United States Patent

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[54] **APPARATUS FOR CHARGING A RECORDING ELEMENT WITH AN ELECTROSTATIC CHARGE OF A DESIRED AMPLITUDE**

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[73] Assignee: **RCA Corporation**

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[52] **U.S. Cl.** ....**250/49.5 ZC,** 317/262 A

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

[58] **Field of Search** ....250/49.5 GC, 49.5 ZC, 250/49.5 TC; 317/262 A

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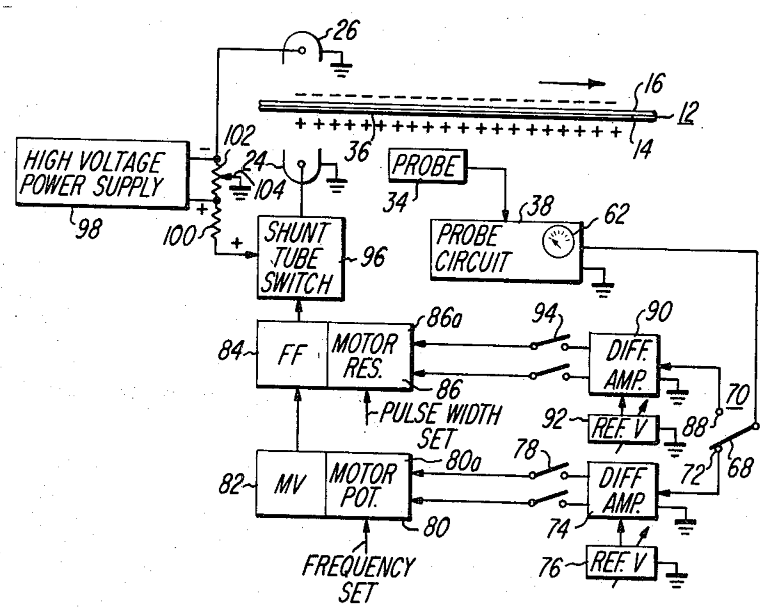
[57] **ABSTRACT**

Apparatus for charging a recording element includes a corona generating device that is energized with pulses of a constant amplitude. Circuitry is provided for obtaining an error signal, if the total charge applied to the recording element tends to vary from a preset desired amplitude, and for controlling the width or the frequency of the pulses in response to the error signal to regulate the applied charge. The method of charging the surface of the recording element to a desired amplitude in a given time includes applying an electrostatic charge to the recording element in pulses and adjusting either the width or the frequency of the pulses to obtain the desired amplitude.

6 Claims, 6 Drawing Figures



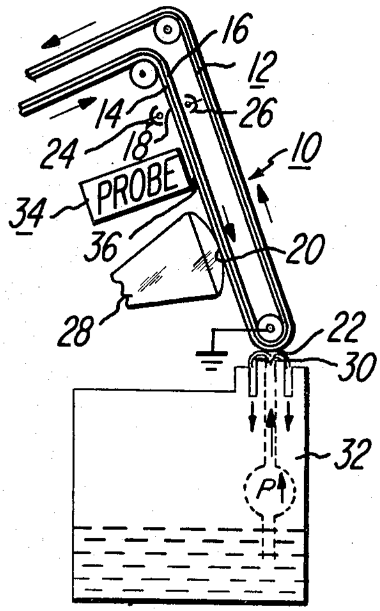


Fig. 1.

