corresponding to the electrostatic latent image. Thereafter, the developed xerographic powder image is usually transferred to a support surface to which it may be fixed by any suitable means.

It has heretofore been the usual practice to uniformly charge a xerographic plate by means of corona discharge apparatus first disclosed in Carlson Patent 2,588,699. A particularly useful corona charging device is disclosed in Walkup U.S. Patent 2,777,957. As an alternative to corona charging, a plate may be charged by other means such as by a form of charging apparatus disclosed in Walkup Patent 2,774,921, which utilizes a slightly conductive fabric or fibrous material that is brushed across a xerographic plate while the fabric is connected to a source of charging potential.

Any of the charging means referred to above are adapted to deposit a uniform electrostatic charge on a plate surface. Charge uniformity has heretofore been found desirable for most reproduction purposes resulting generally in reproduction of high image resolution. This is particularly true with line copy reproductions consisting, for example, of black letters on a white background. However, where images are possessed of wide solid areas, the electrical lines of force emanating from the edges or outer portions are directed in curved paths to the adjacent discharged background areas, such that subsequently in development, only the edges are developed with the central portions remaining blank or white. To overcome the inherent difficulties of developing uniformly charged solid image areas, it has heretofore been necessary to utilize a development electrode apparatus such as disclosed in Gundlach U.S. Patent 2,777,418 that is effective to alter the path of the lines of force in a manner to permit uniform development throughout the wide area.

By the method and apparatus of the instant invention, a xerographic plate can be charged in a manner permitting solid area development without the aid of a development electrode apparatus. This result is attained by charging a xerographic plate in a repetitive pattern of varying voltages, desirably the charge voltage and on absence of voltage, such that the pattern will develop in the manner of small areas or lines producing a substantially homogeneously developed area when viewed with the naked eye. The present invention offers the outstanding advantage of permitting the use of charging voltages in the approximate range of 500–1200 volts as compared to 6000–8000 volts for corona charging apparatus. At the same time the invention utilizes readily available resistance and conductive elements.

It is therefore the principal object of this invention to provide novel charging apparatus and method for charging a xerographic plate.

It is a further object of the invention to provide apparatus and method to charge a xerographic plate in a predetermined charge pattern.

It is a further object of the invention to provide method and apparatus for charging a xerographic plate with a charge pattern whereby solid image areas can be developed independently of a development electrode apparatus.

These and other objects are attained in one embodiment of the invention by means of a plurality of spaced conductive strands, needles, or wire electrodes aligned in a row and in contact with a layer of high resistance material connected to a source of charging potential. Portions of the wire electrodes are supported in contact with a xerographic plate surface and by means of relative movement between a xerographic plate and the contacting electrodes a charge pattern is produced on the plate substantially correlated to the spacing of the electrodes.

Various embodiments of the invention are illustrated in the following drawings in which:

FIG. 1 illustrates apparatus for charging a xerographic plate according to one embodiment of the invention;

FIG. 2 is a sectional view taken substantially along line 2—2 of FIG. 1;

FIG. 3 is a sectional view taken substantially along line 3—3 of FIG. 2;

FIG. 4 is an enlarged sectional view taken substantially along line 4—4 of FIG. 2;

FIG. 5 illustrates a charge profile of a xerographic plate charged in the manner of the invention; and

FIGS. 6–13 illustrate modified forms of charging apparatus constructed in accordance with the invention.

Referring to FIG. 1 an embodiment of charging apparatus constructed in accordance with the invention is designated **10** and is illustrated in charging relation to a flat xerographic plate designated **11** comprised of a photoconductor **8** on a conductive backing **9**. Alternatively the plate could be in the form of a xerographic drum and it is to be understood that charging of a plate in either form will occur in the dark. The xerographic plate is supported on a movable base plate **12** slidably supported on tracks **13** and adapted to be advanced horizontally by a rack and pinion drive **14** and **15** which is in turn driven by a reversible electric motor M–1 through pulley drive **16** whereby plate **11** may be moved horizontally in a path in either direction. For retaining a xerographic plate on the support mechanism there is provided a plurality of resilient clips **17** that can be sprung outwardly for insertion or removal of a plate.

