United States Patent

Frank et al.

[15] **3,660,656**

[45] **May 2, 1972**

[54] LIGHT LOCK FOR CORONA DEVICE

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[22] Filed: **Aug. 26, 1970**

[21] Appl. No.: **66,947**

[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, 49.5 TC; 317/262 A, 262 E

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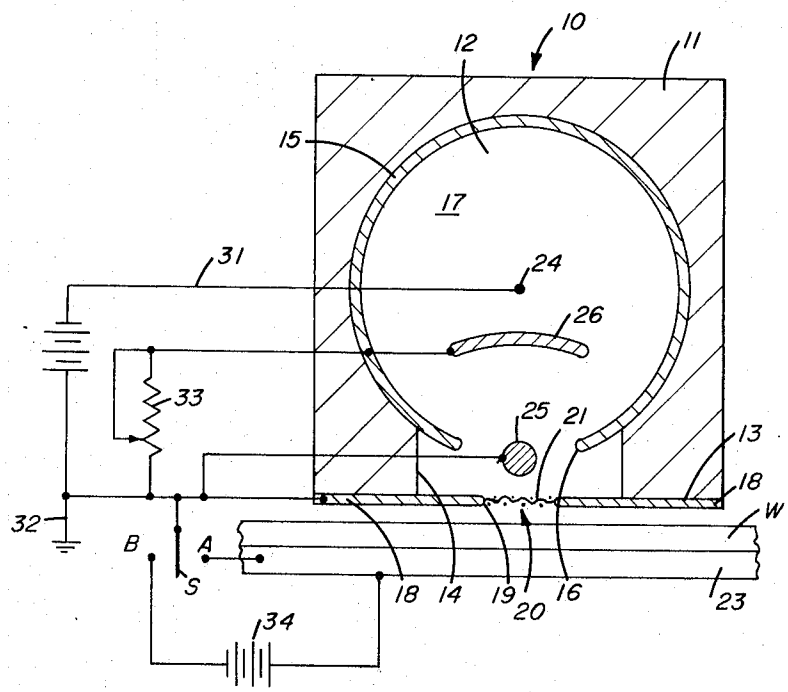
[57] **ABSTRACT**

A device having corona discharge means for generating a flow of ions arranged within a chamber that is part of a dielectric housing and is provided with an elongated opening extending to the side of the housing positionable adjacent the surface of a moving sheet or web of dielectric or photosensitive material to be treated. The opening is covered with a metal screen or a small diameter rod can be arranged relative to the opening. The chamber is lined with an electrically conductive shield. The opening is of sufficient length so that it will extend across and beyond the side edges of the sheet or web that will be moved with respect thereto. Between the corona discharge means and the metal screen, an electrically conductive and biased steering rod is arranged to direct the flow of ions from said corona discharge means through said opening. An electrically conductive and biased plate is arranged between the corona discharge means and the steering rod to shape the electrical field established relative to the surface of the material to focus the flow of ions toward the screen and to prevent irradiation from said corona discharge means from passing through said opening and damaging the material being treated. The device can be used with either an AC or DC source of potential applied to the corona discharge means depending upon the type of material being treated.

12 Claims, 4 Drawing Figures



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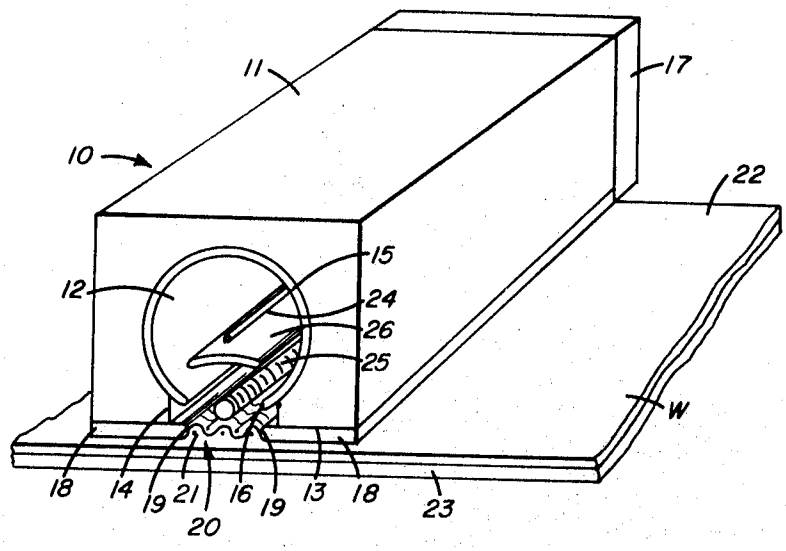

