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COMBINATION LIGHT SOURCE WITH INTEGRAL VOLTAGE CONVERTING MEANS

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Fig. 1.

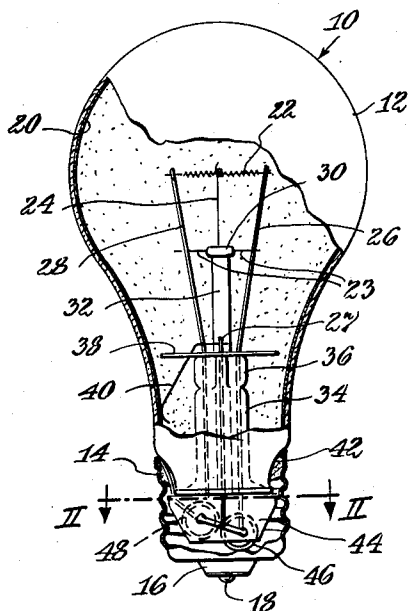


Fig. 2.

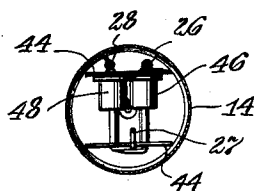


Fig. 3.

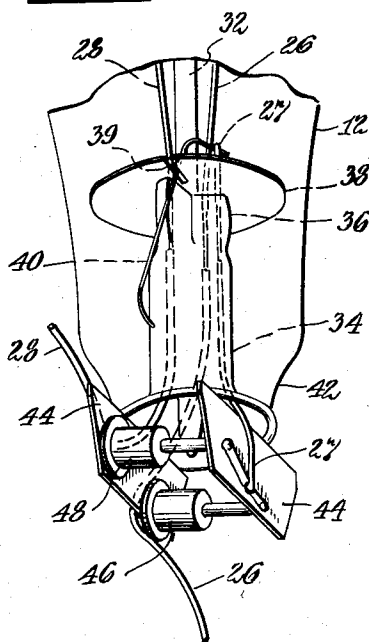


Fig. 4.

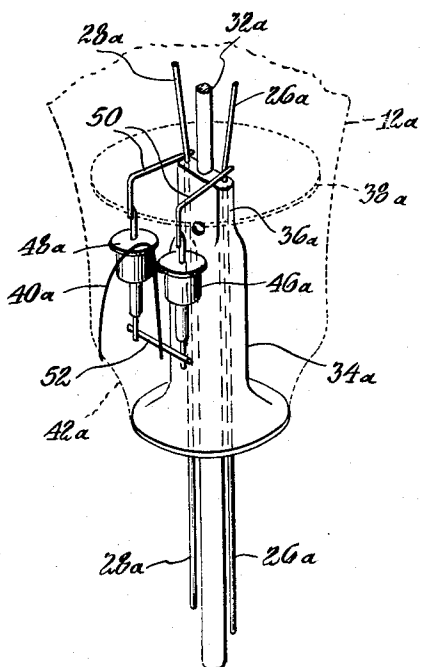
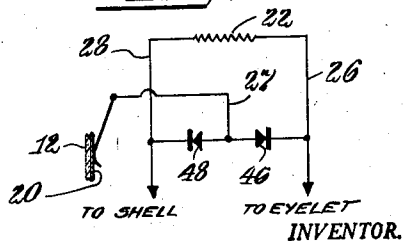


Fig. 5.



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2,928,024

COMBINATION LIGHT SOURCE WITH INTEGRAL VOLTAGE CONVERTING MEANS

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6 Claims. (Cl. 315—51)

This invention relates to electric lamps, and more particularly, to lamps in which the visible radiations generated by incandescent and cathodoluminescent materials are combined to efficiently produce light of the desired intensity and color.

Lamps of the character mentioned may be termed "combination light sources" and generally consist of an ordinary tungsten filament or other suitable incandescent element having high luminous-efficiency and high electron-emissivity supported and sealed within an evacuated envelope in accordance with standard incandescent lamp-manufacturing practice. In place of the so called "inside frost" or light diffusing coating customarily utilized in regular incandescent type lamps marketed for general household use, however, the inner surface of the envelope carries a high-temperature phosphor that generates light of a predetermined wave length or color under the impact of electrons which phenomenon and method of phosphor excitation are generally referred to in the art as "cathodoluminescence" and "cathodo-excitation" respectively.

