May 16, 1950 L. E. SWEDLUND 2,508,001

HIGH-VOLTAGE CATHODE-RAY TUBE CORONA RING

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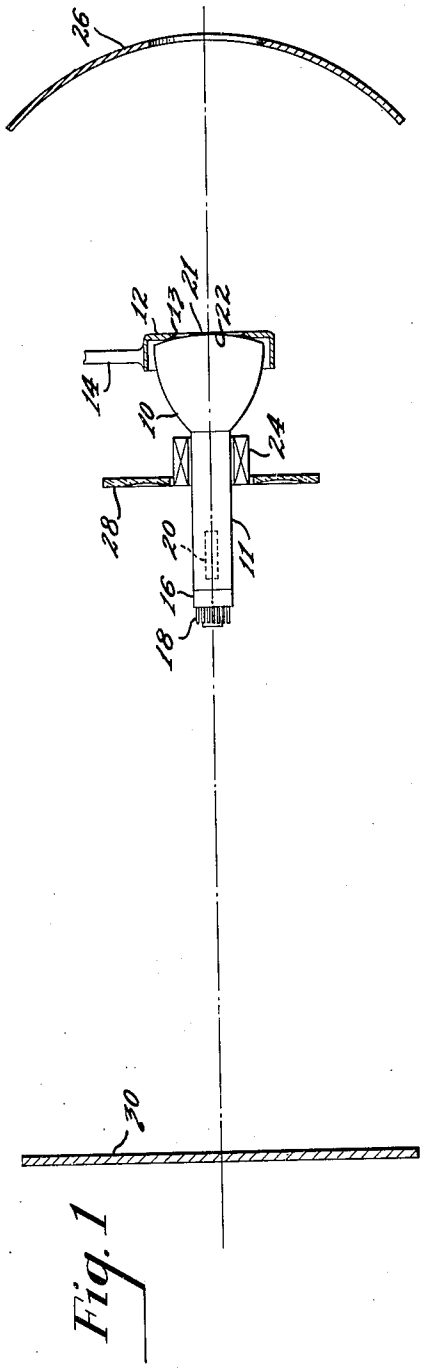


Fig. 1

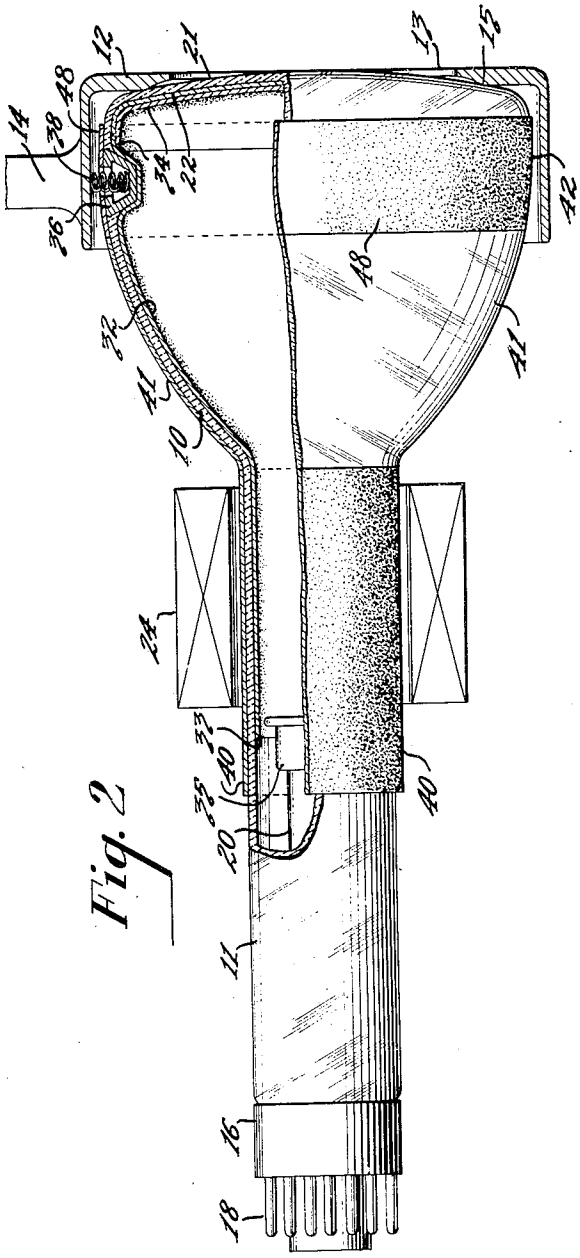


Fig. 2

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HIGH-VOLTAGE CATHODE-RAY TUBE CORONA RING

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My invention is directed to cathode ray tubes and more particularly to cathode ray tubes used with a reflective optical system for a projection type television receiver.

