

[54] REGULATED POWER SUPPLY FOR CORONA CHARGING UNIT

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[57] ABSTRACT

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A regulated power supply for the corona charging unit of an electrostatic copying machine in which the difference between a reference voltage derived from the supply mains and a voltage derived from a sample of the ionic current of the corona unit provides the input for a regulator which controls the amount of power supplied by a full wave rectifier connected to the supply mains to a D.C. converter which feeds a voltage doubler connected to the corona unit.

[52] U.S. Cl. 250/324, 317/262 A

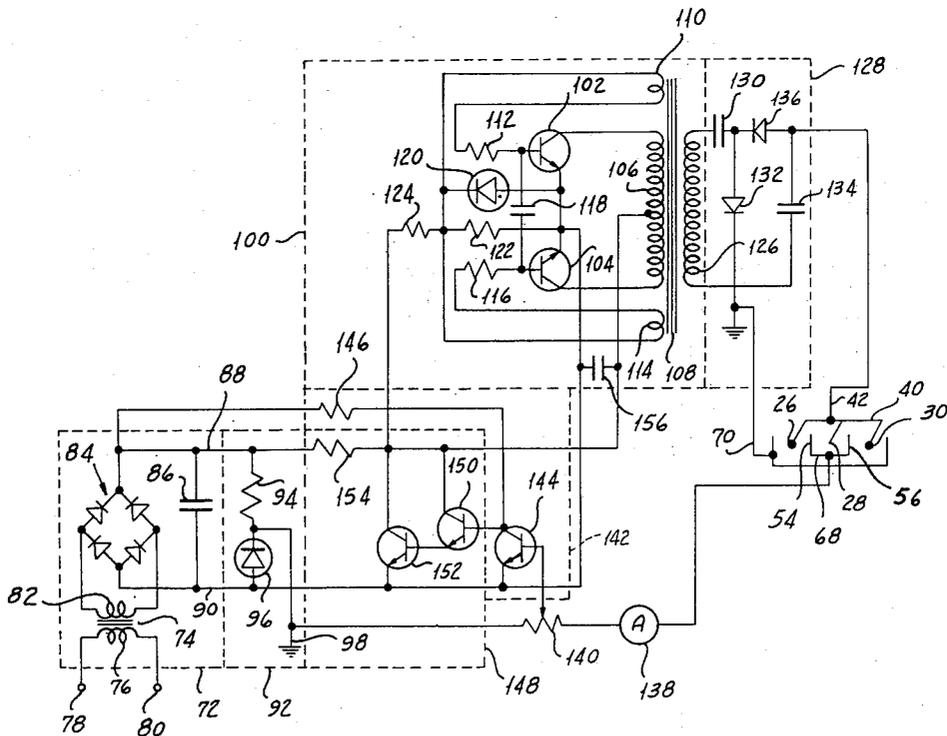
[51] Int. Cl. G03g 15/00

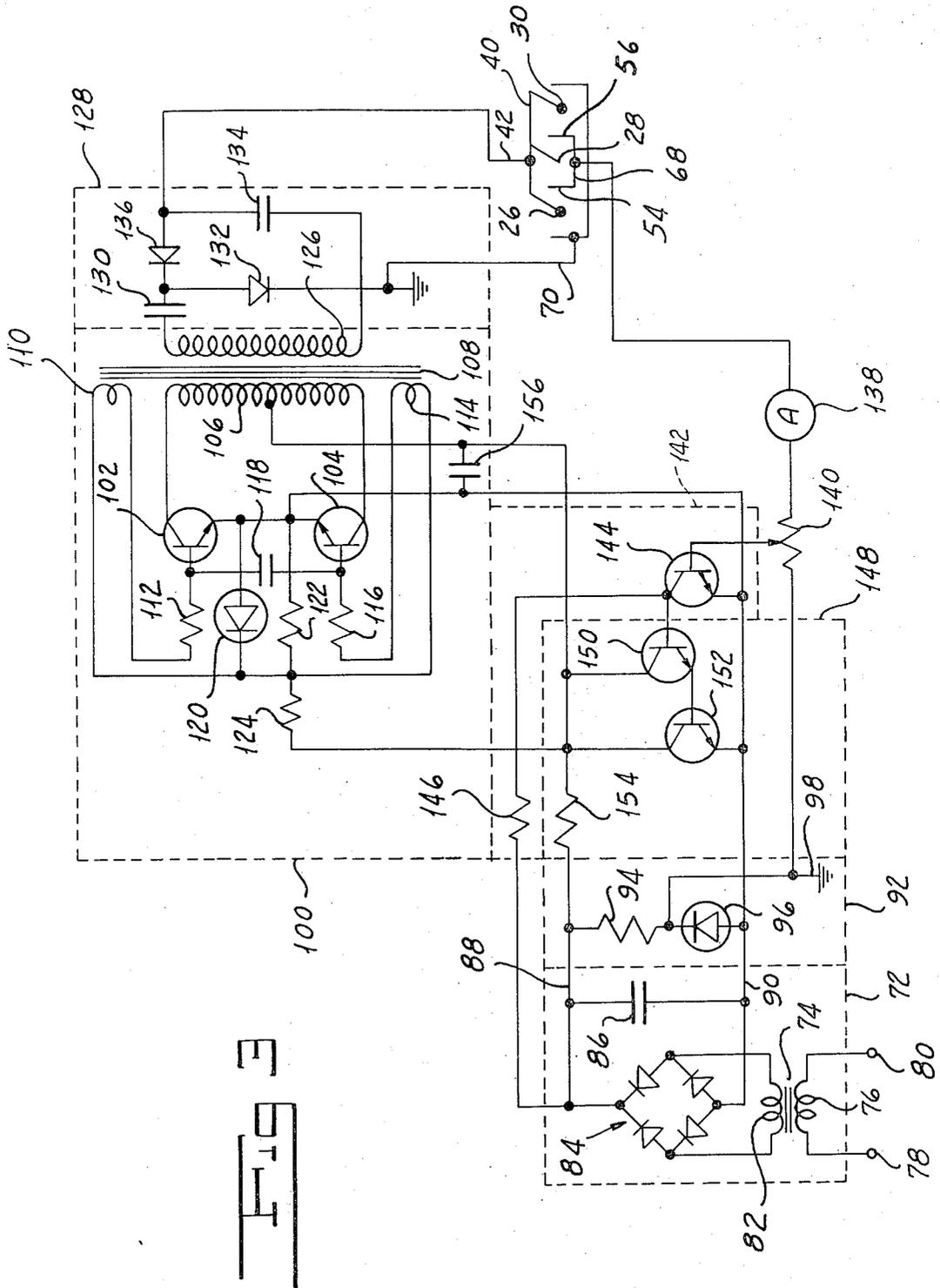
[58] Field of Search 250/324, 325, 326; 317/262 A

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UNITED STATES PATENTS

3,062,956 11/1962 Codichini 250/326

5 Claims, 3 Drawing Figures





REGULATED POWER SUPPLY FOR CORONA CHARGING UNIT

BACKGROUND OF THE INVENTION

As is known in the prior art, in an electrostatic copying system a photoconductive surface first is moved past a corona discharge unit which is intended to apply a uniform electrostatic charge to the surface. After leaving the corona unit the surface moves past an exposure system at which it is exposed to a light image of the original to cause the charge to leak off in exposed areas and to be retained in relatively dark areas of the original. Following the exposure step, the latent electrostatic image is developed by the application of toner particles thereto. In some systems of the prior art, the image may be formed on a sheet of photoconductive material and in other systems the image may be formed on another photoconductive surface such as that of a drum or a belt and be transferred to a sheet of plain paper or the like following development.