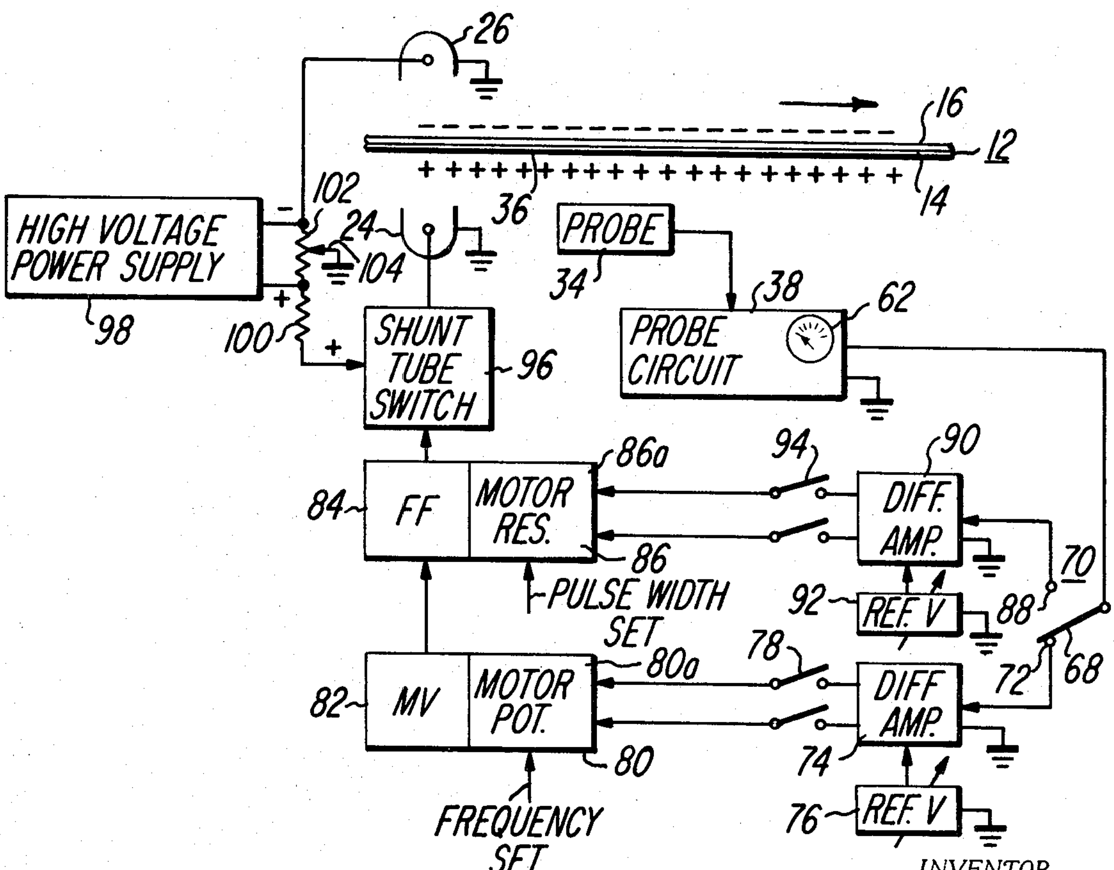


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Fig. 2.

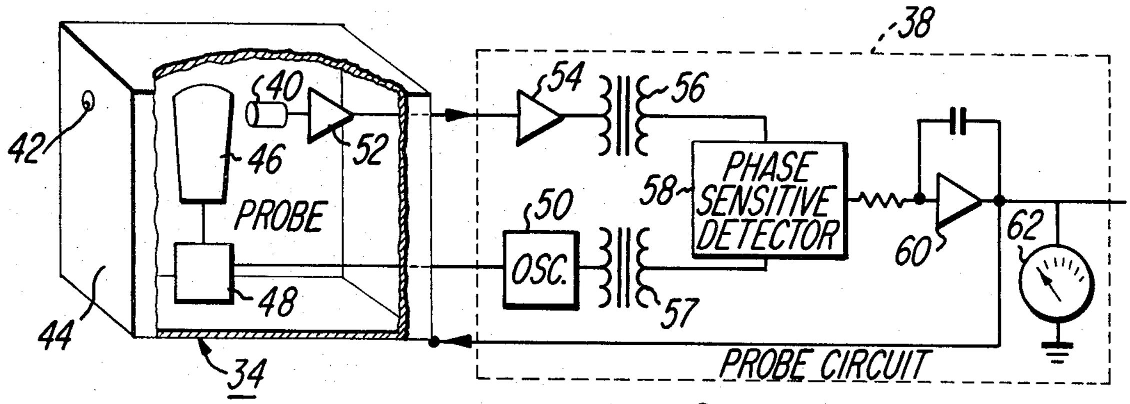

Fig. 3.

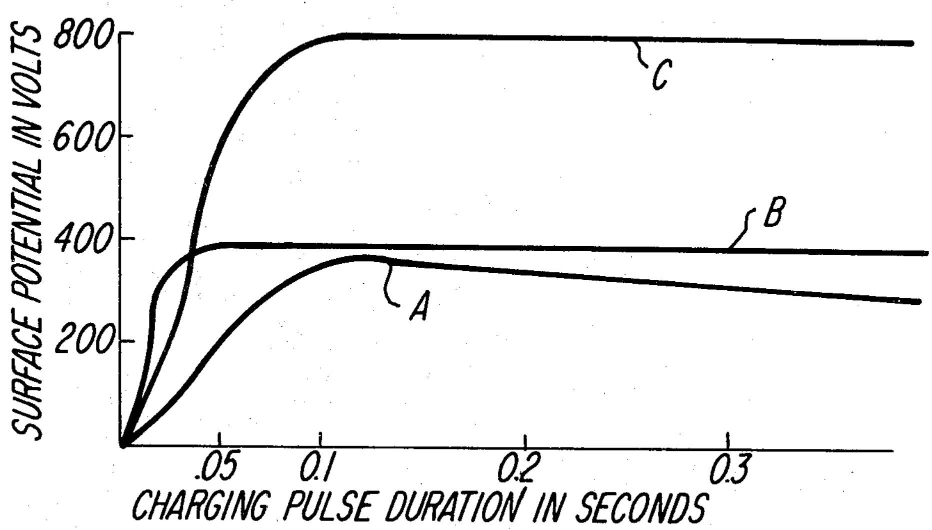

Fig. 6.