In a projection type of television receiver, the cathode ray tube is supported in a metal cup holder enclosing the face plate of the tube. The bottom of the cup holder is apertured so that light from the fluorescent screen can pass therethrough onto a convex spherical mirror which projects the light through a correcting lens onto a viewing screen. The cathode ray tube of one form of such a projection system conventionally uses magnetic means for deflecting the electron beam in a scanning pattern over the fluorescent screen. The magnetic beam deflection is normally provided by two pairs of deflecting coils made up as a ring-shaped yoke encircling the neck of the cathode ray tube in the region adjacent the cone. To prevent corona discharge between the yoke structure and the second anode coating on the inner surface of the tube neck, a grounded conductive coating is applied to the outer neck surface under the deflecting yoke. The second anode electrode coating operates at a very high voltage, for example, in the neighborhood of 27,000 volts. This second anode coating on the inside of the cathode ray tube extends from within the neck to the fluorescent screen on the face plate. External contact with the second anode coating is made through a metal cavity type contact sealed through the tube wall in the region of the face plate.

The cathode ray tube, as described above, is supported in its cabinet by the apertured metal cup holder, in which the large end of the cathode ray tube is enclosed. It has been found more expedient to connect the metal cup holder to the second anode contact rather than insulating the high voltage second anode contact from the cup holder.

Because of the high voltage applied to the tube, dust may be precipitated on the tube and optical surfaces. This precipitation of dust will be accelerated by corona. The tube and optical system, therefore, must be protected as much as possible from accumulation of dust. Dust decreases the insulation of the bulb coating and also reduces the amount of light transmitted by the optical system. Most dust consists of fibrous materials and soluble salts. Fibers absorb and retain moisture when the humidity is high, while soluble salts provide electrical leakage paths that increase in conductivity as the humidity increases. Thus, a dust film nullifies the protection provided by the insulating coating on the bulb cone.

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Although tubes normally have an insulating coating, corona sometimes develops between the low potential surface of the bulb and the high potential structure of the bulb support ring when such tubes are operated in an optical system under a condition of high humidity. Such corona causes sparking along the surface of the bulb. The presence of corona will cause deterioration of organic insulating materials and will induce arcing across the bulb cone to the deflection yoke. Repeated arcing will carbonize the insulating coating and permanently damage it. Corona is further undesirable because the accompanying formation of ozone is deleterious to many insulating materials.

It is, therefore, an object of my invention to provide means for improving the operation of cathode ray tubes used in a projection type television receiver.

It is a further object of my invention to protect a cathode ray tube from the detrimental effects due to the presence of moisture and the accumulation of dust.

It is, therefore, another object of my invention to provide means to prevent corona discharge between a cathode ray tube and associated mount structure electrically connected to the tube.

It is a further object of my invention to provide means for avoiding corona discharge between low potential areas on the surface of a cathode ray tube and high potential tube mount structures.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing, in which:

Figure 1 is a schematic diagram of a reflective optical system used in television receivers and employing a cathode ray tube incorporating the novel features of my invention; and

Figure 2 is a partial sectional view of the cathode ray tube of Figure 1.

Figure 1 shows a reflective optical system utilizing a cathode ray tube 10 which produces a bright picture on a face plate 21 of the tube. The picture is projected onto a spherical collecting mirror 26 from which it is reflected through an annular correcting lens 28 coaxially mounted around the neck of tube 10 at the center of curvature of the collecting mirror 26. The correct-

ing lens 28 focuses the image of the mirror upon a viewing screen 30 with a bulb portion indicated at 10 and a tubular neck portion 11. The cathode ray tube shown at 10 is built somewhat along conventional lines. The tube has mounted within the envelope a gun structure schematically shown at 20, which produces an electron beam and accelerates and focuses the beam upon the end face 21 of the tube. A deflection yoke 24 causes the electron beam to be scanned in the usual manner across the face plate 21.