If the phosphor is electrically-conductive and light-transmissive it is applied directly to the glass surface; otherwise, it is intermixed with or deposited on a layer of material having these attributes. The coating is connected to either the midpoint or one end of the filament thereby applying a steady or pulsating positive potential to the coating when the filament is operated from and A.C. power source and establishing an electrostatic field which impels the electrons emitted by the filament toward the phosphor layer. The ensuing electron bombardment and cathodo-excitation of the phosphor cause it to luminesce and emit light energy of such character that the luminosity of the light generated by the filament is intensified and the color thereof enhanced through the addition of visible energy in that portion of the spectrum in which light from the filament is deficient. In the alternative, an external D.C. power source and a so called "three-light" lamp base may be employed to maintain the phosphor coating at a fixed positive potential with respect to the filament and effect the desired cathodo-excitation of the phosphor.

Combination light sources of the character above-described are disclosed and claimed in copending application, Serial No. 380,408, filed September 16, 1953, now U.S. Patent No. 2,759,119 assigned to the instant assignee. However, light sources of this character in order to become economically and commercially feasible must be operative at ordinary line voltages of alternating current from conventional type sockets and circuits now in use. This requirement has presented a serious obstacle to the development of a practical lamp of this type inasmuch as lamps constructed and operated in accordance with the above-mentioned patent inherently do not utilize to the greatest degree possible the light-generating capabilities of the phosphor since the filament and phosphor coating are electrically coupled in such a manner that

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operation of the lamp on an alternating power source would produce only half wave cathodo-excitation of the phosphor at full line voltage or full wave excitation thereof at half the line voltage applied to the filament. In either case, a proportionate decrease in the light generated by the phosphor and the total light output thus produced would result thereby materially decreasing the efficiency of the lamp. The alternative arrangement employing an external D.C. power source and a "three-light" base to maintain the desired degree and constancy of electrical potential between the filament and the phosphor corrects the foregoing deficiency but has also been found to be impractical from a commercial standpoint due to the expense and inconvenience involved.

It is accordingly the general object of the present invention to overcome and avoid the foregoing deficiencies and objections to the prior art construction and operation of combination light sources by providing a lamp of this character which will operate at optimum efficiency from conventional type sockets and alternating current power supply outlets now in use.

A more specific object of the invention is to provide means for simply and efficiently increasing the cathodoluminescence of the phosphor employed in a combination light source.

Another object of the invention is to provide an incandescent-cathodoluminescent lamp of simple rugged construction having built-in means for maintaining the phosphor continuously positive and at substantially full line voltage with respect to the incandescent electron-emitting component.

The aforesaid objects of the invention, and other objects which will become obvious to those skilled in the art as the description proceeds, are achieved by mounting a pair of rectifying elements such as crystal diodes of suitable physical and electrical character within the lamp envelope or base member attached thereto and electrically orienting them with respect to the filament and phosphor coating so that the latter is continuously positive and at a potential, with respect to the filament, substantially equal to the voltage applied to the filament from the line.

A better understanding of the invention may be obtained by referring to the accompanying drawing in which like numerals of reference indicate similar parts throughout the several views, wherein:

Fig. 1 is an elevational view of an incandescent-cathodoluminescent lamp, partly broken away and in section, which has been modified to include the invention;

Fig. 2 is a cross-sectional view through the basal end portion of the lamp along the line II—II of Fig. 1, in the direction of the arrows, showing the manner in which the voltage converting means of the present invention are integrally combined with the base member;

Fig. 3 is a perspective view on an enlarged scale of the sealed-in end portion of the lamp shown in Fig. 1 at one phase in its fabrication according to the preferred form of the present invention and illustrates the relationship and disposition of the rectifying elements and lead-in conductors just prior to their introduction into the base;

Fig. 4 is a view similar to that shown in Fig. 3 but illustrates an alternative embodiment of the present invention wherein the rectifiers are mounted within the envelope adjacent the stem; and

Fig. 5 is a schematic representation illustrating the electrical disposition of the rectifying elements and various lamp components according to the present invention.

Although the principles of this invention are broadly applicable to other types of combination light sources in addition to those disclosed and described in the aforementioned patent, the invention is especially adapted for use with incandescent-cathodoluminescent lamps which

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are patterned after the well-known type incandescent lamps employed in the home and hence has been so illustrated and will be so described.