It will readily be appreciated that the copy produced in an electrostatic copying system is a function of the charge applied to the photoconductive surface by the corona. Not only should the charge be uniform over the surface, but also it should not vary from copy to copy. Most of the corona systems of the prior art use as a power source a 240 volt alternating current extra-high tension transformer and rectifier system to provide the relatively high direct current potential required to operate the corona. This supply system incorporates a number of defects. Fluctuations in the supply main voltage result in wide variations of corona current which in turn result in variation in the charge applied to the photoconductive surface on successive operations thereof. In addition, these systems of the prior art are heavy, expensive, and bulky. Further, this system of the prior art does not permit ready interchange between power supply units and corona discharge units owing to the fact that different supply transformers have different output voltages and require recalibration when applied to a particular discharge unit.

We have invented a regulated power supply system for a corona discharge unit which overcomes the defects of power supplies of the prior art. Our power supply is lighter, cheaper, and more compact than are corona system power supplies of the prior art. The output of our power supply is independent of fluctuations in the main supply voltage. Our power supply is readily adapted for use with various discharge units.

SUMMARY OF THE INVENTION

One object of our invention is to provide a regulated power supply for a corona charging system.

Another object of our invention is to provide a corona unit power supply which overcomes the defects of corona unit power supplies of the prior art.

A further object of our invention is to provide a corona unit power supply the output of which is independent of fluctuations in the main supply line voltage.

Still another object of our invention is to provide a corona unit power supply which is lighter than are corona unit power supplies of the prior art.

A still further object of our invention is to provide a corona unit power unit which is less expensive than are corona unit power supplies of the prior art.

A still further object of our invention is to provide a corona unit power supply which is more compact than are corona unit power supplies of the prior art.

Yet another object of our invention is to provide a corona unit power supply which is adapted to be used with various discharge units.

Other and further objects of our invention will appear from the following description.

In general our invention contemplates the provision of a corona unit power supply in which a voltage derived from the ionic current of the corona unit is compared with a reference voltage derived from the supply mains to provide an input voltage for a regulator which regulates the output voltage of a full wave rectifier connected to the mains so as to control the power input to a D.C. converter which feeds a voltage doubler connected to the wires of the corona unit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of one form of corona charger unit with which our regulated power supply may be employed.

FIG. 2 is a sectional view of the corona charger unit illustrated in FIG. 1, taken along the line 2—2 of FIG. 1.

FIG. 3 is a schematic view of our regulated power supply for a corona charging unit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. 1 and 2 of the drawings, a typical corona charger unit indicated generally by the reference character 10, with which our power supply may be used, includes a pair of end plates 12 and 14, side plates 16 and 18, and a base plate 20. The unit 10 also includes respective insulating blocks 22 and 24, which are assembled with the end plates, side plates, and base plate in any suitable manner known to the art.

The particular corona unit illustrated in FIGS. 1 and 2 includes three corona wires 26, 28, and 30. One end of each of the wires is connected by a tension spring 32 to a conductive rod 36 which extends from a recess 34 in the block 22 to a connector 38 which electrically couples the rod to a bus bar 40. Bus bar 40 is adapted to receive an external connector 42 which extends through an insulator 44 in the side plate 18. The end of each of the wires 26, 28, and 30 remote from the recess 34 extends into a recess 48 in the block 24. This end of each of the wires is connected by a tension spring 46 to a rod 50 which is received in a receptacle 52 in the block 24. In this manner the three corona wires 26, 28, and 30 are mounted in the unit 10. In use of the unit and as is known in the art, the wires 26, 28, and 30 extend generally transversely of the path of movement of the photoconductive surface to which the charge is to be applied.