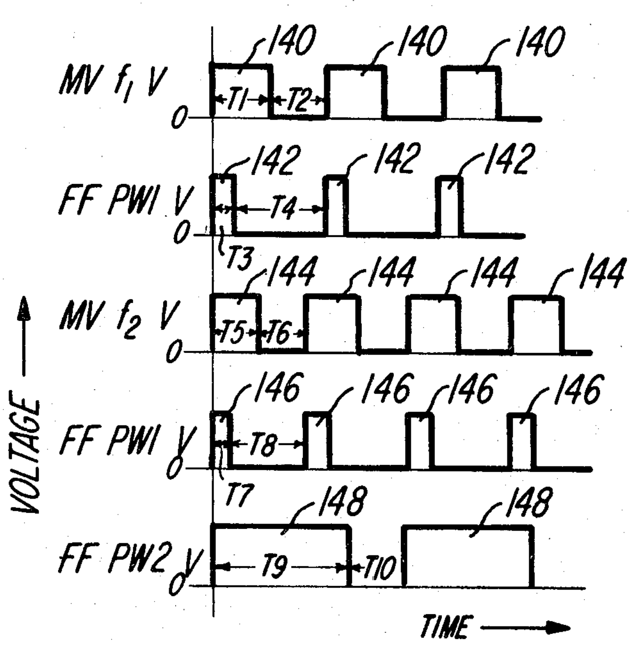

Fig. 5.

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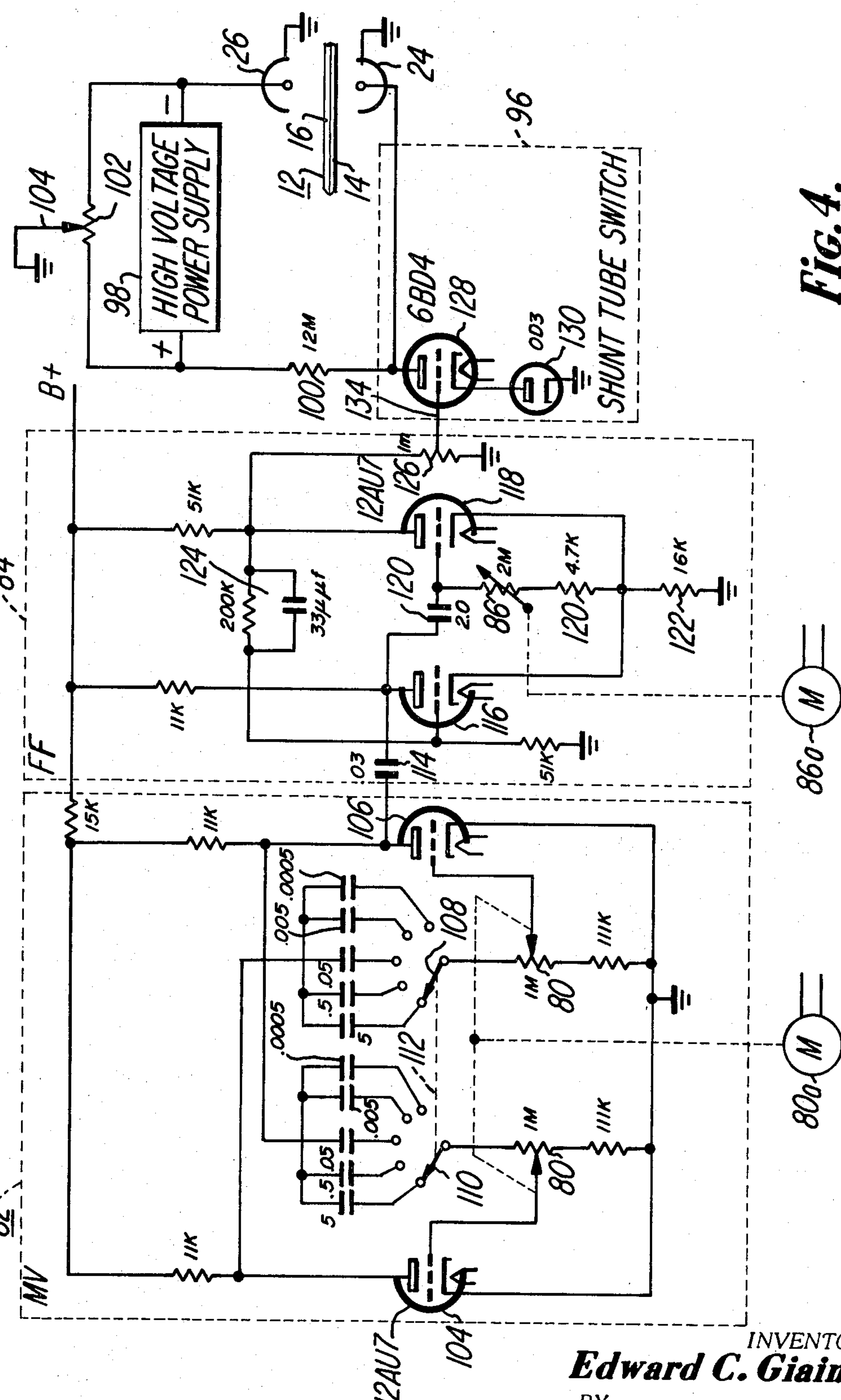

Fig. 4.

