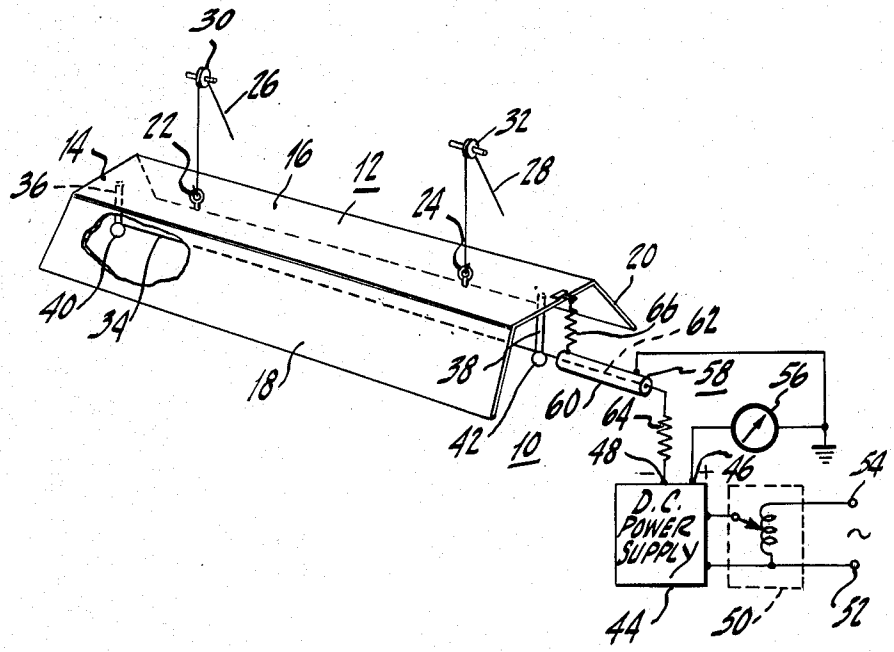
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This invention relates generally to air ionizers, and more particularly to an ion producing device adapted to provide a relatively steady stream of unipolar ions in a desired direction. The apparatus of the present invention is particularly useful for producing a controlled stream of unipolar ions toward a living subject for therapeutic and/or research purposes.

It has been proposed to subject a patient, for example, to ions by injecting the ions into the air and then blowing the ionized air in the general direction of a patient. This method of producing a stream of ions is objectionable because it subjects the patient to air drafts that may be harmful to him. It has also been proposed to produce ionized air by stretching a pair of fine wires across a room and applying a potential to them to produce an ion discharge between them and surfaces of the room. This method of ion production is not quite satisfactory because a large number of the ions produced travel to the nearby ceiling and walls where the ions are lost. The potential necessary to produce ions by this method is excessive, and it may produce an objectionable amount of ozone, oxides of nitrogen, and possibly peroxides, products that are considered harmful in large concentrations.

It has been proposed further to use a grounded metal sheet electrode and a fine wire electrode as an ion-producing device. This means for producing ions also leaves something to be desired because it was found that the ion current to the grounded metal sheet was excessive for desired ion concentrations and tended to increase the probability of the aforementioned undesired products. It was also found that, when the metal sheet was grounded, the ion densities at the patient's location did not vary proportionately with the potentials applied between the electrodes, but the ion densities tended to fluctuate markedly.

It is an object of the present invention to provide improved means for producing a relatively steady stream of ions without producing objectionable drafts.

Another object of the present invention is to provide an improved ion producing device for providing a steady stream of unipolar ions without producing objectionable quantities of ozone, oxides, and peroxides.

Still another object of the present invention is to provide improved ion producing means whose threshold potential for initiating a flow of ions in the air is a minimum and whose current requirements are a minimum for a desired ion density.

A further object of the present invention is to provide improved ion producing means whose output of ions may be easily controlled.

Still a further object of the present invention is to provide an improved ion producing device of the type described that is relatively simple in structure, easy to operate, and highly efficient in use.

Briefly, the ion producing device of the present invention comprises two electrodes, a shield electrode and a wire electrode. Potentials of opposite polarity from a voltage source are applied to the electrodes through a shielded cable. One end of the shielding conductor of the shielded cable is grounded adjacent to one output terminal of the voltage source. The other end of the shielding conductor is connected to the shield electrode through a resistor whose resistance is at least one megohm. The other output terminal of the voltage source is connected to the wire electrode through a series circuit comprising the inner conductor of the shielded cable and a current limiting resistor, the latter usually being a part of the voltage source. With this arrangement, the threshold potential at which ion current is produced is a minimum, and the current required to retain a desired ion density at a remote point from the electrodes is nearly a minimum also. The resistor connected to the shield electrode provides a small steady controlled leakage of ions to ground and causes the ion producing device to emit a steady stream of ions to the desired area.

