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XEROGRAPHIC CHARGING APPARATUS WITH MEANS TO TERMINATE THE CHARGING CYCLE WHEN A PREDETERMINED CHARGE IS OBTAINED

Filed Dec. 4, 1964 2 Sheets-Sheet 1

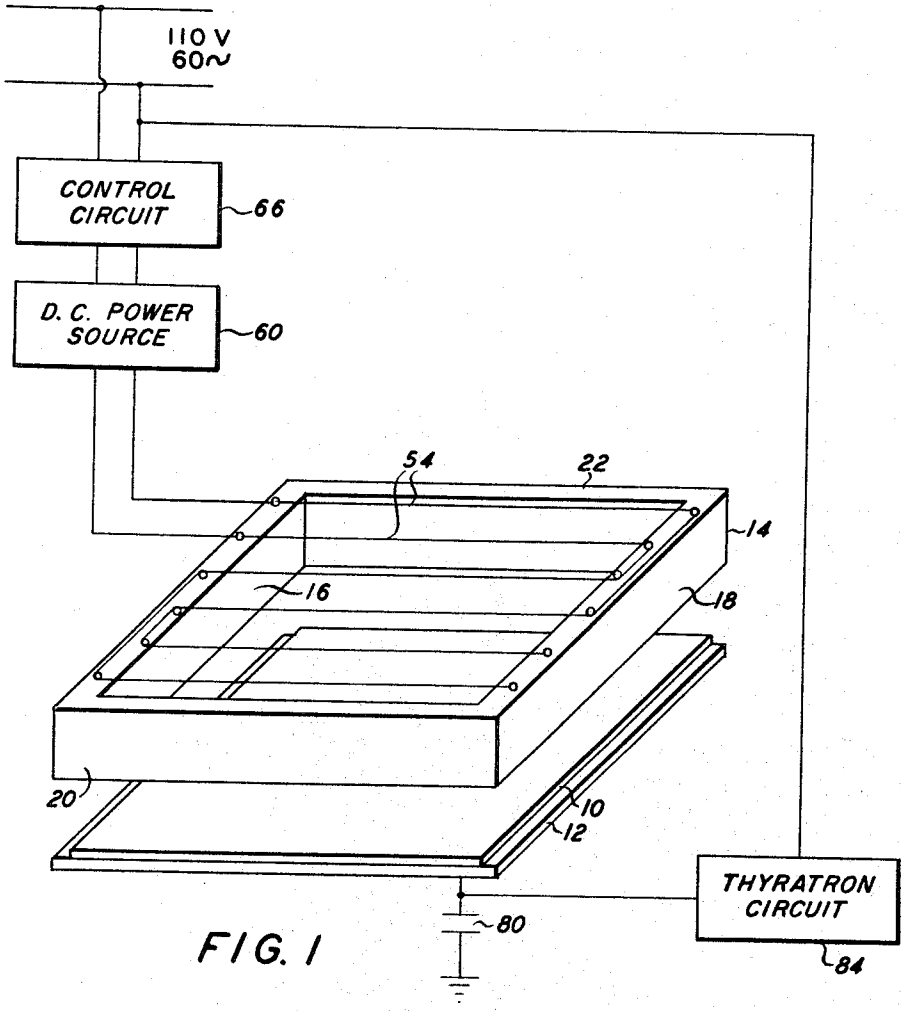


FIG. 1

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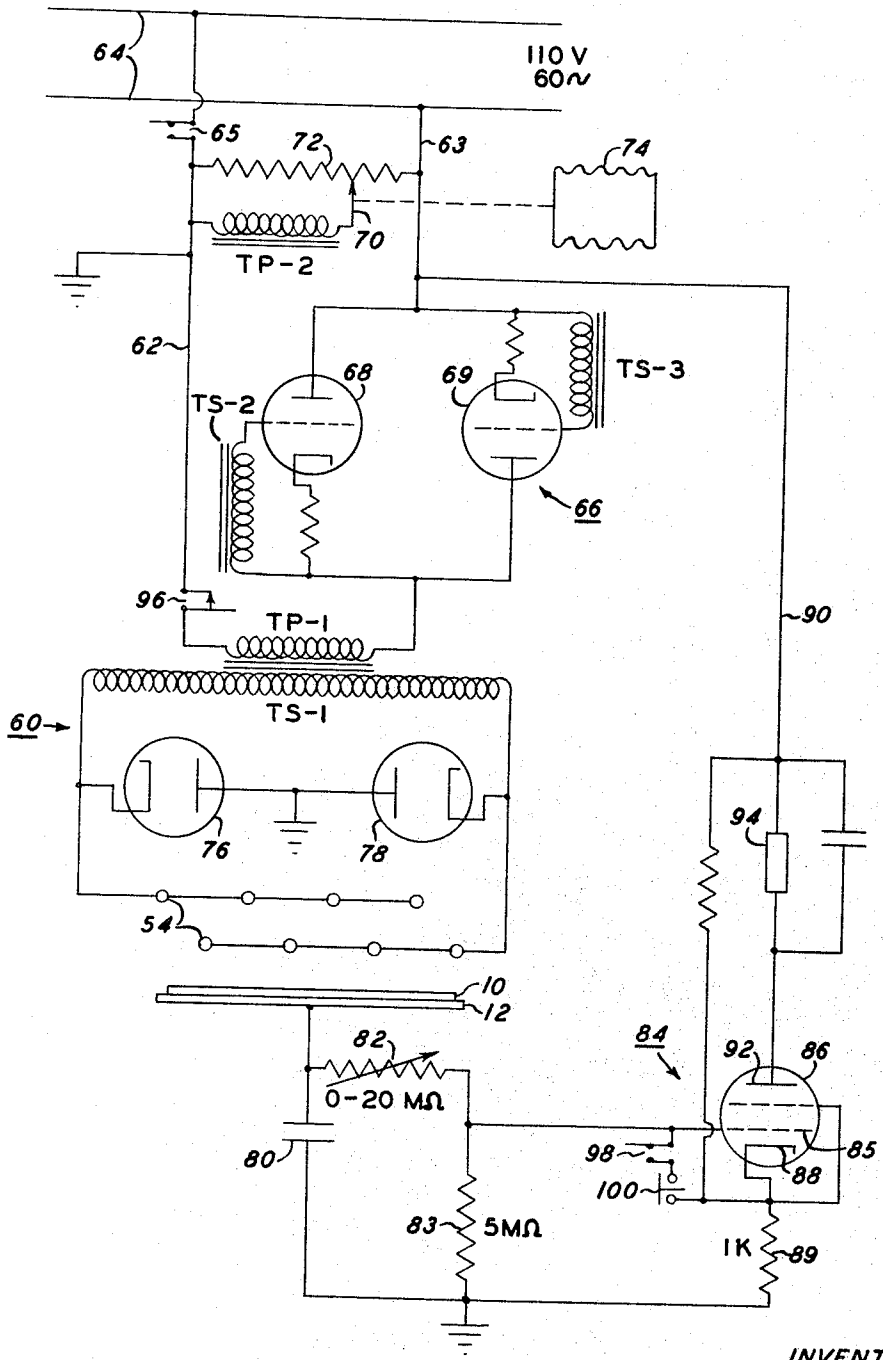


FIG. 2

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XEROGRAPHIC CHARGING APPARATUS WITH MEANS TO TERMINATE THE CHARGING CYCLE WHEN A PREDETERMINED CHARGE IS OBTAINED

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ABSTRACT OF THE DISCLOSURE

A circuit for charging an electrostatic plate having a capacitor connected in series with a plate and a control circuit including a thyratron device for controlling the charging current to the plate upon variations of the voltage drop developed across the capacitor and the plate.