FIG. 1

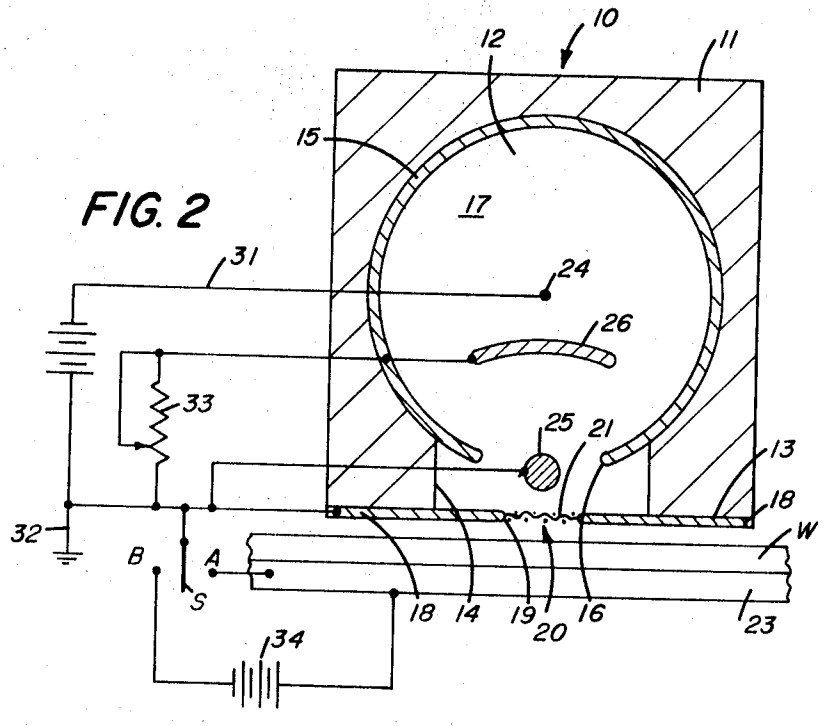

FIG. 2

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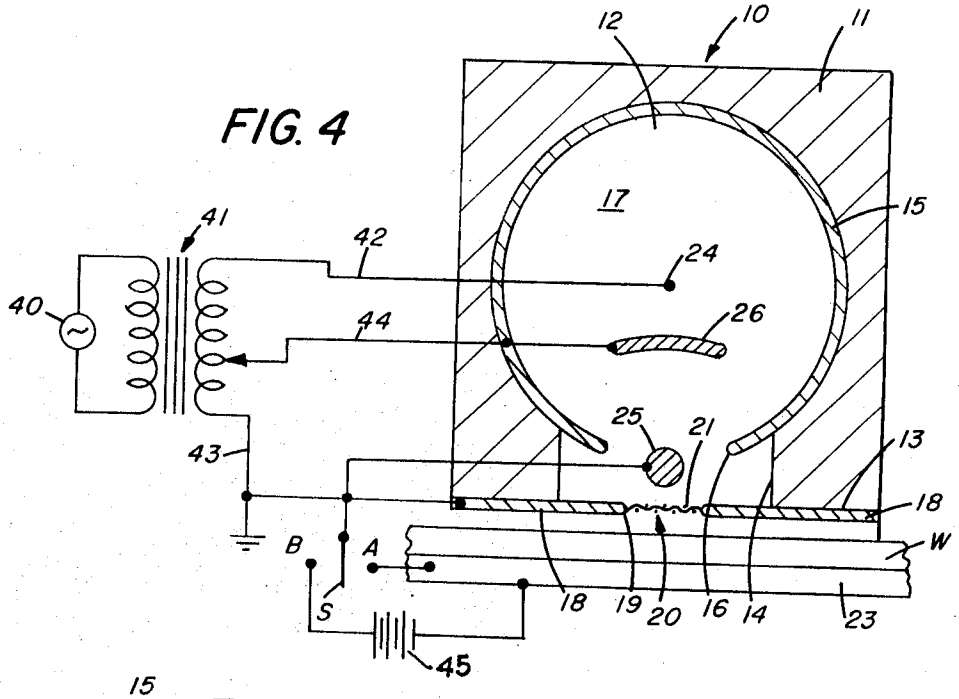
FIG. 4



