

Jan. 29, 1963

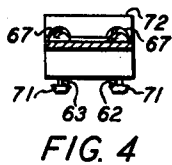
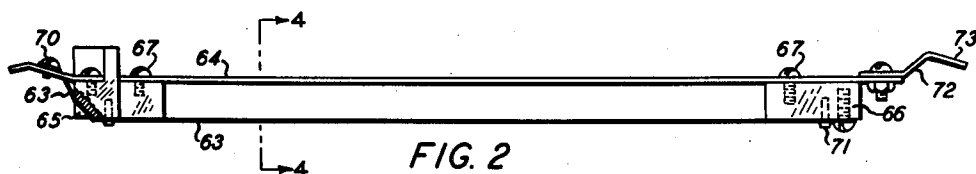
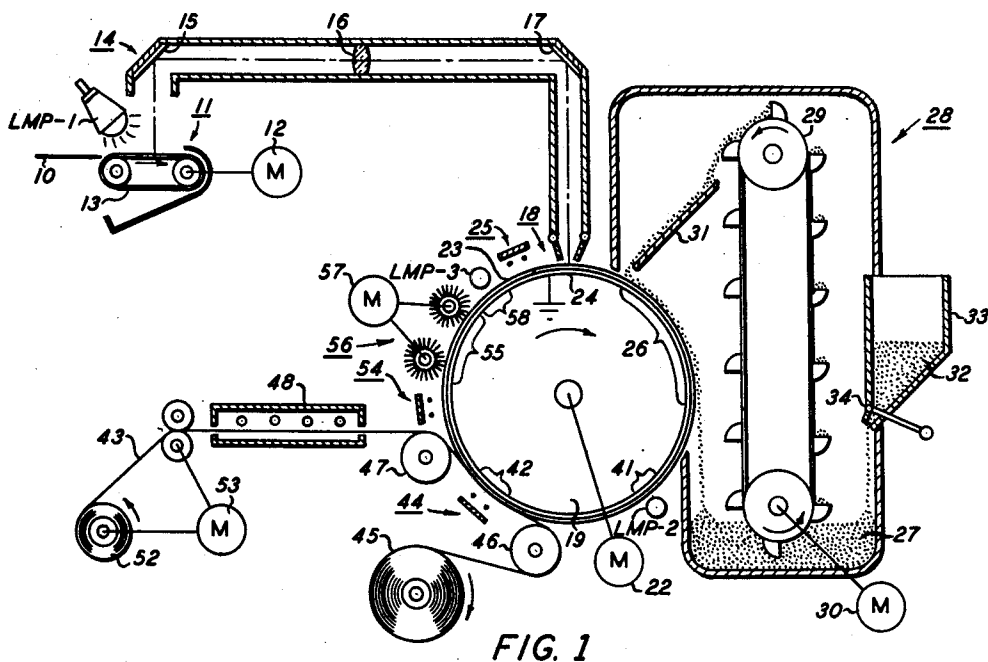
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3,076,092

XEROGRAPHIC CHARGING APPARATUS

Filed July 21, 1960

4 Sheets-Sheet 1



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XEROGRAPHIC CHARGING APPARATUS

