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Hastwell et al.

[11] **3,819,942**

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[54] **REGULATED POWER SUPPLY FOR CORONA CHARGING UNIT**

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[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

[56] **References Cited**

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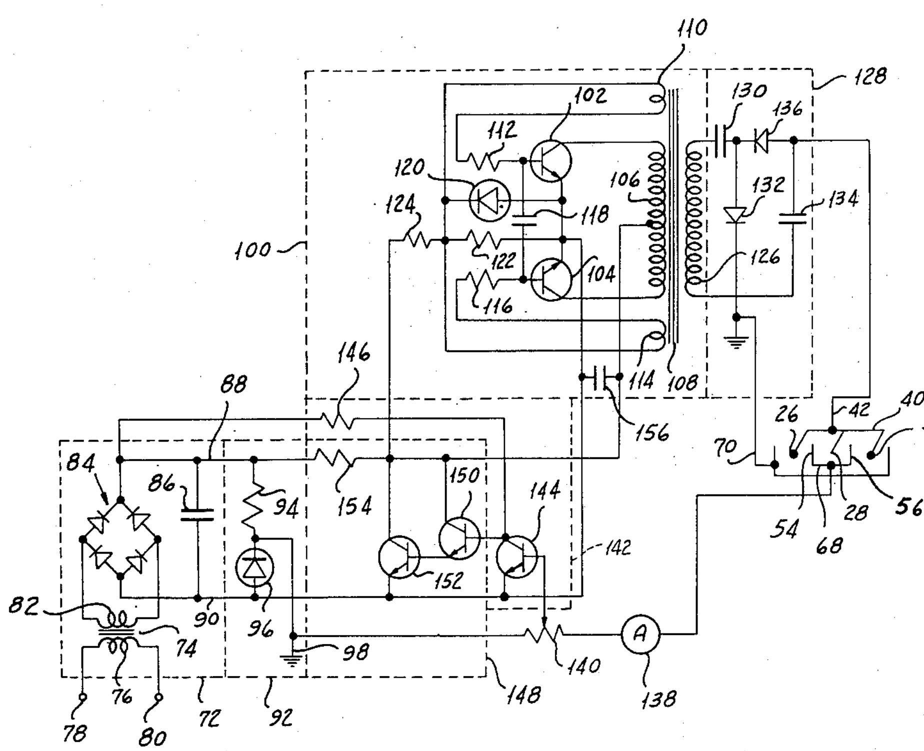
[57] **ABSTRACT**

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.