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APPARATUS FOR CHARGING A RECORDING ELEMENT WITH AN ELECTROSTATIC CHARGE OF A DESIRED AMPLITUDE

BACKGROUND OF THE INVENTION

This invention relates generally to apparatus for and a method of charging a recording element with an electrostatic charge of a desired amplitude, and, more particularly, to apparatus for and a method of controlling the amplitude of an electrostatic charge applied to the surface of a recording element in a given time.

In an electrophotographic printing system, wherein the surface of a recording element is charged with an electrostatic charge in the course of relative motion between the recording element and a closely spaced corona generating device, the applied electrostatic charge is not always uniformly distributed on the surface. The effect of fluctuations in the charge density is believed to be caused by an overcharging condition, resulting in developed prints of reduced contrast. Overcharged developed direct prints exhibit a reduction in image intensity, and overcharged developed reversal prints exhibit unwanted toning in the background areas.

Since the corona discharge wire of a corona generating device is usually disposed about one-half inch, or less, from the surface of the recording element for effectively charging the recording element, a slow relative motion between a continuously energized corona generating device and the recording element usually causes the recording element to become overcharged. Overcharging cannot be remedied practically by decreasing the voltage that energizes the corona generating device because the minimum voltage necessary to produce a corona discharge is critical, and should be at least 4,000 volts.

The best developed prints from an electrostatic printing system are not always those which receive a maximum overall electrostatic charge, but rather are those which receive an overall electrostatic charge of am amplitude less than the maximum, that is, an electrostatic charge of a desired amplitude. A less than maximum electrostatic charge may also be desirable to obtain the fastest exposure, greatest contrast, and a minimum of spurious background (noise) toning with certain electrophotographic recording elements and electrostatic printing systems.

It has been proposed to control the electrostatic charge on a recording element by charging the recording element with a corona generating device provided with a screen grid. While screen-grid control is suitable for certain electrostatic printing applications, it results in a relatively bulky corona generating device and an inefficient use of the corona discharge.

SUMMARY OF THE INVENTION

The novel apparatus and method involves charging a recording element with pulses of corona discharge. Preferably, an error signal is generated when the applied electrostatic charge varies from the desired amplitude and is used to control the width or the frequency of the pulses to regulate the applied electrostatic charge.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary schematic diagram of one embodiment of an electrostatic printing system for applying a controlled electrostatic charge to the surface of a recording element with the apparatus and method of the present invention;

FIG. 2 is a schematic drawing, partly in block diagram form, of one embodiment of novel apparatus for controlling the frequency or the pulse width of energizing pulses applied to corona generating devices, illustrated in FIG. 1, to regulate the electrostatic charge applied to the recording element;

FIG. 3 is a schematic diagram, partly in block diagram form, of the electrostatic probe and circuitry therefor shown in block diagram in FIG. 2;

FIG. 4 is a schematic diagram of components of the apparatus illustrated in block diagram form in FIG. 2;

FIG. 5 is a series of wave forms used to explain the operation of the novel apparatus illustrated in FIGS. 2, 3, and 4; and

FIG. 6 is a graph of the surface potential acquired by three different recording elements resulting from charging the surface of these recording elements with pulses of different pulse widths.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, there is shown an electrostatic printing system **10** of the type wherein an electrophotographic recording element **12** is moved along a path indicated by arrows adjacent to the recording element **12**. The recording element **12** comprises a photoconductive layer **14** on a relatively conductive backing **16**. The recording element **12** is moved along its path, at a substantially constant speed, by any suitable means (not shown), past a charging station **18**, an exposure station **20**, and a developing station **22**, as for example described in detail in U.S. Pat. No. 3,517,994, issued to M. A. Leedom on June 30, 1970 for "Electrophotographic Apparatus." The recording element **12** is charged at the charging station **18** by corona generating devices **24** and **26** disposed on opposite sides of the recording element **12**, each at a distance of about one-half inch from the recording element **12**. The corona generating devices **24** and **26** are of the type described in U.S. Pat. No. 2,922,883, issued to E. C. Giaimo, Jr. on Jan. 26, 1960. The electrostatically charged recording element **12** is exposed at the exposure station **20** by light images on a thin-window cathode-ray tube **28** to produce electrostatic latent images which are developed at the developing station **22** by liquid developer **30** from a developing tank **32**.

The corona generating devices **24** and **26** are energized with pulses of opposite polarity, respectively, in a manner to be hereinafter explained. The recording element **12** would normally be overcharged if the corona generating devices **24** and **26** were energized continuously, especially when the relative motion between the corona generating devices **24** and **26** and the recording element **12** is relatively slow. In the apparatus **10**, the speed of movement of the recording element **12** is generally less than 1 inch/second.

Means are provided to sense the electrostatic charge applied to the recording element **12** by the corona generating devices **24** and **26**. To this end, an electrostatic probe **34** is disposed adjacent the photoconductive layer **14** of the recording element **12** at an electrostatic voltage sampling station **36**, between the charging station **18** and the exposure station **20**. The probe **34** is disposed about one-eighth inch from the photoconductive layer **14**.