Filed July 21, 1960

4 Sheets-Sheet 2

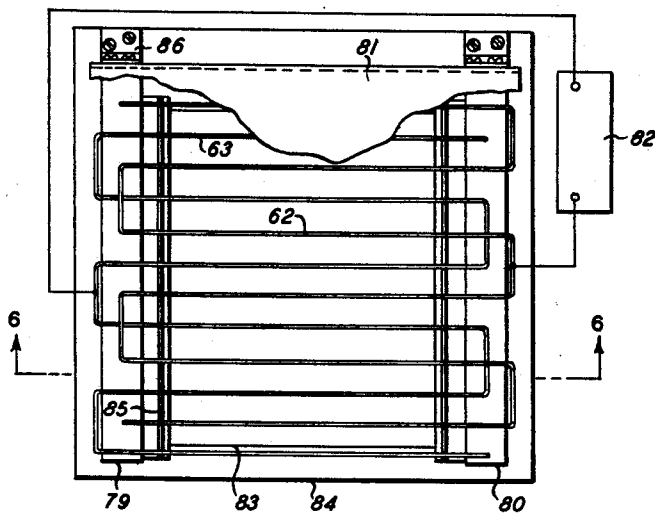


FIG. 5

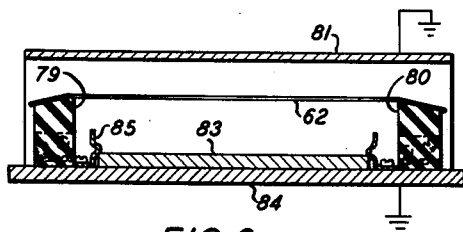


FIG. 6

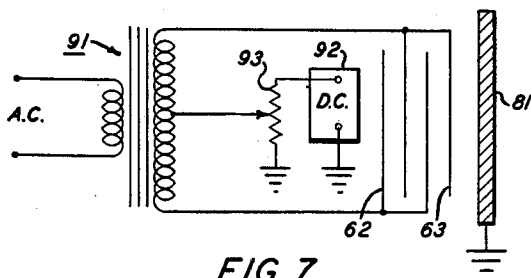


FIG. 7

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Filed July 21, 1960

4 Sheets-Sheet 3

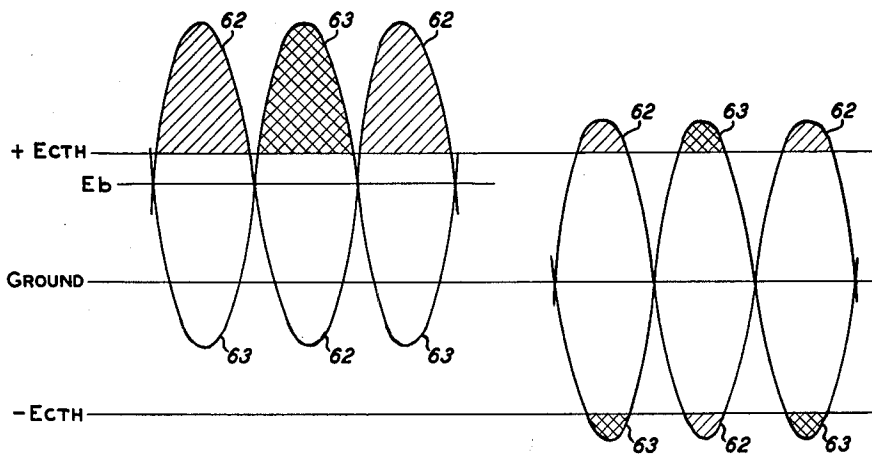


FIG. 8A

FIG. 8B

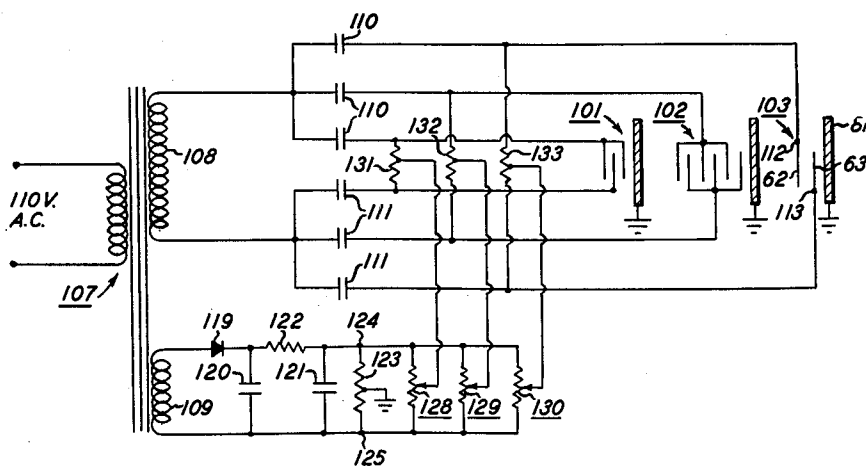


FIG. 9

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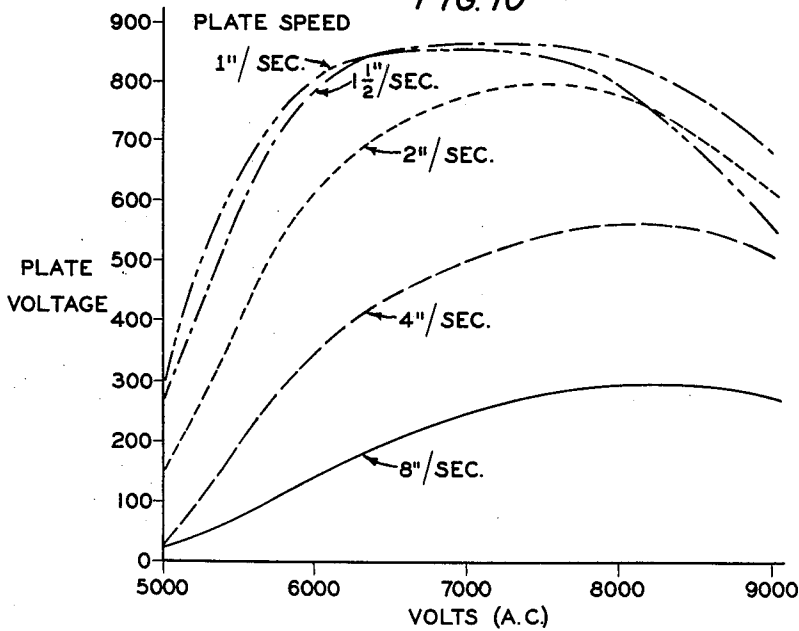
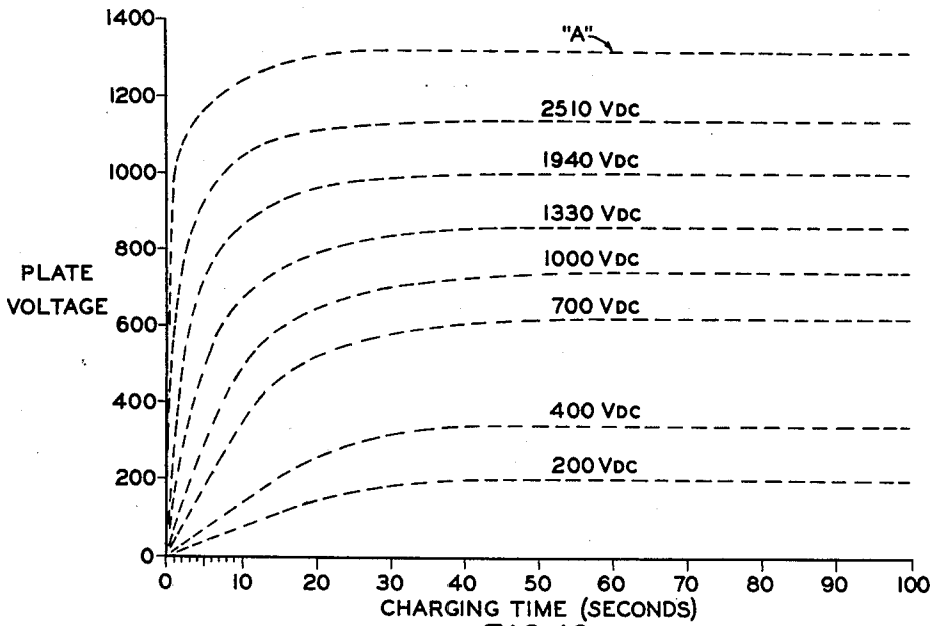
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XEROGRAPHIC CHARGING APPARATUS

Filed July 21, 1960

4 Sheets-Sheet 4



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XEROGRAPHIC CHARGING APPARATUS

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Filed July 21, 1960, Ser. No. 44,300
6 Claims. (Cl. 250—49.5)

This invention relates to improvements in apparatus for effecting controlled corona emission from a corona generating device and, particularly to improved corona generating apparatus for controlling the polarity and magnitude of corona charge applied to a chargeable member.

Although the invention is considered fully applicable to any apparatus requiring application of corona charge, it is described herein in its application to xerography.

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 electrosopic 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.

In the art of xerography it is usual to employ corona generating devices for numerous applications as for example for charging a xerographic plate, transferring a powder image from a plate to a support surface and other applications depending upon the particular type of xerographic equipment being employed. It has heretofore been found necessary in xerographic machines to provide several different sources of corona charge in order to carry out the process properly. Some sources must furnish positive charge, others negative, and often the operating levels must be different for two sources furnishing the same polarity of charge. The straightforward solution heretofore has been to use as many separate power supplies as corona generators. However, this has been a costly solution since the power supply units are relatively complex and therefore relatively expensive.

