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(54) Title: METHOD FOR CLEANING IONIZING ELECTRODES

(57) Abstract: A method and apparatus for cleaning the ionizing electrodes of electronic ion generators, electrostatic air devices, and ion wind devices is provided, wherein electronically altering corona pressure and/or inducing electro-kinetic action during emitter operation has the effect of releasing contaminants in order to maintain emitter performance.

METHOD FOR CLEANING IONIZING ELECTRODES

BACKGROUND

[0001] This invention relates generally to electronic ion generators, electrostatic air devices, and ion wind devices, and more particularly to an improved method and apparatus for cleaning the ionizing electrodes of such devices.

[0002] Electronic ion generators, electrostatic air devices, and ion wind devices utilize atmospheric anions or cations which are usually generated electronically by applying a high voltage DC or pulsed voltage of singular polarity to a metal wire electrode or metal point emitter. The amount of ion production is directly proportional to the amount of high voltage applied, the emissivity properties of the material being used, and the geometry of the emitter element. The most common material used for the electrode or emitter is an extremely pure tungsten wire element because of its durability, cost, and emissive ability. It should be appreciated, however, that other materials, such as molybdenum, gold, platinum, stainless steel, and silver have also been used for electrodes or emitters. In most applications, the electrode or emitter material is seldom a pure element and contains doping materials such as silica to allow it to be formed for the desired use.

[0003] Electronic devices which incorporate these metallic electrodes or emitters to produce ions have historically been burdened with the problem of contamination. Contamination of the metallic ion emitting electrodes causes lower emissivity, sporadic ion emission, and thermal "hot spots" at the contaminated areas. Most of the contamination which occurs on the surface of electrodes is the result of three primary factors.

[0004] First, the doping materials contained within the metal may migrate to the surface of the electrode when exposed to high voltage potentials of 1,000 volts or more. For example, silica and other doping materials have been known to migrate to the surface of the metal when the metal is excited with the high voltage potentials necessary to effect ionization. These materials ultimately build a powder-like coating on the surface of the electrode and hinder its ability to effectively produce charge transference to nearby air molecules.

[0005] Second, ambient contaminants such as dust and airborne microelements may cause contamination of electrodes, particularly in a high humidity environment.

For example, material sources in the ambient air such as calcium carbonate may come to rest upon the electrode and similarly affect charge transference to the nearby air molecules.

[0006] Finally, contamination of electrodes may occur as a result of direct contact with foreign objects, such as by the touching of human fingers and hands.

[0007] Known methods to clean electrode emitter elements involved mechanically wiping the debris from the element or washing the element with a solvent such as alcohol. Such methods are only minimally effective and often result in breakage of the fragile electrode elements.

[0008] A need exists to provide methods for cleaning electrode emitter elements that do not require direct contact with the electrode(s) and, therefore, do not excessively stress the material being treated. A need also exists to provide a means to electronically remove contamination as it occurs, thereby improving the performance and reliability of the electrode(s).

SUMMARY

[0009] The present disclosure provides a method and apparatus for cleaning the emitter electrodes of electronic ion generators, electrostatic air devices, and ion wind devices. More specifically, the present disclosure provides a method and apparatus for cleaning emitter electrodes by electronically altering corona pressure and/or inducing electro-kinetic action during emitter operation to cause the electrodes to release contaminants that has accumulated on the electrode in order to maintain emitter performance. The electrode cleaning feature or method of the present disclosure can be configured to operate in a manual, automatic or in an "as needed" basis.

[0010] It should be appreciated that the electrode cleaning feature or method may be provided for cleaning the emitter electrodes of electronic ion generators, electrostatic air devices, and ion wind devices. However, the phrase "electronic ion generator system" is used in the discussion below to convey the concepts of the present disclosure as it applies to each of these configurations.

[0011] In one embodiment, an electronic ion generator includes an emitter electrode and a voltage source. The voltage source is adapted to provide a sharp high voltage pulse upon the driving voltage which results in a rapid change in corona pressure substantially spherically at the emitter point. The sudden change in pressure causes the emitter electrode to shift position and contaminants that have accumulated on the emitter are thrust into the immediate ambient surroundings.

[0012] In one embodiment, the voltage source applies a pulsed voltage train of high voltage spikes or pulses to the emitter electrode. This causes the corona pressure to be rapidly altered and simultaneously causes the emitter electrode to shift position or oscillate about the emitter electrodes central longitudinal axis. Inducing a mechanical resonance in this manner causes amounts of accumulated contamination on the emitter electrode to be released.