The unit 10 further includes a pair of conductive divider strips 54 and 56. Each of the strips is received in a pair of aligned slots 58 and 60 in the blocks 22 and 24 so that each strip 54 extends across the unit through the space between a pair of adjacent corona wires 26 and 28 or 28 and 30. In our power system we provide respective conductors 62 and 64 which extend through insulators 66 in the base plate 20 for connection to the respective strips 54 and 56. A common conductor 68 connects the two conductors 62 and 64. In addition we

provide a conductor 70 which grounds the assembly of the base plate and side plates in a manner to be described.

Referring now to FIG. 3 of the drawings, a direct current supply unit, indicated by the broken line block 72, includes a transformer 74, the primary 76 of which is connected to the terminals 78 and 80 of a suitable supply main such as a source of 240 volt alternating current voltage. The secondary 82 of the transformer 74 is connected to a full wave rectifier indicated generally by the reference character 84 to provide a direct current voltage across a smoothing capacitor 86 connected between lines 88 and 90.

Our supply system includes means for deriving a reference voltage from the voltage across lines 88 and 90. The reference voltage source indicated by the broken line box 92, includes a resistor 94 and a Zener diode 96 connected in series between lines 88 and 90. We connect the common terminal of the resistor 94 and the diode 96 to a ground line 98. It will readily be appreciated that the reference voltage is independent of variations in voltage at the supply mains.

Another unit of our system is a D.C. converter indicated by the broken line box 100, which is adapted to produce a high A.C. voltage from a direct current voltage supplied to the converter. The converter 100 includes a pair of push-pull connected transistors 102 and 104 connected across the main primary winding 106 of a transformer 108. Transformer 108 includes a first feedback winding 110 for applying a base signal to the transistor 102 through a resistor 112. A second feedback winding 114 provides a feedback voltage for the base of transistor 104 through a resistor 116. We connect a capacitor 118 between the bases of the transistors 102 and 104. In addition, a diode 120 and a resistor 122 are connected in parallel between the common emitter terminal of transistors 102 and 104 and the common terminals of the two feedback windings 110 and 114. A resistor 124 connects the resistor 122 to the voltage regulator to be described hereinbelow.

The secondary winding 126 of the transformer 108 feeds the A.C. voltage generated by the converter 100 to a voltage doubler indicated by the broken line box 128 which rectifies and doubles the signal input thereto. Doubler 128 includes a capacitor 130 connected to the upper terminal of winding 126 and a diode or stack of diodes 132 connected between the other terminal of the capacitor and ground. A second diode or stack of diodes 136 is connected between the output line of the doubler 128 and the common terminal of capacitor 130 and diode 132. A second capacitor 134 is connected between the other terminal of diode 136 and the lower terminal of winding 126. This doubler 128 provides the necessary high corona voltage which is applied to line 42 to energize the corona.

As is known in the art, the corona current is generated when a sufficiently high voltage, such as the output voltage of doubler 128, is applied to the corona wires 26, 28, and 30 in the manner described. Air near the wires becomes ionized and the resultant ions are swept by the electric field toward the photoconductive surface. In addition, in the corona system we have shown the metal partitions or dividers 54 and 56 function to insure a uniform charge distribution over the sheet. These dividers attract a portion of the corona current generated so that the wires may be operated at a potential which exceeds the threshold voltage without

overcharging the photoconductor. Other details of the corona unit per se are described in the co-pending application of Peter J. Hastwell, Ser. No. 287,694, filed Sept. 11, 1972, for a "Corona Charger Configuration". In the arrangement described in that application, the divider plates 54 and 56 are connected to ground. In our arrangement, we use the divider plates to derive a sample of the corona current.

We connect conductor 68 of the plates 54 and 56 through an ammeter 138 to a variable resistor 140 to produce a voltage across the resistor which voltage is a measure of the corona current. A portion of this voltage is applied to an amplifier indicated by the broken line box 142. Amplifier 142 includes a transistor 144 the base of which is connected to the tap on resistor 140 and the collector of which is connected to the upper terminal of rectifier 84 by a resistor 146. The terminal of resistor 140 remote from the ammeter 138 is connected to ground line 98.