As shown in Figure 2 a fluorescent screen material 22 is coated on the inner surface of the face plate 21. The electron beam is scanned back and forth in a conventional manner over the surface of the phosphor 22 by two pairs of deflection coils within the neck yoke 24 to produce a visible fluorescence. The envelope 10 is closed at the tubular end by a stem base 16 having electrode lead pins 18 passing therethrough, and connected to the usual electrodes of the gun 20.

The cathode ray bulb 10 is usually mounted in the system of Figure 1 vertically so that the cone of the bulb rests within a cup ring 12 fixed to a supporting member 14. Cup ring 12 is preferably of heavy cast metal to give strength and rigidity to the bulb support. The face plate 21 is made of ground and polished glass and is of a spherical configuration. The outer spherical surface of the face plate 21 rests upon a locating edge 15 and aperture 13 in the base of cup ring 12. Due to the spherical nature of the face plate 21, any small misalignment of the cathode ray tube 10 within the cup ring 12 is not critical as the spherical surface 21 will be positioned at all times accurately relative to the optical system of mirror 26. Opening 13 of the cup ring 12 is of a rectangular shape and acts as a mask to prevent the unused portions of the face plate from reflecting stray light into the optical system of the mirror 26. To firmly lock the cathode ray bulb 10 within the cup ring support 12, a plurality of thumb screws (not shown) are arranged around the periphery of the cup 12 and also function position bulb 10 accurately within cup ring 12.

Part of the tube gun structure which produces the electron beam is a second anode electrode comprising a conductive coating 32 fixed to the inner surface of the cathode ray bulb and extending from the neck portion 11 of the bulb to the phosphor screen 22 on the face plate 21. This conductive second anode coating 32 is maintained at high potential during tube operation so as to provide an effective accelerating electrode for the electron beam. The electron beam under the accelerating forces of electrode 32 will strike the phosphor screen 22 with sufficient energy to produce a bright picture.

To increase the brightness of the picture projected from the cathode ray bulb 10 a thin layer of aluminum metal 34 may be put down on the phosphor layer 22. This aluminum layer 34 prevents light from the phosphor screen 22 from entering the cathode ray bulb and from being scattered and reflected back to the face plate 21 to produce lighting of the dark areas and reducing detail contrast. Furthermore, all light from the excited phosphor which would tend to enter the bulb 10 is reflected by the aluminum layer outwardly through the face plate 21 and greatly increases the light gains of the tube. The aluminum layer 34 is thin enough so that it has high electron permeability yet is sufficiently thick so as to meet the requirements of high reflectivity as well as good electrical conductivity and mechanical strength.

The second anode coating 32 extends into the neck portion 11 of the bulb 10 to a point 33 adjacent to the first anode electrode 35 of gun structure 20. Since the second anode electrode 32 is maintained at high electrostatic potential, in one example close to 27,000 volts, during tube operation, there will be an electrical field gradient between the second anode coating 32 on the inner surface of neck 11 and the neck yoke 24 which is maintained at much lower potential. Under these conditions corona will be established between neck 11 and the deflection yoke 24. However, the outer surface of neck 11 of the cathode ray bulb 10 is coated with a conductive layer 40 in the region which underlies neck yoke 24. During tube operation conductive coating 40 is maintained at ground potential and functions primarily to prevent corona between yoke 24 and the glass neck 11 of the bulb.

The external lead for the second anode electrode 32 comprises a cavity-type metal cup 36 sealed through the wall of the cathode ray bulb 10 adjacent to the face plate 21 of the tube as is shown in Figure 2. The second anode coating 32 contacts the surface of the metal cup 36 which is exposed interiorly of the bulb 10 so as to maintain a direct electrical contact therewith. Instead of insulating the cup ring 12 from the contact cup lead 36 it has been found more feasible to directly connect the cavity contact cup 36 to the metal cup ring 12. This connection may be of any type, but as shown in Figure 2 it can be a spring element positioned under tension between the cup 36 and the inner wall of the cup ring 12. This arrangement makes the cup ring 12 effectively part of the external lead structure of the second anode electrode 32. The metal cup ring 12 is insulated from adjacent structures by utilizing an insulating material for its support arm 14. A flexible lead, which is not shown, connects the metal cup ring 12 to the appropriate external circuit.