In addition, it was heretofore considered necessary to employ several different structures of corona generating devices dependent upon the application for which the device was to be utilized. For example, embodiments of the types disclosed in Walkup Patent 2,777,957 and in Vyverberg Patent 2,836,725 are employed primarily where there is relative movement between the device and a member to be charged. Such application is typical in automatic machines wherein a xerographic plate in the form of a cylindrical drum is constantly rotated past the corona generator. When charging a flat surface, without relative movement and commonly referred to in the art as "in-place-charging," it has been usual to employ corona generators of the type described in Ebert Patent 2,932,742.

Although corona generating apparatus of the types cited above have enjoyed commercial success, each has limitations. As previously stated, the apparatus of both Walkup and Vyverberg depend upon relative movement between the corona generator and a chargeable member to effect uniformity of charge on or in the member. The

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apparatus of Ebert can be used for in-place charging without relative movement, but when so used a third wire array serving as a control electrode may be desirable between the corona discharge electrode and the chargeable member to govern charging rate and prevent overcharging. The prevention of over-charging is an important consideration, for example when charging a xerographic plate, since over-charging of a plate produces permanent detrimental effects on its photoconductive surface that renders the overcharged areas unable to retain a subsequently applied electrostatic charge.

It has long been desired to have a corona generating device that was simple in structure, efficient in operation, could be employed for either moving or stationary applications, could effect corona application to a chargeable member of either polarity at any desired magnitude of voltage, would inherently prevent overcharging, and could be arranged in tandem with other similar units to be energized with corona generating potential from a single power supply unit while still retaining its charging characteristics as a unit individually energized.

By means of the present invention improved means are employed for exciting the discharge electrodes whereby charging rate and limit control can be achieved. The present invention effects efficient operation of a corona generator utilizing A.C. potentials that alone need not be of sufficient magnitude to generate corona.