5 Claims, 3 Drawing Figures



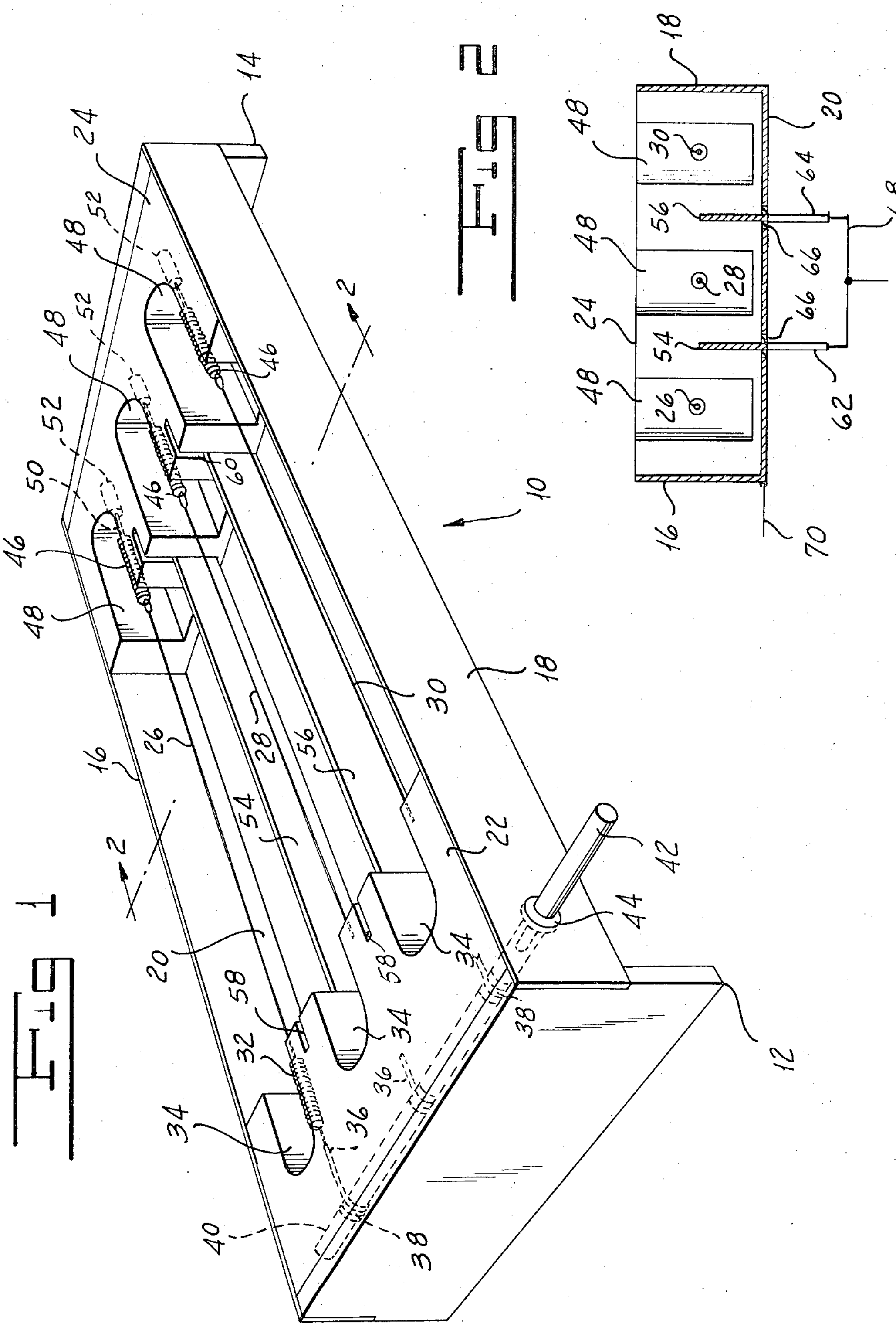

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FIG. 1

FIG. 2

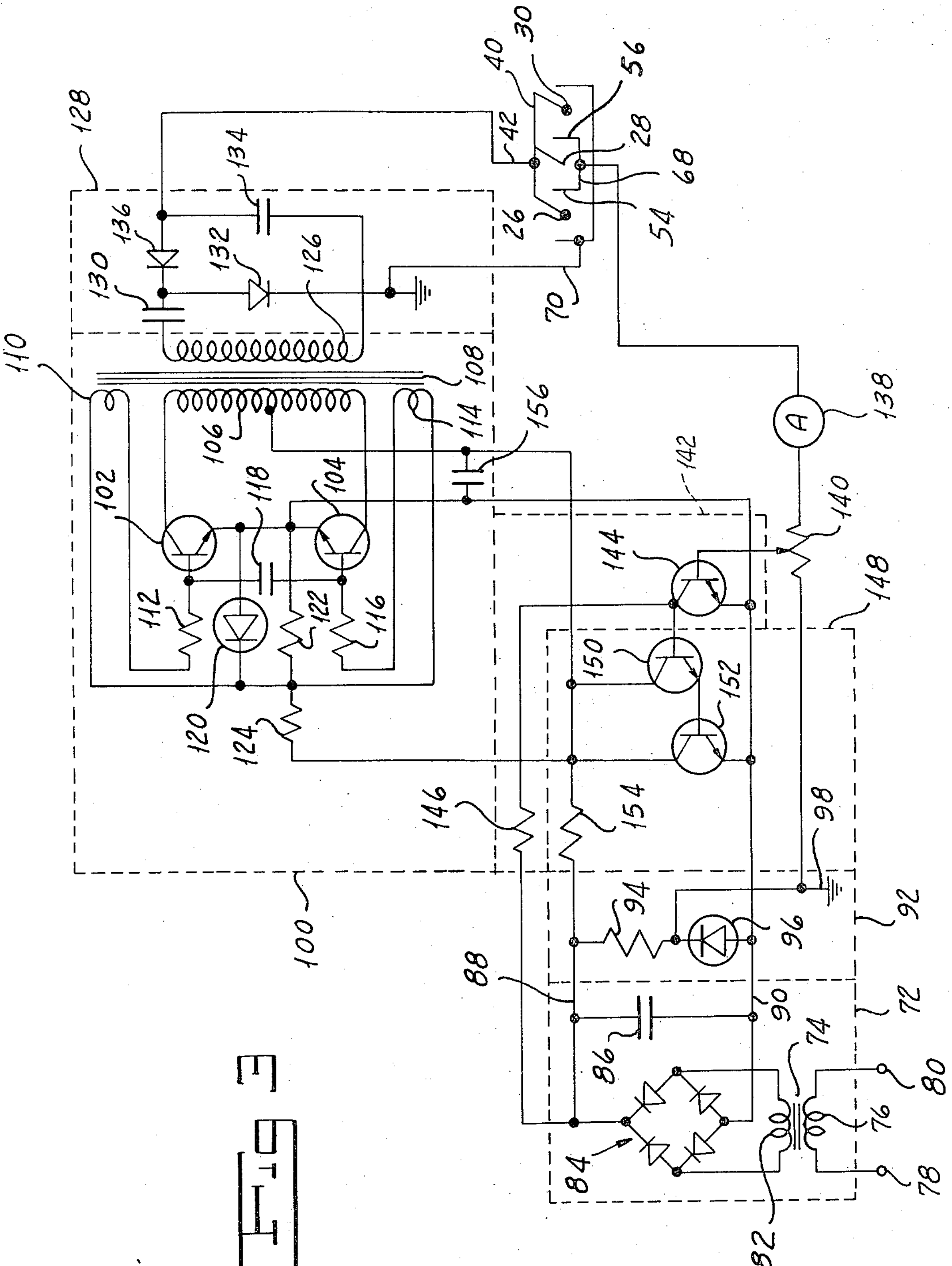
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FIG. 3

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 ouput 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 subcombinations 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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