The high electrostatic potential utilized during tube operation for the second anode 32 introduces problems of insulating the contact cup 36 from external portions of the cathode ray tube 10. The distance along the bulb surface from the second anode contact cup 36 to the grounded conductive coating 40 underlying the yoke 24, in one type of tube of a popular design, is approximately 2¼" long. It has been found that this distance between the contact cup 36 and the grounded coating 40 is adequate insulation for second anode voltages up to 30,000 volts under atmospheric conditions of 50% relative humidity. However, at a relative humidity near 90%, high leakage paths have been found to develop between the second anode contact cup 36 and the conductive coating 40 across the surface of the glass bulb 10. To prevent resulting sparking as well as arc-over which occurs, an external insulating coating 41 is usually applied between the neck coating 40 and the portion of the bulb enclosed within the cup ring 12. This insulating coating 41 may be of any desired composition, as is well known in the art.

The particular bulb disclosed above, and as shown in Figure 2, has been found in practice to possess undesirable operating characteristics. During operation of the tube particularly in humid weather, considerable undesired corona develops between the cup ring 12 and the cathode ray bulb 10. The disadvantage of corona dis-

charge is that the ozone produced is not only disagreeable in odor but it causes breakdown to occur between the low potential neck coating 40 and the high potential cup ring 12. The corona, furthermore, causes deterioration of all organic insulation material, such as would be found in the lacquer commonly used for the insulation coating 41. Furthermore, the presence of ozone can cause failure due to deterioration of insulation in any associated equipment adjacent to the cathode ray tube 10. As mentioned above, the presence of the corona accelerates the precipitation of dust on optical surfaces of the system. Dust will decrease the insulation of the bulb coating 41 as well as reduce the amount of light transmitted through the optical system of mirror 26. Dust particles which collect in the region between the grounded conductive coating 40 and the high voltage cup ring 12 include fibrous materials and soluble salts. Under conditions of high humidity such dust fibers absorb and maintain moisture while the soluble salts provide electrical leakage paths that increase in conductivity with an increase in the humidity. A dust film present on the coating 41 under adverse conditions of high humidity would tend to destroy the effectiveness of the insulation coating 41 between the neck coating 40 and the region of the contact 36. Under such adverse conditions, the region of the bulb surface 10 immediately adjacent to the high voltage contact cup 36 will remain at essentially a high potential. However, other portions of the bulb surface enclosed within ring 12 and farther from the contact 36 will drop considerably in potential. For example, current leakage over the surface of the bulb will tend to bring some intermediate points, as 42, enclosed within the cup ring 12 to a potential very close to the ground potential of coating 40. This, then, will result in a high voltage gradient across the very small space between the edge of the cup ring 12 and the bulb surface portion 42. Such a high concentrated electrostatic field existing in this small space will support corona discharge between enclosed portions of the bulb surface 10 and cup ring 12.

To prevent undesirable corona discharge and to maintain all portions of the bulb surface enclosed within the cup ring 42 at a potential close to that of the cup ring 12, in accordance with my invention, I have provided a conductive ring or band 48 around the surface of the bulb 10. This conductive ring is usually applied from the edge of the cone adjacent to the face plate 21 back along the surface of the bulb to a width approximating the depth of the cup ring 12. The conductive band 48 is maintained in contact with the cavity contact 36 so that during tube operation, this portion of the bulb surface coated by the conductive band 48 is maintained at essentially the same potential as that of the second anode 32 and the cup ring 12. The presence of such a conductive band 48, maintained at the same potential as the cup ring 12, eliminates any difference of potential between the surface of the bulb enclosed within the cup ring and the cup ring itself. Also, all portions of the bulb surface adjacent to the band 48 are at essentially high potential. Thus, intermediate points such as 42, which formerly were at close to ground potential, are now either coated by the conductive band 48 or sufficiently close to the band that they are raised in potential to an extent that no corona discharge is possible between such intermediate points and the cup ring 12. Thus, the conductive band 48 eliminates all low potential areas enclosed in and adjacent to the cup ring 12. The conducting band 48 functions to not only eliminate corona but also to reduce the tendency to arc-over between portions of the tube envelope 10 of the supporting cup ring 12.