The principal object of the invention is to improve apparatus for controlling corona emission from a corona generating device.

A further object of the invention is to improve apparatus for controlling polarity and magnitude of corona potential applied to a chargeable member from a corona generating device.

A further object of the invention is to improve apparatus by which a corona generating device arranged to apply charge to a chargeable member is inherently self-limiting in the magnitude of charge applied.

A further object of the invention is to improve apparatus by which a plurality of corona generating devices are energized from a single power supply unit with each device individually having the operating characteristics as in the aforesaid objects.

A further object of the invention is to improve apparatus by which a single corona generating device can be employed for various application requirements as to polarity and magnitude of charge to be applied and can be employed interchangeably for in-place-charging with relative movement.

These and other objects are attained by means of the improved control means of the invention connected to a corona generating device and includes apparatus to supply a D.C. potential of desired magnitude and polarity to an A.C. source connected at opposite terminals to separate corona discharge electrodes of a corona generating device.

A preferred form of the invention is shown in the accompanying drawings in which:

FIG. 1 is a schematic illustration of an automatic xerographic machine, incorporating corona generator of the invention;

FIG. 2 is a side elevation of a corona generating apparatus constructed in accordance with the invention;

FIG. 3 is a bottom view of the corona generating apparatus illustrated in FIG. 2;

FIG. 4 is a sectional view taken substantially on line 4—4 of FIG. 2;

FIG. 5 is a typical electrode array of a corona generator particularly adapted for in-place-charging;

FIG. 6 is a sectional view taken substantially on line 6—6 of FIG. 5 and illustrated in charging relation to a xerographic plate;

FIG. 7 is a schematic wiring diagram of a power supply connected to a corona generator in accordance with the invention;

FIGS. 8A and 8B illustrate the operating waveforms of a corona generating apparatus with and without the control means of the invention, respectively;

FIG. 9 is a schematic wiring diagram for tandem energizing of a plurality of corona generating apparatuses from a single power supply unit;

FIG. 10 shows curves illustrating typical charging characteristics of the invention as a function of time when charging a xerographic plate with a constant A.C. potential connected to the generator but with different applications of D.C.; and

FIG. 11 shows curves illustrating typical charging characteristics of the invention when charging a xerographic plate moving at different rates with a constant D.C. connected to the generator having variable A.C. connected thereto.

For a general understanding of the xerographic processing system in which the invention may be incorporated, reference is had to FIG. 1 in which the various system components are schematically illustrated. As in all xerographic systems based on the concept disclosed in the above-cited Carlson patent, a radiation image of copy to be reproduced is projected onto the sensitized surface of a xerographic plate from form an electrostatic latent image thereon. Thereafter, the latent image is usually developed with an oppositely charged developing material to form a xerographic powder image, corresponding to the latent image, on the plate surface. The powder image is then electrostatically transferred to a support surface to which it may be fused by any suitable form of fusing device, whereby the powder image is caused permanently to adhere to the support surface.

The xerographic apparatus described herein typically may be of the type disclosed in copending application S.N. 837,173, filed August 31, 1959, in the names of A. J. Cerasani et al. As in the apparatus thereof, opaque copy to be reproduced is placed on a support tray 10 from which it is fed onto a transport mechanism generally designated as 11. Suitable drive means are provided for the transport mechanism from motor 12 to endless belts 13 whereby the copy is moved past the optical axis of projection lens system 14 that is illuminated by a projection lamp LMP-1. The image of the copy is reflected by mirror 15 through an adjustable objective lens 16 and then reflected by mirror 17 downwardly through a variable slit aperture assembly 18 and onto the surface of a xerographic plate in the form of drum 19.

Xerographic drum 19 includes a cylindrical member mounted in suitable bearings in the frame of the machine and is driven in a clockwise direction by a motor 22 at a constant rate that is proportional to the transport rate of the copy, whereby the peripheral rate of the drum surface is identical to the rate of movement of the reflected light image. The drum includes a surface comprised of a layer of photoconductive material 23 on a conductive backing 24 that is sensitized prior to exposure by means of a corona generating device 25, constructed in accordance with the invention.

The exposure of the drum to the light image discharges the photoconductive layer in the areas struck by light, whereby there remains on the drum a latent electrostatic image in image configuration corresponding to the light image projected from the copy. As the drum surface continues its movement, the electrostatic latent image passes through a developing station 26 in which a two-component developing material 27, which may be of the type disclosed in Walkup Patent 2,638,416, is cascaded over the drum surface by means of developing apparatus 28 which may be of the type disclosed in copending application S.N. 393,058, filed November 19, 1953, in the names of C. R. Mayo et al.

In the developing apparatus, developing material is

carried up by conveyor 29 driven by suitable drive means from motor 30 and is released onto chute 31 wherefrom it cascades down over the drum surface. Toner component 32 of the developer that is consumed in developing, is stored in dispenser 33 and is released in amounts controlled by gate 34.