This invention relates to the field of xerography and, particularly, to an improved electric circuit to control a corona generating device for applying electrostatic charge on a xerographic plate.

By present techniques, the charging of an "in-place" xerographic plate in preparation for the exposure step is accomplished by means of a corona generating device whereby an electrostatic charge on the order of 500 to 600 volts is applied to the xerographic plate. A form of corona generating device for this purpose may comprise a plurality of parallel wires connected in series to a high voltage source and supported in a conductive shield that is arranged in closely spaced relation to the surface to be charged. When the wires are energized, corona is generated along the surface of the wire and ions are caused to be deposited on the adjacent photoconductive surface.

As is well known, variations in the potential applied to corona wires of a given diameter will cause relatively large changes in corona current with corresponding variations in the charging rate. In addition, the corona threshold potential and corona current are also affected directly by deposits of dust that may accumulate on the wire, by atmospheric conditions such as humidity, temperature and pressure. Thus when operating at the corona threshold, variations in voltage supply, slight accumulations of dust on the wire, and variations in air current and atmospheric conditions drastically affect the corona generating potential of the wire and cause a non-uniform electrostatic charge to be deposited on the xerographic plate.

In the art of xerography it has been established that consistent high quality reproductions can best be effected when a uniform potential is applied to a xerographic plate to prepare the plate for the exposure step. If the xerographic plate is not charged to a sufficient potential, the electrostatic latent image obtained upon exposure will be relatively weak and the resulting deposition of a developer material thereon will be correspondingly small and, if the xerographic plate is overcharged, the converse will occur, and, if overcharged sufficiently, the photoconductive layer of the xerographic plate may be permanently damaged.

Since the contrast value, comparable to the contrast value obtainable from silver halide papers, of the electrostatic latent image is related directly to the potential charge on the xerographic plate before exposure, it is apparent that if the plate is not uniformly charged over its entire area, the contrast value of the electrostatic latent image obtained upon exposure will vary in different areas on the plate, and a streaky effect will be visible on the image when developed.

It is, therefore, the principal object of this invention to improve the electrical circuit of a corona generating device whereby a uniform electrostatic charge may be deposited on a xerographic plate.

A further object of this invention is to improve a corona generating device control circuit for use in xerographic machines wherein it is desirable to charge a xerographic plate to a uniform potential regardless of variations in the supply line voltage or changes in the surrounding atmospheric conditions.

These and other objects of the invention are attained by cooperative action with a corona generating device comprising a mounting frame and coronode wires mounted and extending within the frame to charge a xerographic plate by corona discharge. The novel charging circuit for ensuring a constant charging current includes a capacitor connected in series with a xerographic plate and a ground circuit arrangement for controlling the charging current in accordance with variations of the voltage drop developed across the capacitor and the xerographic plate.

For a better understanding of the invention as well as other objects and features thereof, reference is had to the following detailed description of the invention to be read in connection with the accompanying drawings, wherein:

FIG. 1 illustrates schematically a preferred arrangement of a xerographic plate, a corona generating apparatus and circuit therefor in accordance with the invention; and,

FIG. 2 is a schematic electrical wiring diagram of the control circuit for the corona discharge device of FIG. 1.

Referring now to the drawings, there is disclosed a preferred arrangement of a corona generating device of the invention as applied to a xerographic plate. As shown in FIGS. 1 and 2, the present invention is adapted to be applied to a xerographic plate having a photocoductive layer or radiation-receiving surface **10**, such as selenium, on a conductive backing plate **12**.