In one form of my invention the conductive ring 48 consists of graphite mixed with flaked silver to increase the conductivity of the coating 48. However, the material used for the conductive band 48 is not limiting, as any substance providing a satisfactory conductivity may be used. For example, a lacquer containing graphite and silver plated copper flakes has also been found satisfactory. Also, various conductive materials which can be made to adhere to the glass surface of the bulb 10 may be used. The width of the conductive band 48 is not critical and the edge of the band 48 may extend somewhat below or above the lip of cup 12. However, the presence of a continuous conductive band surrounding the enclosed portion of the bulb 10 is sufficient to eliminate large differences of potential between the support cup 12 and the end portion of the cathode ray bulb 10 enclosed thereby.

It is also not necessary to enclose the conductive band 48 within the support cup 12. Good results would be obtained by placing the band 48 around the tube bulb 10 at any position between the grounded coating and the support cup 12. At any intermediate position, if band 48 is maintained at second anode potential, the potential field gradient will extend over the bulb surface only between coating 40 and the adjacent edge of band 48, while all portions of bulb 10 enclosed in and adjacent to support cup 12 will be maintained at relatively high potential. However, placing band 48 closer to the grounded coating 40 increases the problem of insulation between these coatings particularly in small size tubes.

While certain specific embodiments have been illustrated and described, it will be understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

What I claim as new is:

1. An electron discharge device comprising an envelope adapted to be surrounded at a first portion thereof by a metal support member, a plurality of electrodes within said envelope for producing an electron discharge, a conductive lead sealed through the wall of said first envelope portion and adapted to be connected during operation of said discharge device to said support member, said conductive lead being in contact with one of said electrodes, a first electrically conductive coating on the outer surface of a second portion of said envelope and spaced from the outer surface of said first envelope portion, said one electrode adapted to be maintained at high electrostatic potential relative to said first conductive coating during tube operation, and a second electrically conductive coating on the outer surface of said first envelope portion and spaced from said first coating, said conductive lead connected to said second conductive coating to prevent corona discharge between said first envelope portion and said metal support member during operation of said discharge device.

2. A cathode ray tube comprising an evacuated vitreous envelope including a stem portion and a cone portion sealed thereto, said cone portion adapted to be supported at one end by a metal member, a plurality of electrodes mounted with-

in said envelope for producing an electron discharge, a lead member sealed through the wall of said one end of said cone portion and adapted to be connected during tube operation to said metal member, said lead member connected with one of said electrodes, a first electrically conductive coating on the outer surface of said stem portion, said one electrode adapted to be maintained at high electrostatic potential relative to said first conductive coating during tube operation, a second conductive coating on the outer surface of said cone portion and spaced from said first conductive coating, said lead member connected to said second conductive coating to prevent corona discharge between said envelope and said support member during tube operation.

3. An electron discharge device comprising an evacuated vitreous envelope, a metal support member in contact with a portion of said envelope, a plurality of electrodes mounted within said envelope for producing an electron discharge, means including a metal lead sealed through the wall of said envelope adjacent said envelope portion for connecting said support member to one of said electrodes, and an electrically conductive coating on the outer surface of said envelope and in contact with said metal lead.

4. An electron discharge device comprising an envelope of insulative material, a metallic member for supporting said envelope at one portion thereof, a plurality of electrodes within said envelope for producing an electron discharge, a metal lead sealed through the wall of said envelope portion and connected to one of said electrodes, means connecting said lead to said support member for use as a conductor, a first electrically conductive coating on the outer surface of said envelope, said one electrode adapted to be maintained at high electrostatic potential relative to said first conductive coating during tube operation, a second electrically conductive coating on the outer surface of said envelope portion in contact with said lead and spaced from said first electrically conductive coating to prevent corona discharge between said envelope and said support member.

5. An electron discharge device having an envelope of insulative material, a plurality of electrodes within said envelope for producing an electron discharge, lead means including a metallic support member enclosing one portion of said envelope and an element sealed through the wall of said envelope portion in contact with one of said electrodes, a first electrically conductive coating on the outer surface of said envelope, said one electrode adapted to be maintained through said lead means at high electrostatic potential relative to said first conductive coating during tube operation, a second electrically conductive coating on the outer surface of said envelope portion in contact with said lead element and spaced from said first electrically conductive coating to prevent corona discharge between said envelope and said support member.