The novel features of the present invention both as to its organization and method of operation, as well as additional objects and advantages thereof, will be more readily understood from the following description, when read in connection with the accompanying drawing, the single figure of which, with parts broken away to show detail, is an air ionizer embodying the present invention.

Referring, now, to the drawing, there is shown an air ionizer **10** employing an ion-producing device in the form of an ion reflector **12**. The ion reflector **21** comprises an elongated shield electrode **14** of metal, such as aluminum, steel, or metallized insulating material. The shield electrode **14** is formed with a central panel **16** and downwardly extending side panels **18** and **20**, as viewed in the drawing. A pair of spaced-apart eyelets **22** and **24** are fixed to the panel **16** for retaining the ends of cords **26** and **28**, respectively, therein. The cords **26** and **28**, from which the panel **16** is suspended, are disposed over pulleys **30** and **32**, respectively, for raising and lowering the shield electrode **14** to a desired position in space.

A wire electrode **34** is depended from the central panel **16** by a pair of insulators **36** and **38**. The wire electrode **34** lies substantially in the plane defined by the lower edges of the side panels **18** and **20**. The insulators **36** and **38** may be capped with metal balls **40** and **42**, connected to and terminating the ends of the wire **34**, to prevent a corona discharge from the ends of the wire electrode **34**.

Means are provided to supply a unidirectional potential between the shield electrode **14** and the wire electrode **34** to cause ions to flow therebetween. To this end, there is provided a D.-C. (direct current) power supply **44** adapted to supply a unidirectional voltage between positive and negative output terminals **46** and **48**, respectively. The power supply **44** comprises an A.-C. input control device **50** having a pair of input terminals **52** and **54** adapted to be connected to any suitable source of A.-C. (alternating current) voltage. The control device **50** comprises a variable auto transformer whose variable output is applied to the input of the power supply **44** for controlling the voltage and current output of the latter in any suitable manner known in the art. The positive terminal **46** of the power supply is connected to a common connection, such as ground, through a micro-microammeter **56**.

A shielded, high voltage cable **58** is used to connect the power supply **44** to the electrodes **14** and **34** of the ion

reflector 12. The cable 58 comprises a shielding conductor 60 and an inner conductor 62. One end of the inner conductor 62 is connected to the negative terminal 48 of the power supply through a protective resistor 64. The other end of the inner conductor 62 is connected directly to the wire electrode 34. The resistor 64, shown schematically as being outside of the power supply 44, is usually incorporated within the power supply 44, and serves to limit the current output of the power supply so as to prevent injuriously shocking a person who may accidentally come in contact with a portion of the circuit connected to the power supply.

The end of the shielding conductor 60 that is adjacent to the power supply 44 is connected to ground, and the end of the shielding conductor 60 adjacent to the shield electrode 14 is connected to the shield electrode 14 through a resistor 66. Depending upon the geometry and the dimensions of the ion reflector 12, the resistor 66 should have a value of resistance of between one and 1,000 megohms. The resistor 66 serves as means to ground the shield electrode 14 when a voltage is first applied between the electrodes 14 and 34, and provides a path of controlled leakage of ions during normal operation. It is the controlled leakage provided by the resistor 66 that prevents unwanted charges from remaining on the shield electrode when the power supply potential and current are adjusted downward, thus providing a relatively proportional flow of ions to the shield electrode 14, and an easily controlled flow of ions for application to a subject.

In order to produce a steady stream of negative ions, in a downward direction, looking at the drawing, the power supply 44 is connected to the ion reflector 12 in the manner illustrated in the drawing. The input terminals 52 and 54 of the power supply are connected to a suitable source of A.-C. voltage, and the control device 50 is varied until a discharge of negative ions from the electrode 34 is initiated. It is apparent that, in the absence of a flow of ions between the electrodes 34 and 14, the shielded electrode 14 is at ground potential. After the flow of ions between the electrodes 34 and 14 has been initiated, a voltage drop occurs across the resistor 66 that varies with the current supplied by the power supply 44, a function of the voltage applied between the electrodes 34 and 14. Thus, the potential at the shield electrode 14 becomes negative with respect to ground as the ion current between the electrodes 34 and 14 increases with the polarity of connections shown. During this process, negative ions travel, in relatively small numbers, not only from the wire electrode 34 toward the shield electrode 14 but travel, in far greater numbers, away from the shield electrode 14 in a relatively steady stream, in a downward direction, looking at the drawing.