After developing, the xerographic powder image passes a discharge station 41 at which the drum surface is illuminated by a lamp LMP-2, whereby residual charges on the non-image areas of the drum surface are completely discharged. Thereafter, the powder image passes through an image transfer station 42 at which the powder image is electrostatically transferred to a support surface web 43 by means of a second corona generating device 44 constructed in accordance with the invention.

The support surface to which the powder image is transferred may be of any convenient type such as paper and is obtained from a supply roll 45 and is fed over guide rolls 46 and 47 and over suitable tensioning rolls being directed into surface contact with the drum in the immediate vicinity of transfer corona generating device 44. After transfer, the support surface is separated from the drum surface and guided through a suitable fusing apparatus 48 which may be an adaptation of the type disclosed in Crumrine Patent 2,852,651, whereby the powder image is permanently affixed to the support surface. Thereafter, the support surface is fed over a further system of guide and tensioning rolls and onto a take-up roll 52 that is driven by motor 53.

After separation of the support surface from the drum, a third corona generating device 54, constructed in accordance with the invention, directs electrostatic charge to the residual powder image on the drum surface.

After transfer and charging by generator 54 the xerographic drum surface passes through a cleaning station 55 at which its surface is brushed by a cleaning brush assembly 56, rotated by a motor 57, whereby residual developing material remaining on the drum is removed. Thereafter, the drum surface passes through a second discharge station 58 at which it is illuminated by a fluorescent lamp LMP-3, whereby the drum surface in this region is completely flooded with light to remove any electrostatic charge that may remain thereon. Suitable light traps are provided in the system to prevent any light rays from reaching the drum surface, other than the projected image, during the period of drum travel immediately prior to sensitization by corona generating device 25 until after the drum surface is completely passed through the developing station 26.

Referring to FIGS. 2, 3, and 4, there is illustrated a corona generating apparatus constructed in accordance with the invention and having two corona discharge electrodes 62 and 63. This configuration of generator generally is suitable for charging relatively narrow areas or for charging in applications wherein there is relative movement between the generator and a chargeable member as illustrated in FIG. 1.

In the form of the invention illustrated, the generator includes a conductive shield 64 extending substantially parallel to the electrode wires and spaced approximately 1/2 inch therefrom. The electrode wires are stretched between and attached to insulating blocks 65 and 66 which are attached at the ends of the shield by means of suitable fastening screws 67. Attached to insulating block 65 there is a pair of conductive fingers 68 and 69 to which one end of electrode wires 62 and 63 are respectively attached at 70 as shown. The fingers 68 and 69 are disposed for engagement with suitable conducting bars carrying high voltage supply, as described below. The opposite ends of the electrode wires are attached to insulating block 66 by a pin 71, while 72 designates a conducting plate secured to shield 64 which is grounded in any suitable fashion with which the finger 73 contacts.

Referring to FIGS. 5 and 6 the corona discharge electrode wires 62 and 63 are arranged in an array in the

manner disclosed in the above-cited Ebert patent for effecting in-place charging. The electrode wires are supported on a pair of insulating support blocks 79 and 80 secured to bed plate 84 by means of hinge 86. The electrode wires are spaced in front of conductive shield 81 that is connected to ground in a suitable manner. As illustrated and as more fully described below, each electrode wire formed into an array is connected to opposite poles of high voltage source, here designated 82, whereby adjacent wires are connected to opposite poles as aforesaid. As specifically illustrated, the wires are alternated along the length of insulating blocks 79 and 80 and accordingly are alternated along the area of the xerographic plate to be charged and designated 83. The xerographic plate is mounted on bed plate 84 by means of clamps 85 or the like. The bed plate preferably is grounded, whereby the backing member of the xerographic plate is connected to ground potential. Although the array of Ebert is illustrated, it is to be noted that this array does not constitute a limitation with which the apparatus of this invention can be utilized since the instant invention can be employed advantageously with corona generating devices having other geometrical electrode arrangements.

In FIG. 7, line voltage alternating current, which conveniently may be 110 volts, 60 cycles is shown connected to the primary side of step-up transformer 91. From opposite terminals of the secondary windings, high voltage alternating current is supplied to adjacent corona discharge electrodes which are then energized in accordance with the phase of the current. Emission of corona occurs at potentials which exceed what is referred to as the "corona threshold" which typically occurs in 2 mil and 3.5 mil wire at approximately 3,000 volts and 3,600 volts, respectively.

In accordance with the invention a D.C. potential, designated 92, and hereinafter referred to as a "bias" is connected to the A.C. By means of the bias potential the discharge electrodes are biased symmetrically with respect to ground and the bias potential may be of either polarity and of a desired magnitude, as more fully described below. Potentiometer 93 permits variation of the magnitude of the bias.