For the purpose of the present disclosure, the several xerographic processing stations for practicing xerography may be described functionally, as follows:

A charging station, at which a uniform electrostatic charge is deposited on the photoconductive layer of the xerographic plate;

An exposure station, at which a light or radiation pattern of copy to be reproduced is projected onto the plate surface to dissipate the plate charge in the exposed areas thereof and thereby form a latent electrostatic image of the copy to be reproduced;

A developing station, at which a xerographic developing material including toner particles having an electrostatic charge opposite to that of the electrostatic latent image is cascaded over the plate surface, whereby the toner particles adhere to the electrostatic latent image to form a xerographic powder image in the configuration of the copy to be reproduced;

A transfer station, at which the xerographic powder image is electrostatically transferred from the plate surface to a transfer material or support surface;

A plate cleaning and discharge station, at which the plate surface is brushed to remove residual toner particles remaining thereon after image transfer, and at which the plate surface is exposed to a relatively bright light source to effect substantially complete discharge of any residual electrostatic charge remaining thereon; and

A fixing station whereat the powder image on the support surface is fused or permanently fixed to the surface.

Referring now to the subject matter of the invention and, particularly FIG. 1, the electrostatic charging of the xerographic plate in preparation for an exposure step is accomplished by means of a corona generating device whereby an electrostatic charge is applied to the plate surface as it is positioned adjacent the charging device. The potential applied to the plate is dependent upon the par-

ticular print contrast desired whereby higher print contrasts require higher initial plate potentials. The charging device comprises a flat frame structure **14** having side members **16, 18** spaced apart by transverse members **20, 22** which connect the ends of the side members, respectively, to form a frame structure.

To effect charging of the plate there is provided a corona generating device and a charging circuit to supply electrical power to the corona generating device. The corona generating device shown in FIG. 2 includes wires **54** called the coronode, which, by a corona discharge, charge the photoconductive surface of the xerographic plate **10, 12**. The potential applied to the plate surface can be controlled by a circuit to be described hereinafter. The wires **54** are made of any suitable non-corrosive material, such as stainless steel, having a uniform exterior. In a preferred embodiment of the charging device, the diameter of the wires is approximately three-and-one-half thousandths of an inch, it being apparent that other size wire can be used.

The corona charging circuit of FIG. 2 is provided with a D.C. power source in the form of a rectifier circuit generally indicated by the reference numeral **60**. The rectifier circuit is connected by a pair of conductors **62, 63** to a source **64** of alternating current, such as a commercial outlet of 110 volts and is adapted to produce a D.C. potential in the range of approximately 6,000 to 11,000 volts. A start switch **65** is provided in the conductor **62** for connecting the various circuits to the source **64**. The conductors **62, 63** are connected to the primary winding TP–1 of a high voltage transformer having its secondary TS–1 as the electrical supply for the rectifier circuit **60**.

Connected in series in the conductor **63** is a control circuit generally indicated at **66** which serves to control voltage impressed upon the primary winding TP–1. The circuit **66** comprises a pair of triodes **68, 69** each of which has its anode connected to the cathode of the other with the connection points thereof being connected to the conductor **63**. A secondary transformer winding TS–2 is connected between the grid and the cathode of triode **68** and a secondary transformer TS–3 is connected between the grid and cathode of the triode **69**. The primary winding TP–2 for the secondary windings TS–2 and TS–3 is connected at one end to the power conductor **62** and at its other end to a wiper arm **70** of a potentiometer resistor **72** which is connected between the supply conductors **62, 63**. The winding TP–2 is associated with the secondary windings TS–2 and TS–3 for supplying the tubes **68, 69** with sufficient bias to control conduction of these tubes and, therefore, the energization of the primary TP–1.

The wiper arm **70** of the potentiometer is linked to a pressure-sensitized bellows **74** which serves to control positioning of the arm along the resistor **72** in accordance with ambient pressures. This arrangement automatically regulates the plate-charging process during changes in ambient pressure by regulating the corona voltage within a safe operating range for any ambient pressure.

In the rectifier circuit **60**, the secondary winding TS–1 is connected at one end to the cathode of a first diode **76** and at its other end to the plate of a second diode **78**. The plate of the first diode is connected to the cathode of the second diode and to ground to maintain these elements at ground potential. The two ends of the winding TS–1 are also connected to the corona wires **54** for the corona generating device **18**. With this arrangement there is a D.C. potential continually supplied to the corona wires **54** for sensitizing charging the xerographic plate **10, 12**.