[0013] In certain embodiments, the present disclosure operates on an automatic, as needed basis. Most applications involve periodic cleaning. Thus, in various alternative embodiments, the cleaning cycle or procedure of the present disclosure is activated by any of: (i) activation of a manual switch by a user, (ii) an interlock event when other service is being performed on the ionizing device, (iii) an internal clock circuit programmed for a desired interval, and (iv) any other suitable method. In one embodiment, the electric ion generator system includes a detection circuit, such as monitoring current at a preset voltage or the like. In such embodiments, the detection circuit determines when a designated amount of contamination has accumulated on the emitter electrode. If the detection circuit determines that the emitter element has become sufficiently contaminated, the detection circuit activates the cleaning cycle or procedure.

[0014] In another embodiment, an excitation source is electro-magnetically coupled directly to the emitter electrode. In one such embodiment, the excitation source provides a pulsed voltage to a coil winding, such as a solenoid winding, which is in very close proximity to a ferrous sleeve fixed on or around the emitter electrode. The rapidly changing magnetic flux induces slight mechanical movement, or shaking, of the emitter electrode without coming in direct contact with the emitter electrode. This provides a dielectric barrier from the high voltage potential applied to the emitter element. The emitter electrode moves or shakes about its longitudinal axis causing any accumulated contamination to be shaken loose from the emitter electrode.

[0015] It is therefore an object of the present invention to provide an improved method and apparatus for cleaning the ionizing electrodes of electronic ion generators, electrostatic air devices, and ion wind devices.

[0016] It is another object of the present invention to provide an improved method and apparatus for cleaning ionizing electrodes which does not stress the material being treated.

[0017] A further object or feature of the present invention is to provide an improved method and apparatus for cleaning ionizing electrodes which electronically removes contamination as it occurs.

[0018] An even further object of the present invention is to provide a method and apparatus for cleaning the ionizing electrodes which does not require direct contact with the electrode(s) and may be configured to operate on an automatic, as needed basis.

[0019] Other novel features which are characteristic of the invention, as to organization and method of operation, together with further objects and advantages thereof will be apparent from, the following Detailed Description and the drawings. It is to be expressly understood, however, that the drawings are for illustration and description only and are not intended as a definition of the limits of the invention.

[0020] There has thus been broadly outlined the more important features of the invention in order that the detailed description that follows may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will form additional subject matter of the claims appended hereto. Those skilled in the art will appreciate that the conception upon which this disclosure is based readily may be utilized as a basis for the designing of other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims be regarded as including such equivalent constructions insofar as they do not depart from the spirit and scope of the present invention.

BRIEF DESCRIPTION OF THE FIGURES

[0021] FIG. 1 is a view of a superimposed pulse train used to excite the emitter electrode; and

[0022] FIG. 2 is a schematic view of an electro-magnetically coupled excitation source.

DETAILED DESCRIPTION

[0023] The present disclosure provides an improved method and apparatus for cleaning the ionizing or emitter electrodes of electronic ion generators, electrostatic air devices, and ion wind devices. In one embodiment, the present disclosure provides a method for cleaning emitter electrodes by electronically altering corona pressure and/or inducing electro-kinetic action during emitter operation. Electronically altering corona pressure and/or inducing electro-kinetic action during emitter operation has the effect of "shaking" loose the lightly coated contaminant before it has an opportunity to accumulate to a level which will deter emitter performance.

[0024] In one examplary embodiment, such as where point emitters are used in inexpensive negative ion generators, a sharp high voltage pulse may be superimposed upon the driving voltage to cause a rapid change in corona pressure substantially spherically at the emitter point. The sudden change in pressure can thrust contaminants from the emitter into the immediate ambient environment.

[0025] A similar approach may be used in electrostatic precipitator devices by periodically applying a superimposed sharp pulse train of high voltage spikes or pulses to the emitter wires or electrodes. This rapidly alters the corona pressure while simultaneously shifting wire or electrode position. By inducing a mechanical resonance in this manner, any accumulated contamination on the emitter wire or emitter electrode will be shaken loose.

[0026] In the case of ion wind devices, the application of a superimposed high voltage pulse train upon either the emitter electrodes or the down line collector electrodes has an even more pronounced effect due to the electro kinetic action occurring as a result of rapid shift of the differential voltage between the two.