The probe **34** and its associated probe circuit **38**, as shown in FIG. **3**, is an electrostatic voltmeter of the type manufactured by Monroe Electronics Inc., Middleport, New York, 14105, under the trademark "ISOPROBE," Model No. 144 S-4 with Detector/Preamplifier Probe Model 1009B. An explanation of the operation of the probe **34** and its probe circuit **38**, substantially as described in the instruction book for this equipment, is as follows:

An electrostatic electrode **40** (FIG. **3**) "looks" at (senses) the charged surface of the recording element **12** through a small hole **42** at the base **44** of the probe **34**. A metal vane **46** is vibrated by an electromechanical vane driver **48** that is energized by an oscillator circuit **50**. The chopped ac signal thus induced on the electrode **40** is proportional to the differential voltage between the surface (of the recording element **12**) under measurement and the probe **34**. The phase of the chopped ac signal is dictated by the dc polarity.

A reference voltage derived from the oscillator circuit **50** and the mechanically modulated signal, conditioned by a high input impedance preamplifier **52** and signal amplifier **54**, are fed through isolation transformers **56** and **57** to a phase sensitive detector **58** whose output dc amplitude and polarity are dictated by the amplitude and phase of the electrostatically induced signal relative to the reference voltage. The output of the phase sensitive detector **58** feeds a high level dc integrating amplifier **60**. The output of the integrating amplifier **60**, whose polarity is identical to the unknown, is fed directly to the probe **34**. As the open loop gain from the probe **34** to the integrating amplifier **60** is extremely high (approximately 10^9), the probe **34** is driven to a dc voltage typically within 0.01 percent of the potential of the unknown for one-eighth inch probe-to-surface spacing. By simply metering the output of the dc integrated amplifier **60**, as with a voltmeter **62**, an accurate indication of the unknown potential (electrostatic charge) is provided. The output voltage from the amplifier **60** is used to obtain an error signal in a manner to be described hereinafter in detail. This output voltage from the amplifier **60** may also be utilized simultaneously with the voltmeter **62** to provide charging characteristics of recording elements, as will be hereinafter described.

Referring now to FIG. **2**, the novel apparatus for charging the recording element **12** with an electrostatic charge of a desired amplitude is shown. Electrostatic charges of opposite polarity are applied to the opposite surfaces, respectively, of the recording element **12** by pulses applied to the corona generating devices **24** and **26** in a manner to be described hereinafter. The electrostatic charge on the surface of the photoconductive layer **14** is detected by the probe **34** at the voltage (measuring) sampling station **36** and applied to the probe circuit **38**, as described in FIG. **3**. The output of the probe circuit **38**, that is, the amplified detected voltage at the measuring station **36**, is applied to an armature **68** of a single-pole, double-throw switch **70**. One contact **72** of the switch **70** is applied to one input of a differential amplifier **74**. A variable reference voltage **76** is applied to another input of the differential amplifier **74** which amplifies the difference of the input voltages.

The output of the differential amplifier **74** is applied, through a double-pole, single-throw switch **78**, to a motor **80***a* (FIG. **4**) of a motor-operated double (ganged) potentiometer **80**. The motor-operated potentiometer **80** is of the type sold by Automation Development Company, Culver City, California, or by Industrial Control Company, Farmingdale, New York, for example. The motor-operated potentiometer **80** is part of a free-running multivibrator circuit **82**, shown in detail in FIG. **4**. The motor **80***a* of the motor-operated potentiometer **80** is a reversible motor adapted to increase or decrease the resistance of the potentiometer **80** in response to the polarity and amplitude of the (error) signal received from the differential amplifier **74**, whereby to decrease or increase the frequency of an output square wave from the multivibrator circuit **82**, in a manner known in the art. The square-wave output of the multivibrator circuit **82** is applied to the input of a monostable flip-flop circuit **84**.

The flip-flop circuit **84**, shown in detail in FIG. **4**, is adapted to be triggered by the leading edge of the square-wave outputs from the multivibrator circuit **82**. A variable resistor **86** in the flip-flop circuit **84** (FIG. **4**) is varied by a motor **86***a* to vary the pulse widths of the pulses produced by the flip-flop circuit **84** in a manner to be hereinafter explained.

Another contact **88** of the switch **70** is connected to one input of a differential amplifier **90**. A variable reference voltage **92** is connected to another input of the differential amplifier **90**. The output, the difference of the input voltages, of the differential amplifier **90** is applied to the input of the motor **86***a* through a double-pole, single-throw switch **94** to vary the resistance of the resistor **86** in the flip-flop circuit **84**. The output of the flip-flop circuit **84** is applied to a shunt-tube switch circuit **96**, shown in detail in FIG. **4**.

The shunt-tube switch circuit **96** is connected between a high-voltage power supply **98** and the corona generating device **24** to apply energy to the corona generating device **24** in pulses, causing the devices **24** and **26** to generate corona discharges of opposite polarity in pulses, in a manner hereinafter to be explained. The positive terminal of the power supply **98** is connected to the shunt-tube switch circuit **96** through a load resistor **100**. The resistor of a potentiometer **102** is connected between the positive and negative terminals of the power supply **98** and the midpoint of the resistor is grounded by a rotor **104**.