6. An electron discharge device comprising a tubular envelope of insulative material, a plurality of electrodes mounted within said envelope for producing an electron discharge, lead means including a metallic support member enclosing one end of said envelope and a contact element connected to said support member and sealed through the wall of said enclosed envelope end, said contact element being in contact with one of said electrodes, a first electrically conductive coating on the outer surface of said envelope, said one electrode adapted to be maintained through said lead means at high electrostatic potential relative to said first electrically conductive coating, a second electrically conductive coating on the outer envelope surface of said enclosed end, said second conductive coating being in contact with said lead element and spaced from said first electrically conductive coating to prevent corona discharge between said envelope and said support member.

7. An electron discharge device comprising an evacuated vitreous envelope including a stem portion and a cone portion having one end sealed thereto, a face plate sealed to the other end of said cone position, lead means including a metallic support member enclosing said face plate and the adjacent part of said cone and a contact element connected to said support member and sealed through the wall of said cone portion enclosed by said support member, a plurality of electrodes within said envelope for producing an electron discharge, said contact element being connected to one of said electrodes, a first electrically conductive coating on the outer surface of said stem portion, said one electrode adapted to be maintained through said lead means at high electrostatic potential relative to said first conductive coating during tube operation, a second electrically conductive coating on the surface of said cone enclosed within said support member in contact with said lead element and spaced from first electrically conductive coating to prevent current discharge between said envelope and said support member.

8. An electron discharge device having an elongated envelope, a plurality of electrodes mounted at one end of said envelope, a first conductive coating externally of said envelope and intermediate the ends thereof, a lead extending through said envelope adjacent the other end and connected to one of said electrodes, an insulating coating extending between said conductive coating and said conducting lead, and another conductive coating extending around said envelope and positioned between said first conductive coating and said lead and connected to said lead.

9. An electron discharge device including an elongated envelope having a plurality of electrodes mounted in one end thereof for directing a stream of electrons toward the other end, a conductive coating on the exterior of said envelope extending around the circumference thereof and intermediate the ends, a conductive coating internally of said envelope, a lead extending through said envelope adjacent the other end and connected to said internal coating, a second conductive coating extending around the outside of said envelope and spaced from the first mentioned conductive coating, and a connection between said lead and said second conductive coating, the end of said envelope adjacent said lead being adapted to be received by a metallic holder.

10. An electron discharge device including an elongated envelope having a cone-shaped portion at one end thereof, electrode means at the other end for providing a beam of electrons, a fluorescent screen at the cone end of said envelope against which said electrons are directed, a conductive coating externally of said envelope and extending around said envelope and positioned between the ends of said envelope, an internal conductive coating within said envelope and extending between said electrode means and said screen, a lead extending through said envelope adjacent said screen and connected to said internal coating of said envelope and spaced from first said conductive coating said ring of conduct-

ing material connected to said lead, and an insulating coating external of said envelope and extending between said external conductive coating and said ring of conducting material.

11. An electron discharge device comprising an envelope having a bulb portion and a tubular neck portion, said envelope bulb portion adapted to be partially enclosed by a metal support member, an electrode within said envelope, said electrode adapted to be maintained at high electrostatic potential relative to the outer surface of said envelope during tube operation, a conductive lead through the wall of said bulb portion and connected to said electrode, said lead adapted to be enclosed within said metal support member and connected thereto, a conductive band on the outer surface of said bulb portion and connected to said lead to prevent corona discharge between said metal support member and the bulb portion.

12. A cathode ray tube comprising an envelope having a bulb portion and a neck portion including a part thereof adapted to be enclosed within a metal support member, an anode electrode within said envelope, a conductive lead connected to said electrode and passing through the wall of said bulb part, said lead and anode electrode adapted to be connected to said metal support member as a source of high electrostatic potential relative to other portions of said envelope surface, a broad band of conductive coating material on the outer surface of said bulb part and connected to said lead to prevent corona discharge between said bulb part and said metal support member.

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