The effect of the bias potential on the operation of the corona discharge electrodes may be understood by referring to FIGS. 8A and 8B. In each of these figures the electrode potentials with respect to time are plotted for the wires connected to alternate terminals, their wave forms being illustrated superimposed on the same figure and for purposes of illustration are designated with the same numerals 62 and 63 as the electrodes with which they are associated. The threshold potentials for corona emission are labelled $+E_{eth}$ and $-E_{eth}$, corresponding to the values for positive and negative polarity, respectively, and electrode potentials exceeding these limits are shown crosshatched.

FIG. 8B represents the case of zero bias, in which the electrode potentials swing symmetrically with respect to ground. This means that during whole cycles, the net output of either electrode is essentially zero, since the positive output of the first half cycle is cancelled by the negative output of the second. Thus, for zero bias there is no net charging effect despite the fact that much ionization is taking place, and when attempting to charge a surface, as for example, a xerographic plate, it can be said that with zero bias there is no net ion migration to the plate.

With a bias potential of the invention, designated E_b of either polarity, as for example positive, the symmetry of the potentials with respect to ground is lost, i.e., either electrode becomes more positive with respect to ground during one half cycle than it becomes negative during the next. This phenomenon is illustrated in FIG. 8A. As a result, the flow of current from either wire takes on a net positive value. Summarily it can be said that the flow of ions of one polarity preponderates in one half cycle

to the flow of opposite polarity ions during the next half cycle. This unbalance increases as the bias is increased and as illustrated in FIG. 8A the magnitude of the bias is such that only positive ions are shown being emitted.

Since the system is completely symmetric, negative ions can be emitted similarly by biasing negative instead of positive. The effect therefore, is to energize the electrodes in phase shifting relation whereby corona of one polarity is emitted and the emission occurs from alternate electrodes during each half cycle.

By the means thus far described, complete flexibility is readily attainable by simply setting a relatively low bias potential which for xerographic purposes is usually in the range of ± 500 to 1000 volts D.C. when employing A.C. corona potentials of approximately 4000 to 8000 volts R.M.S. It is evident from the above that with a corona generating device energized in accordance with the invention, net corona emission is not directly related to the alternating current potential, but rather is a direct function of the D.C. bias potential.

Since by the method of the invention the characteristics of corona emission are essentially a function of the bias, flexibility and accuracy of control are inherent which were not possible with these previous systems. The limiting effects of these systems are known to be only approximate, and the cause is believed to be the phenomenon of corona winds. In a corona discharge, heavy air ions acquire velocities such that their momentum will carry them to the xerographic plate against retarding electric fields.

By the system of the invention, which responds accurately to the bias potential, a xerographic plate cannot be overcharged when the applied potentials are properly chosen. When the surface potential of a xerographic plate and the applied D.C. bias are considerably different, as with an uncharged xerographic plate, for example, corona charge is readily applied from the generator to the plate. As plate charge builds up, this potential difference decreases until an equilibrium potential on the plate surface is reached. Plate potential approaches the bias potential having a voltage difference therefrom that varies depending on the geometry of the generator discussed below. At equilibrium, there is effectively zero bias between the generator and the plate, consequently the generator thereafter performs essentially as described for FIG. 8B, i.e., operating symmetrically with respect to ground without increasing the plate potential.

When using a narrow generator unit of the type illustrated to FIGS. 1 and 2 the time during which the drum section passes beneath the unit may be insufficient to achieve the limiting plate charge. Nevertheless, it is possible to operate at any practical machine speed and obtain the desired plate potential by biasing sufficiently far above the equilibrium potential. This is a very satisfactory approach, and for example, at speeds up to 4 inches per second, the operating bias need not exceed the desired plate voltage by more than about 400 volts. This margin decreases as speed is reduced and likewise an increase in bias potential may be required as drum speed is increased. For reasons discussed below, the relative value of the bias for a fixed of plate movement will vary dependent upon the geometry of the generator. However, even for this application, the final plate potential has been found to be much less dependent on line voltage and plate speed than other known systems.

In addition to the operational advantages of charging with a single generating device, the invention lends itself to energizing a plurality of corona generating devices from a single power supply and when so utilized is referred to as "tandem charging."

Referring to FIG. 9 three generating devices arranged for tandem charging and designated 101, 102, and 103 are schematically illustrated connected to a single power supply. Each device thus powered can be operated as a corona generator of either positive or negative ions, and

at any arbitrarily chosen current output within the capability of the power supply device. Transformer 107 has two high voltage secondary windings 108 and 109. The output of 108 is fed by coupling capacitors to the terminals of each corona generating device; e.g., the output is fed by capacitors 110 and 111 to the terminals 112 and 113 of corona generating device 103. The output of winding 109 is rectified by diode 119 and filtered by means of the low pass smoothing network which includes capacitors 120 and 121 and resistor 122. Resistor 123 is center-tapped to ground which establishes ground potential symmetrically between the output terminals 124 and 125. Potentiometers 128, 129, and 130 are connected to their respective bias terminals in resistors 131, 132, and 133 to which are fed direct current voltages adjustable to either polarity and to any desired magnitude with respect to ground. Each of the bias resistors are center-tapped and can be mounted as shown in the power supply unit or alternately can be mounted near the corona discharge electrodes of their respective generator. This system is ideal for automatic xerographic equipment in which more than one generator is employed and frequently employing as many as three or four generators as is illustrated in FIG. 1.