The charging apparatus (refer also FIGS. 2 and 3) includes a clamp **19** comprising a pair of metal bars **21** secured at one end to an insulator block **27** supported by a bracket **18** and in turn supporting a plurality of fine conductive and pliable electrode strands or wires **20** arranged in a row spanning the plate surface substantially transverse to the direction of plate movement. The wires can be very fine, e.g., 1 mil to 10 mils in diameter although not limited to these dimensions and of Phosphor bronze, stainless steel, foil, metalized plastic sheet slit to individual element size or other springy conductive material. The wires are firmly supported between metal plates or bars **21** but separated therefrom by layers of resistance material **22** of high electrical resistance and which can be of a selected composition, e.g., carbon in a binder such as shellac, or a plastic material similar to that commercially used for volume control paint or radio resistors, thin sheets of conductive

rubber, a high resistance ceramic material or other high resistance layers. These layers may preferably be 5 to 10 mils thick and have a resistance value of at least 10,000 ohms per square cm. to current passing through such a layer. The resistance layers may either be formed by coating resistance paint directly onto bars 21 or be separate inserts. They are held firmly in contact with the electrode wires by means of bolts 23 and nuts 24 which are tightened to draw the metal plates together and sandwich the resistance layers and electrodes therebetween. One bolt and nut in this instance are also used as a voltage terminal for connecting the electrodes to a source of D.C. plate charging potential 42. An insulating spacer 25 is provided surrounding the terminal and bolts and between the plates.

This construction tends to make each electrode wire nearly independent of adjacent wires since the shortest conductive path is through the resistance layers to the metal plates so that if one wire were to be temporarily grounded it would have little or no effect on the adjacent wires.

A magnified cross section of the electrode wires in contact with the surface of a xerographic plate is illustrated in FIG. 4 and a possible charge profile or pattern on the plate effected thereby is illustrated graphically in FIG. 5.

Referring particularly to FIG. 4 the plate, or alternatively the electrode wires, is moved in a direction substantially parallel to the axis of the wires and perpendicular to the sheet on which the diagram is illustrated. It should be apparent therefrom that with a wire of cylindrical cross section, only a minute area or streak tangent to the plate surface is charged by physical contact of the wire. Immediately adjacent areas will, in most cases, be charged to a somewhat lower potential, for reasons discussed below, by gas ionization discharge from the wires to the plate surface as indicated by the arrows illustrating the path of ion discharge. Beyond the zone of ionization discharge, there is believed to be little or no practical charging effect. Obviously this charge relationship and potential variation, i.e., between contact and ionizing deposition, can be varied to effect different patterns of discharge by charging the cross sectional configuration of the electrode wires.

Sparking is essentially a runaway ionization discharge between two conductive electrodes. It has been found that minimum sparking potential in air is approximately 327 volts which, at 760 mm. of Hg air pressure, occurs at a gap distance of approximately 7.5 microns. Since this potential represents the minimum, at smaller or larger gap distances increased voltage would be required to effect sparking. However, some ionization discharge may take place even at lower voltages, but without formation of a spark.

In the instance of charging a xerographic plate the situation is somewhat different. While it is not desired to be limited thereby it is believed that the following discussion gives a fairly accurate description of the conditions prevailing during operation of the wire-type charging apparatus just described. During charging, each wire of the charging unit comprises one electrode, and the photoconductive insulating surface of the xerographic plate is, in effect, the other "electrode." With a voltage somewhat above the minimum sparking potential at the atmospheric pressure encountered it is believed that diffused or non-sparking ionization takes place in the region very close to the wire and in this process charge is transferred to the surface of the photoconductive insulating layer. As charge is deposited on this layer, however, the ionizing field is thereby reduced so that the ionization current is reduced and eventually stopped for each successive region of the plate surface passed over by the wire, without sparking ever taking place.