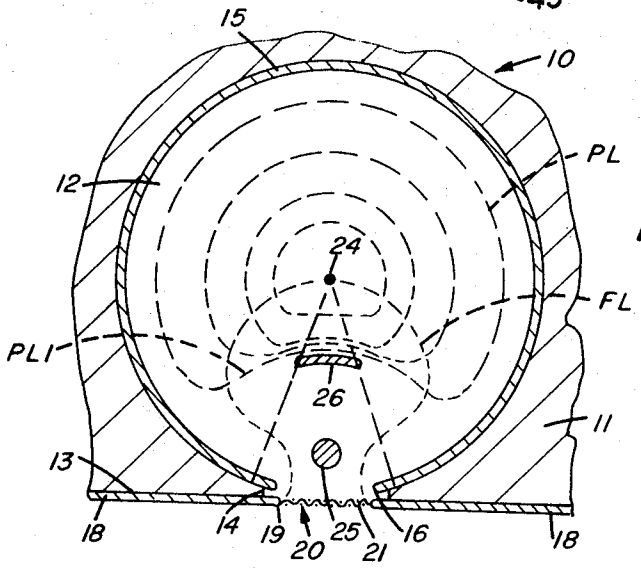


FIG. 3

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LIGHT LOCK FOR CORONA DEVICE

FIELD OF THE INVENTION

The present invention relates to a device for treating the surfaces of a sheet or web of dielectric material, such as a photosensitive material and, more particularly, to a device which generates a flow of ions that is directed to a surface of the material for altering or neutralizing any electrostatic charge thereon, the device including a corona discharge means and means for shielding the surface of the material from any irradiation generated by the corona discharge means.

BACKGROUND OF THE INVENTION

The use of an ionizer for charging, discharging or altering the charge on a surface of a moving sheet or web of dielectric material is well known. Such ionizers direct a flow of ions toward a surface of the sheet or web to remove or alter any electrostatic charge thereon or to place a charge of a particular polarity on the surface. In the manufacture of photosensitive materials, it is essential that the material not be exposed to any irradiation including that generated by a corona discharge means. While it is necessary to remove any static electricity from a web of photosensitive material to facilitate winding, cutting, packaging, etc., of the material, any corona irradiation incident on the material causes fogging streaks which results in portions of the material so exposed being rendered unusable. Consequently, in treating photosensitive materials, any device that is used to alter the electrostatic charge on the material must be one which does not fog the material and one whose efficiency is not substantially reduced by the addition of any means that might be used to shield the photosensitive material from such irradiation.

SUMMARY OF THE INVENTION

One object of the present invention is to provide an efficient light lock for corona discharging means which shields a moving sheet or web of photosensitive material being treated thereby from the irradiation generated by the corona discharge device.

Another object of the invention is to provide a device which can be used as part of a corona discharge means, when treating or altering the electrostatic condition of a surface of a moving sheet or web of a photosensitive material, to prevent irradiation from damaging the material.

Another object of the invention is to provide a device for treating or altering the electrostatic condition of a surface of a moving sheet or web of dielectric material that is capable of being used with high efficiency, which is simple in construction, and is more highly efficient than devices currently in use.

The aforementioned objects of the invention are attained by a device having corona discharge means for generating a flow of ions arranged within a chamber that is part of a dielectric housing and is provided with an elongated opening extending to the side of the housing positionable adjacent the surface of a moving sheet or web of dielectric or photosensitive material to be treated. The opening is covered with a metal screen or a small diameter rod can be arranged relative to the opening. The chamber is lined with an electrically conductive shield. The opening is of sufficient length so that it will extend across and beyond the side edges of the sheet or web that will be moved with respect thereto. Between the corona discharge means and the metal screen, an electrically conductive and biased steering rod is arranged to direct the flow of ions from said corona discharge means through said opening. An electrically conductive and biased plate is arranged between the corona discharge means and the steering rod to shape the electrical field established relative to the surface of the material to focus the flow of ions toward the screen and to prevent irradiation from said corona discharge means from passing through said opening and damaging the material being treated. The device can be used with either an AC or DC source of potential applied to the corona discharge means depending upon the type of material being treated.

While the device is described hereinafter as being used for removing or substantially altering electrostatic charges on a sheet or web of photographic material, it is to be understood that it can also be used with any sheet or web of dielectric material to alter the charge on a surface thereof, that is, to change the charge from one that is negative to one that is positive, or vice versa, to change the level of the charge on the surface of the web, that is, to increase or decrease the charge whether it is negative or positive, or to place a negative or a positive charge on a surface of an uncharged sheet or web. The term, "alter," or "altering" as used in this specification and in the claims is intended to include any one of the aforementioned conditions.