The power supply **98** provides at least 6,000 volts so that when a voltage is applied between the corona generating devices **24** and **26**, the voltage applied to the corona generating device **24** is about 3,000 volts above ground and the voltage applied to the corona generating device **26** is about 3,000 volts negative with respect to ground. Under these conditions, the corona generating devices **24** and **26** generate corona discharges which charge the surface of the photoconductive layer **14** positively and the surface of the backing **16** negatively. In operation, the dc voltage applied to one corona generating device is insufficient to provide a corona discharge. By applying a high voltage pulse to the other corona generating device, the voltage between both corona generating devices is sufficient to produce corona discharges from both devices.

The multivibrator circuit **82**, shown in detail in FIG. 4, is a free-running square-wave oscillator of a type well known in the art. Briefly, the multivibrator circuit **82** comprises two triode tubes **104** and **106** wherein the anode of the tube **104** is coupled to the grid of the tube **106** through one of a plurality of capacitors, as determined by a switch **108**. Similarly, the anode of the tube **106** is coupled to the grid of the tube **104** through one of a plurality of capacitors, as determined by a switch **110**. The switch **110** is ganged to the switch **108**, as indicated by the dashed line **112**, for contacting capacitors of different capacitance. The frequency of the free-running multivibrator circuit **82** can be selected, that is, preset, by positioning the switches **108** and **110** to selected contacts, and the selected frequency may be varied over a range of frequencies if the reversible motor **80***a*, coupled to the ganged potentiometer **80**, varies the resistance in the multivibrator circuit **82**. The values of the resistors in FIG. **4** are in ohms, and the values of the capacitors are in microfarads, unless otherwise indicated. Thus, the multivibrator circuit **82** is capable of providing pulses at a frequency in the range between 0.2 to 20,000 pulses per second.

The flip-flop circuit **84** is monostable in operation and will provide a square-wave output every time it is triggered by the leading edge of a square-wave pulse from the multivibrator circuit **82**. The output of the multivibrator circuit **82**, at the anode of the tube **106**, is coupled to the input of the flip-flop circuit **84** through a coupling capacitor **114**. In the flip-flop circuit **84**, the anode of a triode tube **116** is coupled to the grid of a triode tube **118** through a capacitor **120**. The grid of the tube **118** is connected to ground through the variable resistor **86** and resistors **120** and **122**. The anode of the tube **118** is connected to the grid of the tube **116** through a resistor-capacitor network **124**. By varying the resistance of the variable resistor **86**, as by the motor **86***a* coupled to the variable resistor **86**, the pulse widths of the pulses produced by the monostable flip-flop circuit **84** are varied. The pulse width of a square wave pulse may be varied in the range between 0.010 and 4.0 seconds, using the values of the components indicated in FIG. 4. The output from the flip-flop circuit **84** is taken from a potentiometer **126** whose resistor is connected between the anode of the tube **118** and ground.

The shunt-tube switch circuit **96** (FIG. 4) comprises a triode **128** whose cathode is connected to ground, through a gas tube **130**, and whose anode is connected to the positive terminal of the high voltage supply **98**, through the load resistor **100**, as explained for the circuit in FIG. 2. The corona generating device **24** is connected directly to the anode of the tube **128**, and the corona generating device **26** is connected to the negative terminal of the power supply **98**, as explained previously. The output of the flip-flop circuit **84** is connected to the grid of the tube **128** through a rotor **134** of the potentiometer **126**.

The electrostatic charging of the recording element **12** with pulses will now be described with reference to the circuit diagram of FIG. **4** and the pulse diagrams of FIG. **5**. Let it be assumed that multivibrator circuit **82** is providing square-wave output pulses **140** at the anode of the tube **106** at a frequency *f***1**, as shown in FIG. **5**. The duration of one cycle of the output of the multivibrator circuit **82** is T1 plus T2. The flip-flop circuit **84** is triggered on by the leading edge of every positive input pulse **140** and provides pulses **142** at its output, the rotor **134** of the potentiometer **126**.

The tube **128** of the shunt-tube switch circuit **96** is biased so that each of the pulses **142** triggers the tube **128** into conduction which, in turn, essentially short circuits one-half of the power supply **98** so that the energy provided by the power supply **98** to the corona generating devices **24** and **26** are not sufficient to produce a corona discharge. Thus, when the tube **128** is conducting for a period of time T3 (FIG. 5), the corona generating devices **24** and **26** are not energized. When the shunt tube **128** is not conducting, as during the time period T4, energy is supplied to the corona generating devices **24** and **26** and they produce positive and negative coronas, respectively.