[0027] In one embodiment, as illustrated in FIG. 2, shaking the contamination loose from emitter electrodes is achieved by electro-magnetically coupling an excitation source 10 directly to the emitter electrode 12 or emitter electrode material. In one such embodiment, this is accomplished by providing pulsed voltage to a coil winding 14, such as a solenoid winding, which is in close proximity to a ferrous sleeve 16 fixed on or around the emitter electrode 12 or emitter electrode material. The rapidly changing magnetic flux induces slight mechanical movement, or shaking, of the emitter element without coming in direct contact with the emitter electrode, thus providing a dielectric barrier 18 from the high voltage potential applied to the emitter element 12.

[0028] Excitation schemes vary with particular applications. In one embodiment, the voltage pulses include low frequency sawtooth type drive voltage pulses since these result in the most dramatic kinetic and corona pressure action. In certain embodiments, the timed cycle of the cleaning procedure will be quite long, such as once every 72 hours of operation. It should be appreciated, however, that the length of the pulse train, may be quite brief, typically as short as 300 milliseconds to as long as 60 seconds, depending upon the application.

[0029] In one embodiment, the pulse repetition frequency varies from 30HZ to as high as 20KHZ depending on the particular application. It has been determined that in most applications a PRF of 60HZ to 300HZ is effective.

[0030] The amplitude of the superimposed pulse train also varies with application. Most applications using a direct superimposed voltage spike require at least 30% higher voltage than that used to excite the emitter electrode. In one example, as illustrated in FIG. 1, if the excitation voltage applied to the emitter electrode is 6,500 VDC, the superimposed voltage should be at least 1,950 peak volts allowing the DC plus peak to rise to an instantaneous level of 8,450 Volts peak.

[0031] In one embodiment where a magnetically coupled excitation source is used, the desired movement of the emitter electrode should be at least equal to the diameter of the electrode itself. For example, if the electrode diameter is .005" the vibration induced by the field should result in electrode movement of at least .005". It should be appreciated that a higher level of movement will result in a more effective cleaning event. Typically a ratio of 2:1 movement to wire size will result in best overall performance and cost effectiveness. Thus, in various embodiments, the flux density, geometric configuration and excitation voltage source will vary depending of size and type of application.

[0032] Other schemes which may be used to effect the excitation of the emitter for cleaning purposes include frequency modulation of the direct excitation voltage, pulse width modulation of the direct excitation voltage and offset mechanical rotors to physically vibrate the emitter element.

[0033] In one embodiment, the method of the present disclosure is configured to operate on an automatic, as needed basis. Most applications only require periodic cleaning. Therefore, in various alternative embodiments, the cleaning cycle is activated by any of: (i) activation of a manual switch by a user, (ii) an interlock event when other service is being performed on the ionizing device, (iii) an internal clock circuit programmed for a desired interval, and (iv) any other suitable method. In one embodiment, the electric ion generator system includes a detection circuit. In such embodiments, the detection circuit determines when a designated amount of contamination has accumulated on the emitter electrode. If the detection circuit determines that the emitter element has become sufficiently contaminated, the detection circuit activates the cleaning cycle or procedure.

[0034] The above disclosure is sufficient to enable one of ordinary skill in the art to practice the invention and provides the best mode of practicing the invention presently contemplated by the inventor. While there is provided herein a full and complete disclosure of the preferred embodiments of this invention, it is not desired to limit the invention to the exact construction, dimensional relationships, and operation shown and described.

[0035] It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art and may be employed, as suitable, without departing from the true spirit and scope of the invention. Such changes might involve alternative materials, components, structural arrangements, sizes, shapes, forms, functions, operational features or the like. Such changes and modifications can be made without departing from the spirit and scope of the present subject matter and without diminishing its intended advantages. It is therefore intended that such changes and modifications be covered by the appended claims.

CLAIMS

The invention is claimed as follows:

1. A electronic ion generator system comprising:

an emitter electrode; and

a voltage source adapted to provide a pulsed voltage train including one or more pulses of high voltage to said emitter electrode to cause the emitter electrode to shift position;

wherein an amount of accumulated contamination on said emitter electrode is released from said emitter electrode as a result of said emitter electrode shifting position.

2. The system of Claim 1, wherein said pulsed voltage train is provided periodically.

3. The system of Claim 1, which includes an internal clock circuit, wherein said pulsed voltage train is provided based on an interval programmed in said internal clock circuit.