The term "corona discharge" device or means, as used in this specification and in the claims, is intended to define a self-sustaining electrical discharge device for generating positive and/or negative ions in accordance with the applied voltage; that is, with alternating current applied to the corona discharge device, positive ions will be generated on the positive half of the cycle, whereas negative ions will be generated on the negative half, and with direct current positive or negative ions will be regenerated in accordance with the direction of current flow.

DESCRIPTION OF THE DRAWING

Reference is now made to the accompanying drawings in which like reference numerals designate like parts and wherein:

FIG. 1 is a schematic perspective view of a device in accordance with the invention and showing the relation of the device to a surface of a moving sheet or web of dielectric material;

FIG. 2 is a schematic vertical cross-sectional view of the device shown in FIG. 1 in conjunction with a simplified circuit for generating a corona discharge with a DC source of potential;

FIG. 3 is a vertical cross-sectional view of the device shown in FIG. 1 in which some field lines are shown together with the line of current flow; and

FIG. 4 is a schematic vertical cross-sectional view of the device shown in FIG. 1 in conjunction with a simplified circuit for generating a corona discharge with an AC source of potential.

Referring now to FIG. 1, the device **10** comprises an elongated hollow housing **11** including a generally cylindrical chamber **12** and which is fabricated of an insulating or dielectric material, such as plastic. The chamber **12** is connected to a side **13** by an elongated opening **14** and is lined with a sleeve **15** fabricated of a conducting material, such as stainless steel. The sleeve **15** is also provided with an opening **16** that is aligned with and, preferably, smaller in width than opening **14**. The chamber **12** is enclosed when each of the ends is covered by an end plate **17** which can be fabricated of an insulating material the same as that used for housing **11**. Attached to the side **13** of housing **11** is a pair of plates **18** which are fabricated of an electrically conductive material, such as stainless steel. Each of the plates **18** is arranged along an edge of opening **14** with the edges **19** thereof forming an exit slot **20** that is aligned with openings **14** and **16**. Attached to plates **18** is a screen **21** of an electrically conductive material, such as stainless steel, which effectively overlies or covers the exit slot **20**. In place of screen **21**, a single small diameter rod or a plurality of rods extending parallel to edges **19** can be used, the rod or rods being electrically interconnected with plates **18** in the same manner as screen **21**. The plates **18** and screen **21** or the rods comprise grid means for controlling a flow of ions through the exit slot **20**. The length of the housing **11** is such that exit slot **20** extends across and beyond the edges **22** of a moving sheet or web of a dielectric material W. Web W can be any dielectric material although the invention is directed primarily to treatment of a photosensitive material because of the problem of irradiation. The web W can be moved by any suitable means not shown past slot **20** and is supported in the vicinity of the

device **10** by a plate **23** which is also fabricated of an electrically conductive material, such as stainless steel.

A corona wire **24**, which extends the length of housing **11** and is attached at its ends in any suitable manner to the end plates **17** is arranged so as to be generally coincident with the axis of sleeve **15**. Positioned just above slot **20** is a steering rod **25**, which is fabricated of an electrically conductive material, such as stainless steel. Rod **25** is generally aligned with openings **14** and **16** and slot **20** and, when biased, serves to directionally control the flow of ions from corona wire **24** in chamber **12** through slot **20** and into contact with web W. Steering rod **25** extends the length of housing **11** and is attached at its ends by any suitable means to the end plates **17**. Between steering rod **25** and corona wire **24**, an arcuate plate **26** is arranged such that it curves away from corona wire **24** and is of an electrically conductive material, such as stainless steel. Plate **26** also extends the length of housing **11** and is attached by any suitable means to end blocks **17**.

Referring now to FIG. **2**, a DC source of potential **30** is connected by line **31** to corona wire **24**, and to ground via line **32**. Sleeve **15** and plate **26** are serially connected through an adjustable resistor **33** to ground to provide a passively generated bias for these elements. The current source for resistor **33** is corona wire **24**. Steering rod **25**, plates **18** and screen **21** are also connected to ground The embodiment shown in FIG. **2** can be used either to neutralize a charge existing on the surface of web W, or to alter an existing charge depending upon the position of switch S. If switch S is in position A, plate **23** will then be connected to ground. With switch S in position A, plate **23**, plates **18** and screen **21** will be at the same level of potential, thus causing the charge present on web W to be neutralized. If switch S is in position B, then a bias voltage is applied to support **23** through a DC source of potential **34**. Plate **23** is therefore at a different potential than plates **18** and screen **21**, thus permitting a flow of ions to web W, that alters the charge on web W. By a suitable switching arrangement, the polarity of the corona voltage and of the bias voltages can be changed in accordance with the polarity of the charge to be removed or added.