The width of the area charged by any wire will depend upon the voltage applied. Along the line of contact the potential of the charge on the plate will be the highest as is indicated in the charge profiles shown graphically in FIGURE 5. Outside the line of contact the potential may be at a much lower value and from that zone outward the potential may taper off to zero at some short distance from the wire. Between the edges of charged areas produced by two adjacent wires the plate surface may remain uncharged. The charge pattern thus produced is commonly referred to as "half tone," i.e., in contrast to the "uniform" charge deposit effected by the apparatus of Walkup Patent 2,774,921 supra.

Referring to FIG. 6, there is illustrated another embodiment of the invention in which the electrode wires 20 are woven into a fabric of insulating strands 26 which serve to maintain an insulated separation between adjacent electrode wires. Otherwise, the electrodes may be clamped between resistance layers and supported similarly as described in FIGS. 1–4.

In FIG. 7 is illustrated an embodiment of the invention particularly adapted for a xerographic plate in the form of cylindrical drum 30 adapted for rotation. In this instance, the electrodes may be stretched between a pair of clamps 19 of a type illustrated in FIG. 2 and the electrode wires contact the plate surface tangent with its periphery. Being secured at two ends, there is less likelihood of contact between wires. It is preferred that one of the clamps 19 is resiliently supported by a spring 28 from a stationary support 29 as shown.

Another embodiment is illustrated in FIG. 8 in which the apparatus is particularly adapted for use with a xerographic drum 30. In this embodiment a conductive, preformed member, such as a channel section 31, may be presprayed with a resistance paint of the aforementioned type to form a resistance layer 32 around which electrode wires 20 are wound. The wires are cut along a line designated "A" in channel recess 41 and an insulating rod 33 inserted in the recess to hold the cut ends while electrically isolating each wire turn. Alternatively, the channel could be covered with an insulating layer, after which the wires are wound around the channel as aforesaid and sprayed with a resistance paint. A conductive paint is then applied over the resistance paint to serve as a basis for a terminal and the wires are cut and held as before.

To prevent contamination of the electrode wires with residual developing material on the plate surface not having been removed by other previous means, a wiper unit 34 may be employed to wipe the plate prior to charging, being supported ahead of the charging apparatus and may consist, for example, of a felt material 35 or the like in contact with the plate surface.

In FIG. 9, the electrode wires 20 are partially enclosed within a channel shield 36 and clamped between resistance layers 22 by means of a resilient springy material such as spring clip 37. Formed on the clip are a pair of ears 38 pivotally supporting the clip on a rod 39 extending laterally through the shield sidewalls. Lever 40 is attached to the rod at either end and a cam plate 45 is also secured to the rod in a manner to engage clip 37, such that by rotation of the lever the electrode wires can be retracted to within the shield for protection during handling or when otherwise required. Spring 46 urges the electrodes into contact with the xerographic plate and a suitable means 47 may be provided for the adjustment of spring tension and regulation of force applied by the electrode wires against the plate surface. A suitable detent, not shown, may be provided to maintain electrode wires in retracted position within the shield.

FIG. 10 illustrates a modified embodiment adapted for automatic cleaning of the wires by means of a brush or wiping material, such as layers of felt 48 supported in a channel shield 44. The electrode wires 20 are wound around a tube or rod 49 adapted for rotation on a shaft 52 and on which there had been applied a resistance layer 22 and containing a longitudinal groove 50. The wires

are cut along a line designated "B" in the groove **50**, thus permitting the lower section of the electrode wires to spring out into contact with a xerographic plate while the upper section thereof is retained in a rigid position by a rigid insulating layer **51**. Alternatively, another resistance layer can be applied over the wires and a conductive layer applied thereover in the non-plate contacting portions of the electrodes. For rigidity, an outer rigid clamp, not shown, can be applied to maintain firm contact between the built-up layers.