We apply the output of the amplifier 142 to a regulator indicated by the broken line box 148. Regulator 148 includes a first transistor 150, the collector of which is connected by a resistance 154 to the upper terminal of the rectifier 84, and the emitter of which provides the signal for the base of a second transistor 152, the collector of which is connected to resistor 154.

The input voltage to the converter 100 is derived from regulator 148 by connecting the terminal of resistor 154 remote from line 88 to a center tap on primary winding 106 and by connecting line 90 to the common emitter terminal of transistors 102 and 104. We connect a capacitor 156 between these two points. In addition, resistor 124 is connected to the terminal of resistor 154 remote from line 88.

In operation of our regulated power supply for a corona charger unit, the voltage input from the regulator 148 to the converter 100 results in a very high voltage at the secondary winding 126 which is rectified and doubled by the doubler 128 to produce a corona voltage of from 3 to 10 kilovolts. The sample current through the ammeter 138 produces a voltage across resistor 140, a portion of which is applied to amplifier 144 to provide the input to the regulator. The brush of resistor 140 is set to give the desired corona voltage. After that has been done, any change in the ionic current of the corona unit is reflected in the voltage applied to the input of amplifier 142. If, for example, the ionic current decreases, the regulator operates to draw less current through resistor 154, thus to increase the input voltage to the converter 100. Conversely, if the ionic current increases, the voltage supply to the converter 100 by the regulator will be decreased. It will readily be appreciated further that variations in the voltage of the source having terminals 78 and 80 does not affect the corona voltage. My system automatically compensates for such variations.

It will readily be appreciated that, rather than using the shunt regulator 148, we might employ a series regulator. It will further be appreciated that other means than the particular D.C. converter shown may be employed to generate the extra-high tension voltage required for the corona. Further, instead of using the doubler 128 we might employ a voltage tripler. Our system is adapted to various corona units. When applying the system to a particular unit, the brush of resistor 140 can readily be set to provide the required corona voltage. In addition, while we have shown a negative output

corona voltage, we may, if desired, provide a positive voltage. The variable resistor or potentiometer 140 may be replaced by several pre-set resistances in parallel to provide the same total resistance. The regulator input could then be switched among the various resistors of pre-set values.

It will be seen that we have accomplished the objects of our invention. We have provided a regulated power supply for use with a corona charger. The output of our supply is independent of fluctuations in line supply voltage. It is readily adapted for use with corona systems requiring different inputs. Our system is lighter, cheaper, and more compact than are power supplies used in corona systems of the prior art.

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

Having thus described our invention, what we claim is:

1. A corona discharge system for an electrostatic copying machine including in combination, a source of alternating current line voltage, means responsive to said source line voltage for producing a relatively low level direct current voltage, a voltage regulator adapted to be actuated to regulate said low level direct current

voltage, means responsive to said regulated low level direct current voltage for producing a high level direct current corona voltage, a corona unit, means for applying said corona voltage to said corona unit to produce an ionic current therein, means for producing a sample voltage as a measure of said ionic current, a source of a reference voltage, and means responsive to the difference between said sample voltage and said reference voltage for actuating said voltage regulator.

2. A system as in claim 1 in which said source of said reference voltage includes means responsive to said low level direct current voltage for producing said reference voltage.

3. A corona discharge system as in claim 1 in which said sample voltage producing means comprises variable resistance means and means for applying said ionic current to said variable resistance means.

4. A corona discharge system as in claim 1 in which said corona unit comprises a corona element and in which said sample voltage producing means comprises a conductive member positioned adjacent and in spaced relation to said corona element to receive a portion of the ionic current therefrom and a resistor connected to said conductive member.

5. A corona discharge system as in claim 1 in which said corona voltage producing means comprises a direct current converter responsive to said low level direct current voltage for producing a large alternating current voltage and a voltage doubler responsive to said large alternating current voltage.

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