Referring now to FIG. **4**, an AC source of potential **40** is connected to the primary side of transformer **41**. The secondary of transformer **41** is connected by line **42** to corona wire **24** and to ground via line **43**. Sleeve **15** and plate **26** are serially connected by line **44** to a variable tap on the secondary of transformer **41**, so that the phase and voltage of sleeve **15** and plate **26** can be controlled with respect to the phase and voltage of corona element **24**. Steering rod **25**, plates **18** and screen **21** are also connected to ground. The embodiment shown in FIG. **4** can be used to either neutralize a charge existing on web W, or to alter the existing charge on web W, depending upon the position of switch S. If switch S is in position A, then support **23** is connected to ground. This condition of switch S causes support **23**, plates **18** and screen **21** to be at the same potential, thus causing the charge present on the surface of the web W to be neutralized. If switch S is in position B, then a bias voltage is applied to support **23** through a DC source of potential **45**. Support **23** is therefore at a different potential than plates **18** and screen **21**, thus permitting a flow of ions to web W that alters the charge on the surface of web W.

Reference is made particularly to FIG. **3** for an explanation of the interrelationship of the elements comprising the device **10**. Equal potential lines PL are formed about corona wire **24**. Normally, these lines are concentric provided the wire **24** is completely confined within a tube. However, the combination of an open shield or sleeve **15** and an arcuate plate **26**, which are arranged as shown, causes these equal potential lines PL to shape themselves around the plate **26** as indicated by PL1. Charged ions are known to travel in the same direction as the field lines FL which are at right angles to the equal potential lines PL. The field lines FL are bent or formed around the plate **26** toward the control grid or screen **21**. The steering rod **25** performs the final alignment of the field lines to the exit slot **20**. Thus, it is possible to have ion current output with very little light leakage to the material being treated. As a matter of fact, the light leakage is of such an insignificant amount that essentially no fogging of a light-sensitive material will take plate. Accordingly, plate **26**, steering rod **25**, plates **18** and screen **21** (or the rod or rods) comprise means for shaping the electric field to focus and directionally control the flow of ions toward the surface of the material. Such means is carried by housing **11** and aligned with openings **14** and **16** between wire **24** and the surface of the material.

All surfaces located within chamber **12** are blackened to assure that the light irradiating from corona wire **24** undergoes multiple reflections from black surfaces so the light is dissipated in intensity to a very low level prior to any passage thereof through exit slot **20**. The blackening of all surfaces within chamber **12** reduces the emitted light to between about one to four orders of magnitude.

Arcuate plate **26** can be about ⅛ inch thick with approximately the same radius of curvature as sleeve **15** and is positioned so as to curve away from the ion source, namely, wire **24**. Plate **26** shapes the lines of the electrical field that is established between corona wire **24** and the surface of web W. In addition, plate **26** prevents essentially any light generated by corona wire **24** from escaping through exit slot **20** while not adding to the bulkiness of device **10**. Consequently, the angle formed by corona wire **24** and the edges of plate **26** must be greater than that formed by wire **24** and the edges of opening **16** in shield **15**.

All surfaces which the ions from corona wire **24** strike within chamber **12** are made electrically conductive to maintain a stable, constant isopotential, which is not true if the stream of ions were to come into contact with an insulating surface. For this reason, the edges of opening **16** in shield **15** extend beyond those of opening **14**. In other words, opening **16** should be smaller than opening **14**. All of the edges of any of the conductive elements, such as the edges of opening **16** in sleeve **15** are rounded and polished to avoid edge glare and to prevent corona generation.

Housing **11** is made of an insulating material, preferably polymethyl methacrylate, silicone rubber or a material having similar electrical properties. For safety, housing **11** should have a volume resistivity of at least 10^{12} to 10^{18} ohms/cm and a dielectric strength of between 400 to 4,000 volts/mil. Corona wire **24** can be any one of the series normally used in the art, but preferably should be tungsten alloy having a diameter of between about 0.010 inch to 0.00025 inch.