4. The system of Claim 1, wherein said pulsed voltage train is provided upon activation of a manual switch by a user.

5. The system of Claim 1, which includes a detection circuit, wherein said pulsed voltage train is provided when the detection circuit determines that a designated amount of contamination has accumulated on said emitter electrode.

5. A electronic ion generator system comprising:

an emitter electrode having a longitudinal axis; and

a cleaning procedure configured to remove any contamination from said emitter electrode, wherein during said cleaning procedure, said emitter electrode oscillates about its central emitter electrode axis causing contamination on the emitter electrode, if any, to be released from said emitter electrode.

7. The system of Claim 6, wherein said cleaning procedure occurs periodically.

8. The system of Claim 6, which includes an internal clock circuit, wherein said cleaning procedure occurs based on an interval programmed in said internal clock circuit.

9. The system of Claim 6, wherein said cleaning procedure occurs upon activation of a manual switch by a user.

10. The system of Claim 6, wherein a voltage source provides one or more pulses of high voltage to said emitter electrode during said cleaning procedure to cause said oscillation of the emitter electrode.

11. The system of Claim 6, which includes a detection circuit, wherein said cleaning procedure occurs when the detection circuit determines that a designated amount of contamination has accumulated on said emitter electrode.

12. A electro-static precipitator system comprising:

an emitter electrode;

a ferrous sleeve associated with said emitter electrode; and

an excitation source adapted to be electro-magnetically coupled to said emitter electrode by providing a pulsed voltage to a coil winding in close proximity to the ferrous sleeve associated with said emitter electrode;

wherein said pulsed voltage induces mechanical movement of the emitter electrode, and wherein said mechanical movement of the emitter electrode causes any contamination on said emitter electrode to be released from said emitter electrode.

13. The system of Claim 12, wherein said excitation source does not come into direct contact with said emitter electrode.

14. The system of Claim 12, wherein said emitter electrode includes a longitudinal axis.

15. The system of Claim 14, wherein said mechanical movement of the emitter electrode occurs about said longitudinal axis.

16. The system of Claim 12, wherein said coil winding includes a solenoid.

17. The system of Claim 12, wherein said pulsed voltage is provided periodically to cause said mechanical movement of the emitter electrode.

18. The system of Claim 12, which includes an internal clock circuit, wherein said pulsed voltage is provided based on an interval programmed in said internal clock circuit.

19. The system of Claim 12, wherein said pulsed voltage is provided upon activation of a manual switch by a user.

20. The system of Claim 12, which includes a detection circuit, wherein said pulsed voltage is provided when the detection circuit determines that a designated amount of contamination has accumulated on said emitter electrode.

21. The system of Claim 12, wherein the ferrous sleeve is fixed on the emitter electrode.

22. The system of Claim 12, wherein the ferrous sleeve is fixed around the emitter electrode.

23. A method of cleaning an emitter electrode, said method comprising:

providing a pulsed voltage train including one or more high voltage pulses to the emitter electrode to cause said emitter electrode to shift position, wherein contamination on said emitter electrode is released from said emitter electrode when said emitter electrode shifts position.

24. The method of Claim 23, which includes providing said pulsed voltage train periodically.

25. The method of Claim 23, which includes providing said pulsed voltage train based on a programmed interval.

26. The method of Claim 23, which includes providing said pulsed voltage train upon activation of a manual switch by a user.

27. The method of Claim 23, which includes providing said pulsed voltage train upon a determination that a designated amount of contamination has accumulated on said emitter electrode.

28. A method of cleaning an emitter electrode of an electronic ion generator system, said method comprising:

causing said emitter electrode to oscillate about a central emitter electrode axis, wherein said oscillation causes contamination on said emitter electrode, if any, to be released from said emitter electrode.

29. The method of Claim 28, which includes providing one or more pulses of high voltage to said emitter electrode to cause said oscillation.

30. The method of Claim 28, which includes causing said emitter electrode to oscillate about said central emitter electrode axis based on a programmed interval.

31. The method of Claim 28 which includes causing said emitter electrode to oscillate about said central emitter electrode axis upon activation of a manual switch by a user.

32. The method of Claim 28, which includes determining whether a designated amount of contamination has accumulated on said emitter electrode.

33. The method of Claim 32, which includes causing said emitter electrode to oscillate about said central emitter electrode axis when said designated amount of contamination has accumulated on said emitter electrode.

34. A method of cleaning an emitter electrode, said method comprising:

inducing a mechanical movement of said emitter electrode by providing a pulsed voltage to a coil winding in close proximity to a ferrous sleeve associated with said emitter electrode, wherein said mechanical movement of the emitter electrode causes contamination on said emitter electrode to be released from said emitter electrode.