From the curves of FIG. 10 it may be seen how plate voltage is increased to equilibrium as a function of time for various magnitudes of bias potential connected to a constant A.C. source. Whereas the curves hereof may be considered typical of a family of curves the data of FIG. 10, except for curve designed "A," are for a particular geometric configuration of corona generator connected to a 4000 volts (R.M.S.) A.C. source and comprised of a shield formed of 2 mil wire at $\frac{1}{4}$ " spacing, corona discharge electrodes space $\frac{1}{16}$ inch from the shield and formed of 2 mil wires at $\frac{1}{2}$ " spacing and spaced $\frac{1}{16}$ " from a 20 micron selenium plate.

Changes in geometry are known to vary the charging characteristics of the generator. For example, raising the shield and maintaining all other geometrical parameters and A.C. voltage constant reduces the rate of charge deposition on a xerographic plate. Raising the shield under these conditions also generally has the effect of reducing the equilibrium potential for a given value of bias. Raising the plane of the discharge electrodes, keeping all other geometrical parameters fixed, tends to reduce charging rates and depress equilibrium plate potential below the bias voltage. Also, for reasons not known but believed attributable to particular geometric configurations, equilibrium potential has been known to exceed bias potential by as much as 10 percent. In addition, the number and size of corona discharge electrodes will influence charge application, especially on moving plates; and to effect very rapid application of charge on plates moving at high velocity; a high magnitude of bias may be required. A curve illustrating charge application for in-place charging is designated "A" on FIG. 10. From the curve thereof it can be seen that approximately 900 volts is produced on the plate in approximately $\frac{1}{2}$ second. This latter curve was derived with 3.5 mil wire electrodes energized with 3500 volts A.C. to which there is connected a 3000 volt D.C. bias.

The change of plate potential effected by increasing A.C. potential at a constant D.C. bias can be understood by referring to FIG. 11 that also illustrates relative charging characteristics for plates moving at different rates of speed. In FIG. 11 it can be seen that there is a limit of magnitude to which the A.C. potential can be increased to increase plate potential beyond which the effect is to reduce plate potential. This is accounted for by the amplitude of the sine wave increasing to the point where corona of opposite polarity is being emitted at a rate faster than the corona emission of like polarity as the bias. Whereas the curves may be considered typical as establishing a family of curves, the data thereof was derived using a generator comprised of two 3.5 mil wires spaced

$\frac{1}{4}$ " from the drum surface and a constant 1000 volt D.C. bias applied thereto.

The charging characteristics of the generator are also affected by the thickness of the photoconductive layer being charged. In general, thicker layers are brought to equilibrium potentials higher than those for thinner layers charged under identical circumstances. This effect is not understood, but is believed caused by a modification of the electric fields in the space between the charge-emitting wires and the photoconductive layer of reduced capacitance per unit area.

In operation the corona generating device of the invention is connected to the secondary terminals of a high voltage transformer. For in-place charging, the device is arranged substantially parallel and coterminous with a member to be charged, as for example a xerographic plate. A bias voltage is imposed on the circuit and may be of either polarity and any desired magnitude with respect to ground. With the discharge electrodes energized they emit corona of like polarity as the polarity of the bias selected. As the plate assumes a charge and a state of equilibrium is arrived at, i.e., when the charge potential approaches the bias potential so essentially there is effectively zero bias, no net additional charge is thereafter added to the plate.

For charging rotary type xerographic plates in automatic machines, wherein the charging apparatus employed may have as few as two discharge electrodes, the bias level is pre-set to give the desired charging conditions at rated speed. This level will, in general, not be the equilibrium value for the system but in accordance with the invention may be adjusted to suit the requirements of any particular application.

In tandem charging, several different corona generating devices may be operated from a single, power supply unit. The various generators which might, for example, all be used in a single xerographic machine, may each be used to charge to an individual potential and polarity. As for a single unit, each generator is separately connected to opposite terminals of an alternating current supply, conveniently through a pair of coupling capacitors. A direct current bias voltage is superimposed on both sets of wires wherein the bias determines the voltage and polarity applied to a chargeable member and overcharging is prevented in the same manner described above. By this means, the complete generator power supply for an automatic xerographic machine can consist of a single transformer with a high voltage secondary coupled to the electrodes of each generator through a separate pair of capacitors and a low voltage winding feeding a rectifier and several potentiometers for applying a different and adjustable direct current potential to each generator. The advantages of such a system should be apparent.