Steering rod **25**, plate **26**, plates **18** and the rod or rods that can be used in place of screen **21** are preferably made of stainless steel, as indicated hereinabove, but could be made of an electrically conductive plastic material, electrically conductive black glass, many metals and their alloys, and the like, providing they are electrically conductive, corrosion resistant, and fall in the area of resistance of 0 to 10^6 ohms/cm^2. The steering rod **25**, for example, can have a diameter of about one-quarter inch.

In the embodiment shown in FIG. **2**, corona wire **24** is maintained at a potential of approximately 15 KV, and plate **26** and sleeve **15** are maintained at approximately 4.65 KV. In the embodiment shown in FIG. **3**, corona wire **24** is maintained at 15 KV AC peak, while sleeve **15** and steering rod **25** are maintained at approximately 4.65 KV AC peak.

It will be recognized by those skilled in the art that device **10** can be supplemented by means for measuring the amount and polarity of any electrostatic charge on web W prior to its being moved past exit slot **20**, in order that the voltage can be varied to provide the required ionized flow of air to alter or change the electrostatic charge on web W. Also, a suitable gas under pressure can be introduced into chamber **12** to further enhance ion current output through exit slot **20**.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

We claim:

1. A device for generating and directing a flow of ions toward a surface of a dielectric material for altering the electrostatic condition thereof, said apparatus comprising:

a dielectric housing having a chamber provided with an elongated opening extending to the side of said housing facing said surface;

an electrically biased shield generally lining said chamber and having an elongated opening aligned with and smaller in width than the opening in said housing;

corona discharge means arranged within said chamber and connected to a source of potential for generating a flow of ions and establishing an electrical field relative to said surface; and

electrically biased means comprising grid means mounted on said housing relative to said opening therein and between said corona discharge means and said surface and generally in alignment with said opening in said shield for directionally controlling said flow of ions toward said surface and means arranged within said housing between said corona discharge means and grid means for shaping said electrical field and focusing said flow of ions toward said grid means and for inhibiting the passage through said openings of any direct irradiation from said corona discharge means.

2. A device for generating and directing a flow of ions toward a surface of a dielectric material for altering the electrostatic condition thereof, said apparatus comprising:

a dielectric housing having a chamber provided with an elongated opening extending to the side of said housing facing said surface;

an electrically biased shield generally lining said chamber and having an elongated opening aligned with and smaller in width than the opening in said housing;

corona discharge means arranged within said chamber and connected to a source of potential for generating a flow of ions and establishing an electrical field relative to said surface;

grid means mounted on said side in overlying relationship to said opening in said housing and providing an exit slot generally in alignment with said openings and positionable adjacent said surface, said grid means being electrically biased for controlling said flow of ions;

blocking means arranged within said chamber intermediate said corona discharge means and said grid means and electrically biased serially with said shield for shaping said electrical field and focusing said flow of ions toward said grid means and for inhibiting the passage through said exit slot of any direct irradiation from said corona discharge means; and

steering means arranged within said chamber intermediate said blocking means and said grid means and electrically biased for directionally controlling said flow of ions relative to said grid means and said surface.

3. A device in accordance with claim 2 wherein said shield is generally cylindrical and provided with an axial opening generally aligned with said opening in said housing and said exit slot.

4. A device in accordance with claim 3 wherein the edges of said exit slot are rounded and polished to inhibit corona generation.

5. A device in accordance with claim 3 wherein at least the inner surface of said shield is coated with a layer of ultra-violet radiation absorbing material.

6. A device in accordance with claim 2 wherein said grid means comprises an electrically conductive member secured to said side adjacent each edge of said opening, the facing edges of said members forming said exit slot, and a metal screen overlying said exit slot and electrically connected to each of said members.

7. A device in accordance with claim 2 wherein said grid means comprises an electrically conductive member secured to said side adjacent each edge of said opening, the facing edges of said members forming said exit slot and at least one metallic member extending longitudinally of said slot and electrically connected to each of said members.

8. A device in accordance with claim 2 wherein said blocking means comprises an arcuate electrically conductive plate having a length and a width relative to those of said opening in said shield and said exit slot so as to prevent the passage through said exit slot of any direct irradiation from said corona discharge means.

9. A device in accordance with claim 8 wherein the curvature of said plate corresponds generally to that of said shield and is positioned so as to curve away from said corona discharge means and the width of said plate is greater than that of said exit slot.

10. A device in accordance with claim 2 wherein said steering means comprises a metal rod axially aligned with said openings and said exit slot.

11. A device in accordance with claim 2 wherein said source of potential is a direct current.

12. A device in accordance with claim 2 wherein said source of potential is an alternating current.

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