A capacitor **80** is electrically connected on one side to xerographic plate **10, 12** and, a voltage divider comprising two resistors **82, 83** in series is connected across this capacitor. The resistors **82, 83** form part of a thyratron control circuit, generally indicated at **84**. The junction point for the resistors is connected to the control grid **85** of a thyratron **86** having its cathode **88** through a resistor **89** connected to the other side of the capacitor **80** and to ground. Both the cathode and this side of the capacitor are maintained at ground potential. The A.C. plate supply for the thyratron is derived from the conductor **63** by way of a conductor **90** connected to the plate **92** of the thyratron.

A relay **94** is connected in the conductor **90** in series with the plate **92** and is adapted to become energized during conduction of the thyratron for opening a normally closed relay contact switch **96** connected in series with the primary winding TP–1. A normally open contact switch **98** is also associated with the relay **94** and is connected in series with a manually actuable reset switch **100** and between the junction point for the resistors **82, 83** and the cathode **88**. When the relay **94** is energized, the switches **96, 98** are actuated to open and closed conditions, respectively, and, conversely, when the relay is in a de-energized state, the switch **96** will be closed and the switch **98** opened.

For control of the charging current on the corona wires **54**, the capacitance of the capacitor **80** between the plate **10, 12** and ground is made relatively large compared to the capacitance through the selenium layer **10**; for example, a suitable relative ratio between these capacities may be 20 to 1. With this relationship, as the corona charge accumulates on the selenium layer **10**, the potential therebetween is raised because of the potential drop through the selenium layer and the potential drop across the capacitor **80**. When the sum of these two potentials reaches a sufficiently high value during a plate charging cycle which will be indicative of a predetermined charge upon the plate, say, for example, 600 volts, corona charging of the plate will be controlled in order to maintain the predetermined level between the plate and the corona wires **54**. With this arrangement, complete control is possible over the value of the potential on the selenium layer and, consequently, the amount of corona on the layer by utilizing the voltage drop across the capacitor.

To illustrate, it will be assumed that 600 volts is necessary on the xerographic plate and that 7,000 is to be used as a charging potential. The D.C. corona potential on the surface of the plate with respect to ground will reach 3,000 at the time when the potential drop across the selenium reaches 600 volts. In order to accomplish 600 volts across the selenium layer and with the capacitance of the capacitor **80** being 20 times greater than that of the selenium layer, the potential drop across the capacitor **80** must be 30 volts, and this drop will be utilized to control or maintain the charge of 600 volts on the plate. It will be apparent that by changing the capacity of the capacitor **80**, other potentials on the selenium layer may be produced.

The voltage across the capacitor controls closely the larger voltage on the xerographic plate through the operation of the thyratron. When the voltage drop across the capacitor **80** reaches a predetermined value, depending upon the desired voltage across the plate and the capacitance of the capacitor, a control voltage, as determined by these values and the action of the voltage divider **82, 83**, is fed to the control grid **85** of the thyratron. When at a predetermined value, the control voltage will produce conduction in the thyratron which action will energize switch **96** to open the primary circuit to the high voltage transformer, thereby terminating charging of the xerographic plate.

Specifically, the voltage divider **82, 83** as applied to the capacitor **80** and to the voltage drop thereacross results in a negative voltage being applied to the grid **85** and, consequently, the prevention of conduction in the thyratron. As the voltage drop across the capacitor increases with the charging of the xerographic plate, this voltage will approach zero and, when at a predetermined level due to full charging of the plate, at the time that the plate **92** goes positive during the positive half signal of the supply voltage, the thyratron will conduct. This conduction will open the circuit that produces charging of the plate.