With the circuitry shown in the drawing, the shield electrode 14 functions as an artificial ceiling with respect to the wire electrode 34. It is thus possible to raise or lower the ion reflector 12 to any position over a patient, for example, without having the walls and ceiling of the room interfere variably with the stream of ions reaching the patient. Without the controlled leakage provided by the resistor 66, the shield electrode 14 would become excessively charged periodically and would discharge periodically, thereby causing the stream of ions in the direction of a patient to vary excessively.

In order to produce a stream of positive ions from the electrode 34, it is only necessary to reverse the polarity of the power supply so that the terminal 48 is positive and the terminal 46 is negative.

From the foregoing description, it will be apparent that there has been provided an improved air ionizer employing an improved ion-producing device that utilizes a minimum potential to initiate an ion discharge and utilizes a minimum potential to maintain a desired steady stream of ions. While the improved apparatus of this invention has been shown in diagrammatic form, various components useful therein, as well as variations in the apparatus itself, coming within the spirit of this invention will, no doubt, readily suggested themselves to those skilled in the art. Hence, it is desired that the foregoing shall be considered merely as illustrative and not in a limiting sense.

What is claimed is:

1. In apparatus of the type wherein a voltage is to be applied between two electrodes to cause ions to flow therebetween, one of said electrodes comprising a metal shield, the other of said electrodes comprising a wire spaced and insulated from said shield, the improvement comprising a shielded cable including an inner conductor and a grounded shielding conductor for conducting current to said electrodes, means connecting said inner conductor to said wire, a resistor, and means connecting said resistor between said shield and said shielding conductor whereby ions travel in a relatively steady stream away from said metal shield.

2. In apparatus of the type wherein a voltage from a unidirectional voltage source is to be applied between two electrodes to cause ions to flow therebetween, one of said electrodes comprising a metal shield, the other of said electrodes comprising a wire spaced and insulated from said shield, the improvement comprising a shielded cable including an inner conductor and a grounded shielding conductor therefor, means for connecting one end of said shielding conductor to one terminal of said voltage source, means for connecting another terminal of said voltage source to said wire through said inner conductor, a resistor having a resistance within a range of 1 to 1,000 megohms, and means connecting said resistor between said shielding conductor and said shield whereby ions travel in a relatively steady stream away from said metal shield.

3. Apparatus comprising a metal shield electrode, a wire spaced from said metal shield and insulated therefrom, a shielded cable comprising an inner conductor and a grounded shielding conductor therefor, means connecting said inner conductor to said wire, a resistor, and means connecting said shielding conductor to said metal shield through said resistor whereby ions travel in a relatively steady stream away from said metal shield.

4. Apparatus comprising a metal shield electrode, a wire spaced from said metal shield and insulated therefrom, a shielded cable comprising an inner conductor and a grounded shielding conductor therefor, said inner conductor being connected to said wire, a resistor having a value of resistance between 1 megohm and 1,000 megohms, and means connecting said shielding conductor to said metal shield through said resistor whereby ions travel in a relatively steady stream away from said metal shield.

5. Apparatus comprising an elongated shield electrode having opposite edges extending to one side of said shield to act as a reflector, a wire electrode spaced from said shield electrode and insulated therefrom, means to apply a unidirectional potential to said electrodes through a shielded cable, said cable comprising a first conductor and a grounded second conductor adapted to shield said first conductor, a resistor, means connecting said first conductor to said wire electrode, and means connecting said second conductor to said shield electrode through said resistor whereby ions travel in a relatively steady stream away from said shield electrode.

6. Apparatus comprising an elongated metal shield electrode having opposite side portions extending to one side of said shield electrode to function as a reflector, a wire electrode spaced from said shield electrode and insulated therefrom, means to apply a unidirectional potential between said electrodes through a shielded cable, said cable comprising a first conductor and a grounded second conductor adapted to shield said first conductor, a resistor having a value of a resistance of at least one megohm, means connecting said first conductor to said

wire electrode, and means connecting said second conductor to said shield electrode through said resistor whereby ions travel in a relatively steady stream away from said shield electrode.

7. An ion reflector comprising a metal shield, insulating means, a wire electrode spaced from said metal shield by said insulating means, a resistor having a value of resistance within the range of 1 to 1,000 megohms, one end of said resistor being connected to said metal shield and another end of said resistor being adapted to be connected to ground, means to apply a source of voltage between ground and said wire electrode, and means connected to said metal shield to adjust the position of said

ion reflector in space whereby said metal shield acts as an artificial ceiling with respect to said wire electrode.

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