If the recording element **12** is provided with an excessive amount of electrostatic charge, as when the time period T4 is too long, the frequency of the multivibrator circuit **82** can be increased either by varying the capacitance of the circuit through the switches **108** and **110** or by decreasing the resistance of the variable resistors **80**. Pulses **144** (FIG. 5) represent pulses of the same amplitude as the pulses **140** but they are produced at a higher frequency, *f***2**. Under the conditions of frequency *f***2**, the shunt tube **128** is on for a period T7 and off for a period T8. The flip-flop circuit **84** under these latter conditions is switched on at a higher rate than it was previously, that is, it is switched on for a period of T7 and switched off for a period T8, as indicated by the pulses **146** in FIG. 5. Since the period T8 is smaller than the period T4, the shunt tube **128** will be off for less time than previously stated and the power supply **98** will energize the corona generating devices **24** and **26** for a lesser period of time than previously.

If it's desired to energize the corona generating devices **24** and **26** even less than previously, the pulse width of the pulses produced by the flip-flop circuit **84** can be increased by increasing the resistance of the variable resistor **86**. Thus, pulses **148** having a duration of T9 can be produced, using the pulses **144** of the multivibrator circuit **82** to trigger the flip-flop circuit **84**. Since the pulses of the flip-flop circuit **84** are triggered by the leading edge of the pulses from the multivibrator circuit **82**, the pulses **148** of the flip-flop circuit **84** are triggered by every third pulse **144** of the multivibrator circuit **82**, the latter running at a frequency of f2. This occurs because the time T9 is greater than the sum of the times T5 and T6. Under the latter conditions, the shunt tube **128** will be triggered "on" by the long pulse **148** for the relatively long time period T9 and would be triggered "off" for the relatively shorter time period T10. During the "off" time T10, the corona generating devices **24** and **26** are energized by the power supply **98**.

Referring now to FIG. 2, the operation of the novel apparatus for charging the recording element **12** with a regulated electrostatic charge of a desired amplitude will be explained: Let it be assumed that the recording element 12 is being moved, in the direction of the arrows associated therewith, at a constant speed past, and between, the corona generating devices 24 and 26. Let it also be assumed that the settings of the switches 108, 110 and the resistors 80 of the multivibrator 82 are set to provide a desired charge on the recording element 12. Let it be assumed further that the variable resistor 86 is set to provide output pulses from the flip-flop circuit 84 of a desired pulse width so that the corona generating devices 24 and 26 are energized periodically by the power supply 98 to provide the desired electrostatic charge on the recording element 12.

The probe 34 senses the electrostatic charge that passes by it, at the voltage sampling station 36, and applies it to the probe circuit 38. The output of the probe circuit 38, which is indicated on the voltmeter 62, is applied to the armature 68 of the switch 70. The armature 68 is making an electrical connection with the contact 72 of the switch 70, and the switch 78 is closed. Under these conditions, the voltage applied to the recording element 12 is regulated by varying the frequency of the pulses applied to the corona discharge devices 24 and 26. The output of the probe circuit 38 is thus applied to the input of the differential amplifier 74 and compared with a preset reference voltage 76 to obtain an error signal. If the voltage input from the probe circuit 38 is equal to the preset voltage from the reference voltage 76, no error signal is applied to the motor 80*a*, and the rotor of the potentiometer 80 remains stationary. If, however, the voltage applied to the recording element 12 tends to increase, this increase in voltage is sensed by the probe 34 and the output from the probe circuit 38 to the differential amplifier 34 is increased. This increased voltage is compared with the preset reference voltage 76 and produces an error signal at the output of the differential amplifier 74 to rotate the reversible motor 80*a* and to move the rotor of the potentiometer 80 in a direction to increase the output frequency of the multivibrator circuit 82. Under these latter conditions, the shunt tube 128 is triggered off for a lesser duration of time, (i.e., T8 now as against T4 previously), and the corona generating devices 24 and 26 are energized by pulses less frequently than previously. Hence, any tendency for the voltage on the recording element 12 to increase is automatically regulated by providing fewer pulses per unit of time to the corona generating devices 24 and 26, thereby regulating the electrostatic charge applied to the recording element 12. Conversely, any tendency for the voltage on the recording element 12 to decrease results in an error signal of a polarity which decreases the frequency of the multivibrator circuit 82, increases the "off" time of the flip-flop circuit 84, and energizes the corona generating devices 24 and 26 longer per unit of time.

The voltage (electrostatic charge) applied to the recording element 12 may also be regulated by varying the pulse width of the pulses provided by the flip-flop circuit 84. In this mode of operation, the armature 68 of the switch 70 is moved to make electrical contact with the contact 88 (FIG. 2). The switch 78 is opened, the switch 94 is closed, and the frequency of the multivibrator circuit 82 is preset to a fixed frequency. Any variation in the electrostatic voltage applied to the recording element 12 is sensed by the probe 34, applied to the probe circuit 38, and the output of the probe circuit 38 is compared with the preset reference voltage 92 by the differential amplifier 90. Error signals at the output of the differential amplifier 90 are applied to the motor 80*a* through the now closed switch 94 to vary the resistance of the resistor 86 degeneratively. Thus, the resistance of the resistor 86 is either increased or decreased depending upon whether less or more electrostatic charging respectively, of the recording element 12 is needed to regulate the electrostatic charge.