When the thyratron ceases conduction during the negative half cycle of the supply voltage, the charging will be restored until the next positive half cycle. In effect then, the signal on the grid controls the period during each cycle that the thyratron may conduct during charging of the xerographic plate and for maintaining a charge thereon. During the charging cycle, the flow of ions to the plate **10**, **12** is continuously maintained under control of the thyratron circuit. After the charging has terminated, the start switch **65** is opened and the plate **10**, **12** removed whereupon the reset switch **100** is momentarily closed thus causing the grounding and discharging of the capacitor **80** which, in effect, dissipates the bias on the grid **85**. With this condition of the thyratron, the relay **94** will become deenergized causing the opening of the switch **98** and the closing of the switch **96** to condition the corona charging device and the control circuit for another charging cycle.

While the invention has been described with reference to the circuit disclosed herein, it is not confined to the details set forth since it is apparent that certain electrical equivalent components may be substituted for the components of the preferred circuit without departing from the scope of the invention. This application is therefore intended to cover such modifications or changes as may come within the purposes of the invention as defined by the following claims.

What is claimed is:

1. An appaartus for charging a xerographic plate including a corona generating device having at least one corona discharge wire positioned adjacent to a xerographic plate to impose an electrostatic charge onto the xerographic plate; a source of alternating current; a high voltage direct current supply electrically connected to said source and being electrically coupled to said corona discharge wire for charging the same; a control tube having a cathode electrically connected to ground, an anode and a grid, a relay electrically connected in series with said anode and being energizable during conduction of said tube; said relay including a normally closed contact switch interposed between said direct current supply and said source; a capacitor electrically connected between the xerographic plate and said cathode and being electrically coupled to the grid of said control tube for imposing a bias on said grid in accordance with the charging current through the xerographic plate, said capacitor having a capacitance whereby a variation in the charging current above a predetermined value will vary the grid bias to initiate conduction of said tube for energizing said relay thereby opening the circuit between the source and the discharge wire.

2. An apparatus for charging a xerographic plate including a corona generating device having at least one corona discharge wire positioned adjacent to a xerographic plate to impose an electrostatic charge onto the xerographic plate; a source of alternating current; a high voltage direct current supply electrically connected to said source and being electrically coupled to said corona discharge wire for charging the same; a pressure sensitive device mechanically connected between said source and said supply for varying the alternating current to said supply in accordance with atmospheric pressure; a thyratron having a cathode electrically connected to ground, a first grid and an anode connected to said source and, a second grid; a relay connected in series with said anode and being energizable during conduction of said thyratron; said relay including a normally closed contact switch interposed between said direct current supply and said source; a capacitor electrically connected between the xerographic plate and said cathode and being electrically coupled to the second grid of said thyratron for imposing a bias on that grid in accordance with the charging current through the xerographic plate, said capacitor having a capacitance whereby a variation in the charging current above a predetermined value will vary the second grid bias to initiate conduction of said tube for energizing said relay thereby opening the circuit between the source and the discharge wire.

3. An apparatus for charging a xerographic plate including a corona generating device having at least one corona discharge wire positioned adjacent to a xerographic plate to impose an electrostatic charge onto the xerographic plate; a source of alternating current; a high voltage direct current supply electrically connected to said source and being electrically coupled to said corona discharge wire for charging the same; a control tube having a cathode electrically connected to ground, an anode and a grid; a relay electrically connected in series with said anode and being energizable during conduction of said tube; said relay including a normally closed contact switch interposed between said direct current supply and said source; a capacitor electrically connected between the xerographic plate and said cathode and being electrically coupled to the grid of said control tube for imposing a bias on said grid in accordance with the charging current through the xerographic plate, said capacitor having a capacitance whereby a variation in the charging current above a predetermined value will vary the grid bias to initiate conduction of said tube for energizing said relay thereby opening the circuit between the source and the discharge wire; and means for selectively discharging said capacitor after the xerographic plate has attained said predetermined level of charge.

References Cited

UNITED STATES PATENTS

3,062,956 11/1962 Godichini ---------- 250—49.5

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