By the apparatus thus described there is disclosed means for effecting improved operation of a corona generating device. Corona charging in accordance with the apparatus of the invention offers advantages not available with previous systems. Devices thus powered can be employed in all xerographic applications requiring charging, have complete flexibility for charging with either polarity at a chosen magnitude, are substantially self-limiting in magnitude of applied charge, and can be arranged for tandem charging from a single power supply unit.

Whereas the apparatus of the invention has been described primarily for use in xerographic machines, it is apparent that its unique characteristics may suit it to other industrial applications such as discharging static build-up on insulators like paper and fabric, establishing ohmic contact to surfaces for solid state research purposes, etc.

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 con-

tained in the drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. Apparatus for applying a unipolar charge onto a chargeable member, said apparatus including at least two corona discharge electrodes for applying charge to a chargeable member which member is supported in charging position relative to the electrodes, said electrodes being arranged substantially parallel to each other and being substantially uniformly spaced from the surface of a chargeable member supported in charging position, terminals on said electrodes for connecting adjacent electrodes to opposite terminals of a high voltage A.C. potential source, and charge control means connected to said electrodes while said electrodes are connected to said A.C. potential source, said control means including a source of D.C. potential of different magnitude than the potential on a chargeable member to which charge is to be applied.
2. Apparatus for applying a unipolar charge onto a chargeable member, said apparatus including at least two corona discharge electrodes for applying charge to a chargeable member which member is supported in charging position relative to the electrodes, said electrodes being arranged substantially parallel to each other and being substantially uniformly spaced from the surface of a chargeable member supported in charging position, terminals on said electrodes for connecting adjacent electrodes to opposite terminals of an A.C. potential source, and charge control means connected to said electrodes while said electrodes are connected to said A.C. potential source, said control means including a source of D.C. potential of a magnitude different than the potential on a chargeable member to which charge is to be applied, and presettable means to selectively set the magnitude of a D.C. potential connected to said electrodes.
3. Apparatus for applying a unipolar charge onto a chargeable member, said apparatus including at least two corona discharge electrodes for applying charge to a chargeable member which member is supported in charging position relative to the electrodes, said electrodes being arranged substantially parallel to each other and being substantially uniformly spaced from the surface of a chargeable member supported in charging position, terminals on said electrodes for connecting adjacent electrodes to opposite terminals of a high voltage A.C. potential source, and charge control means connected to said electrodes while said electrodes are connected to said A.C. potential source, said control means including a source of D.C. potential, of magnitude different than the potential on a chargeable member to which charge is to be applied and of polarity the same as the polarity of the charge to be applied, and selectively settable means to alternatively connect either the positive or negative pole of said D.C. source to said electrodes.
4. Apparatus for applying a unipolar charge onto a chargeable member, said apparatus including at least two corona discharge electrodes for applying charge to

a chargeable member which member is supported in charging position relative to the electrodes, said electrodes being arranged substantially parallel to each other and being substantially uniformly spaced from the surface of a chargeable member supported in charging position, terminals on said electrodes for connecting adjacent electrodes to opposite terminals of a high voltage A.C. potential source, and charge control means connected to said electrodes while said electrodes are connected to said A.C. potential source, said control means including a source of D.C. potential of magnitude different than the potential on a chargeable member to which charge is to be applied and of polarity the same as the charge to be applied, presettable means to selectively set the magnitude of said D.C. potential, and selectively settable means to alternatively connect either the positive or negative pole of said D.C. source to said electrodes.

5. Apparatus to apply electrostatic charge onto a plurality of chargeable members, said apparatus including a corona generator for each chargeable member to which charge is to be applied, each of said generators having at least two corona discharge electrodes for applying charge to a chargeable member which member is supported in charging position relative to the electrodes, said electrodes being arranged substantially parallel to each other and being substantially uniformly spaced from the surface of a chargeable member supported in charging position, and means to couple adjacent electrodes of each generator to opposite terminals of a high voltage A.C. potential source, a plurality of charge control means each connected to the electrodes of a different generator while said electrodes are connected to said A.C. potential source, each charge control means including a source of D.C. potential of magnitude different than the potential on the respective chargeable member to which the connected generator is to apply charge.

6. Apparatus for applying a unipolar charge onto a xerographic plate, said apparatus including at least two corona discharge electrodes for applying charge to a xerographic plate which plate is supported in charging position relative to the electrodes, said electrodes being arranged substantially parallel to each other and being substantially uniformly spaced from the surface of a xerographic plate supported in charging position, terminals on said electrodes for connecting adjacent electrodes to opposite terminals of a high voltage A.C. potential source, and charge control means connected to said electrodes while said electrodes are connected to said A.C. potential source, said charge control means including a source of D.C. potential, said D.C. potential being of a magnitude substantially constituting a limiting value in the magnitude of charge to be applied by said electrodes onto a xerographic plate being charged.

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