Instead of using two double corona generating devices 24 and 26, a single corona generating device 24 may be used and the corona generating device 26 can be replaced with a metal plate adjacent, and in contact with, the surface of the backing 16 of the recording element 12. Under these latter conditions, the metal plate would be connected to one terminal of the power supply 98 and grounded, and the corona generating device 24 would be connected to the other terminal of the power supply 98.

The novel method of charging the recording element with an electrostatic charge of a desired amplitude in a given time will be described with reference to the graphs in FIG. 6. Referring now to FIG. 6, there are shown three graphs A, B, and C which represent the relationships between potentials on the surfaces of three different recording elements A, B, and C resulting from charging pulses of different pulse widths.

Data for the Graphs A, B, and C is of the type obtained by using the apparatus shown in FIG. 1. A recording element A of one manufacturer was moved past the corona generating devices 24 and 26 at a speed of 0.3 inches/second. Corona generating devices 24 and 26 were energized with substantially constant amplitude pulses of opposite polarity, respectively, from a power supply to provide corona discharges. The Graph A shows the relationship between the charge on the recording element A, as measured by the probe 34 and read on the output voltmeter 62 (FIGS. 2 and 3), and the pulse widths of the pulses applied to the corona generating devices 24 and 26. The curves B and C were obtained in a manner similar to that of the curve A except that recording elements B and C of different manufacturers were used.

It has been observed that in reproducing images by electrophotographic apparatus, such as the apparatus 10 in FIG. 1 in which reversal development and a development electrode was used, the best reproduction was not always obtained when the recording element was charged to a maximum. In fact, the same amount of electrostatic charge for the different recording elements A, B, and C did not produce the same results. For example, a surface potential of 600 volts on the recording element C may give the same results as a surface charge of 340 volts on the recording element B or 250 volts on the recording element A. Once a determination of the relationship between the potential on the surface of a particular recording element and the pulse width of pulses for energizing the corona generating devices is made, a selection of the desired electrostatic charge for optimum results on the moving recording element can be made by adjusting the pulse width of the pulses applied to the corona generating devices 24 and 26. This is accomplished by adjusting the reference voltage 92 while watching the voltmeter

62. It is also possible, as described previously, to adjust the total electrostatic charge on the moving recording element by varying the frequency of the pulses instead of their pulse widths. This is accomplished by varying the reference voltage **76** while watching the voltmeter **62** until the desired voltage for optimum results is indicated.

If the electrostatic printing system is one wherein the electrostatic charge on the recording element is not regulated, the novel method may still be practiced if means are provided to vary either the frequency or the pulse width of the pulses applied to the corona generating devices. For example, if the charging apparatus of the printing system comprised only the circuitry indicated in FIG. **4**, without the motors **80***a* and **86***a*, either the frequency or the pulse width of the charging pulses could be controlled manually by either varying the resistance of the resistors **80** in the multivibrator circuit **82** or the resistor **86** in the flip-flop circuit **84**, respectively.

I claim:

1. In an electrostatic printing system of the type wherein a corona generating device is disposed to apply an electrostatic charge to a surface, the improvement of means to regulate the electrostatic charge resulting on said surface at a desired amplitude comprising:

electrical energizing means to energize said corona generating device with voltage pulses of a constant amplitude, whereby to apply an electrostatic charge to said surface,

means to obtain an error signal when the amplitude of the electrostatic charge on said surface varies from said desired amplitude, and

feed-back means, responsive to said error signal, to control the width or the frequency of said voltage pulses of a constant amplitude, whereby to regulate the electrostatic charge on said surface.

2. An electrostatic printing system of the type described in claim **1**, wherein

said corona generating device comprises at least one corona discharge wire disposed for relative motion with respect to, and adjacent, said surface, and

said surface is a surface of a recording element.

3. An electrostatic printing system of the type described in claim **2**, wherein

the speed of said relative motion between said corona generating device and said surface is substantially constant,

said energizing means includes a power supply adapted to provide an output voltage that is substantially constant and at least sufficient to produce a corona discharge from said corona discharge wire, and

said energizing means comprises switching means to connect and disconnect said power supply to said corona discharge wire in response to said error signal, whereby to provide said voltage pulses of a constant amplitude.

4. An electrostatic printing system of the type described in claim **3**, wherein

said means to obtain an error signal comprises an adjustable reference voltage means, whereby to select or preset said desired amplitude of said electrostatic charge,

probe means to sample the voltage applied to said surface, and

means to compare said reference voltage with the sampled voltage, whereby to obtain said error signal.

5. An electrostatic printing system of the type described in claim **4**, wherein

said feed-back means comprises

a free-running multivibrator circuit having means to vary its frequency in response to said error signal, and

means to apply the output of said multivibrator circuit to said switching means to control the frequency at which said power supply is connected and disconnected to said corona discharge wire.

6. An electrostatic printing system of the type described in claim **4**, wherein

said feed-back means comprises

a free-running multivibrator circuit having means to set its frequency of output at a constant frequency,

a monostable flip-flop circuit having an input, responsive to the output of said multivibrator circuit, and having an output connected to said switching means, and

means to apply said error signal to said flip-flop circuit to vary the pulse width of the output of said flip-flop circuit, whereby to control the rate of switching of said switching means.

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