By rotating rod **52** through a suitable lever arrangement or by a knob **53** shown dotted, in a counterclockwise direction as viewed in FIG. 10, the electrode wires are moved past the cleaning brush and dust or dirt removed therefrom. For safety or other purposes the electrode wires can be stored within the channel shield until ready for service. It will be apparent that this apparatus is readily adapted for automatic operation by utilizing an intermittent drive connected to rod **52** and operated in timed relation to the reproduction of copy, as for example, after each charging step of the cycle, to rotate the wires past the cleaning brush or felt.

FIG. 11 illustrates an electrode arrangement in plan view by which charge deposition is increased onto more of the plate area. Here, the electrode wires **20** in contact with a drum **30** are slanted across the path of travel indicated by the arrow so that the path of the wires overlap and effect substantially uniform charging of the plate.

Increased charge uniformity, as well as substantial charge uniformity on a plate can also be effected using multiple rows of electrode wires such as illustrated in FIG. 12 and arranged in a pattern such as illustrated in FIG. 13. By this arrangement there are increasingly finite paths of charge deposition asymptotically approaching uniformity. To avoid physical contact between wires, it may be preferred to apply a thin insulating coating to each electrode wire which is omitted or removed where the wire is to contact the xerographic plate and where it is to make contact with a resistance paint or layer **22**. The wires may be held by a suitable clamp **57**. A conductive layer **58**, such as silver paint, is applied to the resistance layer and a terminal plate **59** applied to the conductive layer. To render the wires in this arrangement increasingly pliable, the spacing between rows can be increased and each row separated by a short length of insulating plate or sheet **60**.

The speed of relative movement between the plate and charging electrodes is not regarded as critical and may vary through a wide range as for example, from relatively slow speeds of 1 inch per second to speeds of 20 inches per second or more. It is important that there be relative movement between the plate and charging apparatus and although relative movement has been illustrated in each instance herein utilizing a moving plate relative to a stationary charging apparatus, quite obviously the charging apparatus could be moved relative to a stationary plate or both moved simultaneously relative to each other.

From the above description there is disclosed novel method and apparatus for charging a xerographic plate in which the electrostatic charge is deposited on the plate surface in a predetermined pattern. Electrode wires energized with plate charging potential are applied in contact against a plate surface which may be the surface of the photoconductor or may be a suitable overcoating material such as disclosed in U.S. Patents 2,693,416; 2,860,048; and 2,886,434. As pointed out above, the apparatus of the invention is particularly adapted for half-tone charging but by appropriately arranging the electrode wires in the manners disclosed can also be adapted to effect uniform charging of a plate. The invention offers the major advantage of charging a xerographic plate either half-tone or uniformly utilizing a relatively low plate charging potential on the electrodes thereby effecting high charging efficiency.

While the device of the instant invention is useful with any sort of sensitive photoconductor, such as reusable vitreous selenium, because of the tendency of selenium to wear under constant reuse the invention is particularly useful with disposable xerographic plates of the type termed "binder plates" first disclosed in U.S. Patent 2,663,636 and since disclosed elsewhere, as for example in U.S. Patent 2,937,944; U.S. copending application Serial No. 668,165, filed June 26, 1957, and Canadian Patent 568,707, issued January 6, 1959.

Since many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A charging system for charging the surface of an insulating or photoconductive insulating layer coated on a conductive base, said system comprising a voltage source having one pole adapted for connection to said conductive base, an electrical terminal connected to the other pole of said voltage source, said terminal comprising an elongated conductor, a layer of high electrical resistance overlying said terminal and in electrical contact therewith, and a plurality of separate closely-spaced parallel electronically conductive strands, each of said strands having a first portion thereof in contact with said resistance layer and a second portion thereof spaced from said resistance layer and said terminal and separately capable of making electric contact with a surface to be charged.

2. A device for charging the surface of an insulating or photoconductive insulating layer, said device comprising an elongated conductive electrical terminal, a layer of high electrical resistance overlying said terminal in electric contact therewith, and a plurality of separate closely-spaced parallel electronically conductive strands, each of said strands having a first portion thereof in contact with said resistance layer and a second portion thereof spaced from said resistance layer and said terminal and separately capable of making electrical contact with a surface to be charged.