35. The method of Claim 34, wherein said emitter electrode includes a longitudinal axis.

36. The method of Claim 35, wherein said mechanical movement of the emitter electrode occurs about said longitudinal axis.

37. The method of Claim 34, wherein said coil winding includes a solenoid.

38. The method of Claim 34, which includes providing said pulsed voltage periodically to cause said mechanical movement of the emitter electrode.

39. The method of Claim 34, which includes providing said pulsed voltage based on a programmed interval.

40. The method of Claim 34, which includes providing said pulsed voltage upon activation of a manual switch by a user.

41. The method of Claim 34, which includes determining whether a designated amount of contamination has accumulated on said emitter electrode.

42. The method of Claim 41, which includes inducing said mechanical movement of the emitter electrode when said designated amount of contamination has accumulated on said emitter electrode.

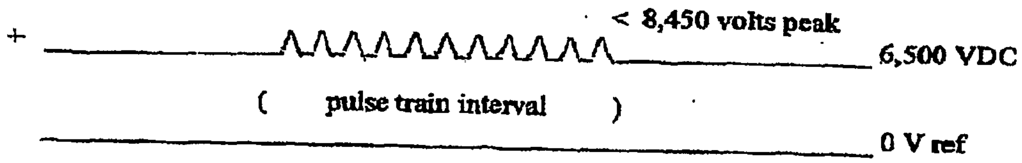

FIGURE 1

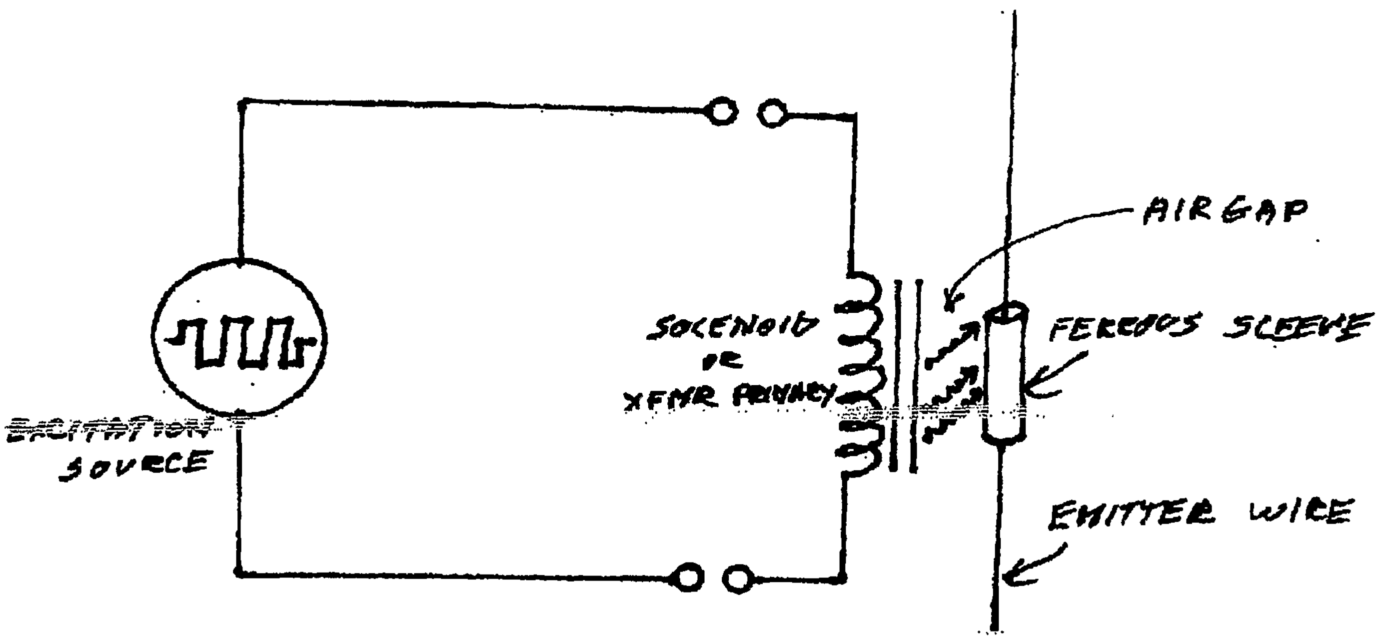

FIGURE 2