3. A device for charging the surface of an insulating or photoconductive insulating layer, said device comprising an elongated conductive terminal, a high resistance layer overlying said terminal and in electrical contact therewith, and a row of substantially parallel electrically independent electronically conductive strands overlying said resistance layer, said strands extending transversely to said terminal and with a portion of each strand making independent electrical contact with a separate area of said resistance layer, a bare portion of each of said strands being spaced from said resistance layer and said terminal and adapted to make independent electric contact with a surface to be charged.

4. A device for charging the surface of an insulating or photoconductive insulating layer, said device comprising a conductive terminal bar, a layer of high electrical resistance overlying said bar and in electrical contact therewith, and a brush formed of a plurality of closely-spaced but electrically separated fine electronically conductive wires, each of said wires making independent electric contact with a separate area of said resistance layer overlying said terminal, and each of said wires having a bare portion spaced from said resistance layer contacting portion and adapted separately to make wiping contact with a surface to be charged.

5. Apparatus for charging a xerographic plate comprising means to support a xerographic plate in position to be charged, a plurality of uniformly spaced electronically conductive charging electrodes substantially aligned, means to support said electrodes with a portion thereof in surface contact with a plate on its support means, each of said electrode contact portions being substantially in-

sulated electrically from adjacent electrode contact portions, a resistance material connected to a non-contact portion of each electrode, said resistance material having an electrical resistance of at least 10^4 ohms per sq. cm. per cm. length, terminals for connecting a potential source to the resistance material, and means for moving the electrodes and plate relative to each other in a direction transverse to the alignment of said electrodes, whereby when said terminals are energized with plate charging potential a charge pattern is deposited from the electrodes onto the plate surface correlated to the spacing of said electrode contact portions.

6. The apparatus of claim 5 in which the xerographic plate is a disposable binder plate.

7. In a xerographic apparatus in which an electrostatic latent image formed on a previously charged xerographic plate is developable by the presentation of electroscopic developing powder thereto and including a continuously moving xerographic plate, the improvement comprising a stationary charging device for applying charge to a xerographic plate surface, said charging device comprising a plurality of strand electronically conductive charging electrodes arranged in a predetermined pattern with each electrode spaced apart from each other electrode a distance adapted to charge a plate surface substantially independently from each electrode in a variation pattern correlated to said arrangement, means to support said electrodes with at least a portion thereof in contact with a surface of a plate to be charged, each of said electrode contact portions being substantially insulated electrically from contact portions of adjacent electrodes, a resistance material connected to a non-contact portion of said electrodes, said resistance material having an electrical resistance of at least 10^4 ohms per sq. cm. per cm. length, an electrical terminal electrically secured to the resistance material, and a potential source adapted to be connected to said terminal to energize said electrodes independently to a plate charging potential.

8. In a xerographic apparatus in which an electrostatic latent image formed on a previously charged xerographic plate is developable by the presentation of electroscopic developing powder thereto, the improvement comprising a charging device for applying charge to a xerographic plate surface, said charging device comprising a plurality of strand electronically conductive charging electrodes arranged in a predetermined pattern with each electrode spaced apart from each other electrode a distance adapted to charge a plate surface substantially independent from each electrode in a variation pattern correlated to said arrangement, means to support said electrodes with at least a portion thereof in contact with a surface of a plate to be charged, each of said electrode contact portions being substantially insulated electrically from contact portions of adjacent electrodes, a resistance material connected to a non-contact portion of said electrodes, said resistance material having an electrical resistance of at least 10^4 ohms per sq. cm. per cm. length, an electrical terminal electrically secured to the resistance material, and a potential source adapted to be connected to said terminal to energize said electrodes independently to a plate charging potential.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,146,385 August 25, 1964

Chester F. Carlson

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 43, for "charging" read -- changing --.

Signed and sealed this 30th day of March 1965.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents

UNITED STATES PATENT OFFICE

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