Referring now to the drawing in detail, Fig. 1 illustrates one embodiment of the present invention wherein a combination incandescent and cathodoluminescent light source having a conventional screw type base member is provided with the integral voltage converting means of the present invention. The lamp 10 consists generally of an envelope 12 having an enlarged spherical shaped portion and a restricted cylindrical neck portion which is fused to a re-entrant stem 34 and shaped while plastic to provide a molded seal 42. A base member comprising a threaded cylindrical metal shell 14 and an insulating button 16 carrying an end contact 18 is fitted over the sealed-in end portion of the envelope 12 and cemented or otherwise fastened thereto to facilitate connection of the lamp with a source of electrical energy through conventional type sockets customarily employed in general lighting fixtures. The interiorly disposed end portion of the stem 34 is sealed off and worked while plastic to form a T-shaped press 36 through which a pair of main conductors 26, 28 and an auxiliary conductor 27 are hermetically sealed in triangular spaced relation. The main conductors 26, 28 project upwardly into the spherical shaped portion of the envelope 12 whereas the auxiliary conductor 27 extends only a short distance from the press 36.

A coaxially disposed glass arbor 32 the inner end of which is enlarged to form a button 30 may be interposed between the main conductors 26, 28 and fused to the press 36 to provide means for buttressing the structure. A linear coiled-coil tungsten filament 22 or other incandescent element having high luminous-efficiency and thermal-emissivity is transversely mounted on the inner end portions of the main conductors 26, 28 and an axial support 24 and laterally extending tie wires 23 of molybdenum or other refractory material having a high melting point are desirably embedded in the arbor button 30 and coupled to intermediate portions of the filament 22 and main conductors 26, 28, respectively, to keep the desired degree of tension on the coil and strengthen the filament mount assembly in the manner shown and described in U.S. Patent No. 2,145,911 issued February 7, 1939, to W. E. Anderson et al.

The interior wall portion of the envelope 12 carries a light-transmitting electrically-conductive high-temperature phosphor, such as manganese-activated zinc fluoride or other suitable material which will luminesce under the bombarding influence of low voltage electrons; or, in the alternative, a light-transmitting conductive coating such as a glass or glaze containing tin oxide may be deposited on the bulb wall and a phosphor layer formed thereon to form a composite coating or the phosphor may be admixed with conductive material, if not naturally conductive, as described in U.S. Patent No. 2,759,119 previously referred to. The phosphor-including coating 20 may be conveniently connected to the interiorly disposed end portion of the auxiliary conductor 27 by means of a resilient arcuate extension 40, rigidly fastened to said conductor, as by welding, and of such configuration that it is compressed during the fabrication of the lamp into firm contacting engagement with the restricted neck portion of the envelope 12 and the conductive coating 20 thereon in the manner disclosed in the above-mentioned patent.

The essence of this invention resides in the provision of means for converting an alternating voltage applied to the main lead-in conductors and filament to a unidirectional electrical potential impressed across the filament and phosphor deposited on the envelope and in the manner in which the converting means is integrally combined with and connected to the lamp to increase its operating efficiency and these are hereinafter more fully described.

As will be seen in the preferred form of the invention

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shown in Fig. 1, electrical components 46, 48 of extremely small physical size capable of converting or rectifying A.C. voltage to D.C., such as low-current high-voltage type transistors or crystal diodes, are connected to the outer end portions of the main conductors 26, 28 and auxiliary conductor 27 and disposed to lie adjacent the sealed-in end portion of the envelope 12 so that they are completely enclosed and protected by the base member attached thereto. Inasmuch as the electrical characteristics of such elements are generally deleteriously affected by excessively high ambient temperatures, a heat deflecting disc 38 of reflective material, such as aluminum, provided with suitably disposed apertures and a radial slot 39 (see Fig. 3) may be threaded over the main conductors 26, 28, auxiliary conductor 27 and its contacting extension 40, and arbor 32 during fabrication of the filament mount assembly and firmly seated on the stem press 36 transverse to the lamp axis and locked thereat by the divergent end portions of the conductors 26, 28 to shield the basal end portion of the lamp from the incandescent filament and reduce to a minimum the ambient temperature within the base during the operation of the lamp. If the shield material is conductive due care should be exercised to insulate it from at least one of the main conductors 26, 28 as by grommets of nonconductive material inserted into the apertures intended to receive the conductors, in order to obviate the danger of a shorting out the filament 22 and causing a destructive arc.

The number of free electrons liberated from the tungsten filament of an ordinary 60 or 100 watt incandescent lamp by thermal emission during normal operation is sufficiently high that current densities in the order of 250 to 500 ma. can reasonably be expected as a result of the electron flow from the filament 22 to the phosphor-including coating 20. Of course, the number of electrons emitted by the filament 22 may be increased and the magnitude of the electron flow toward the coating 20 and the intensity of the resultant cathodo-excitation of the phosphor thereat proportionately increased by adding a low work function material, such as thorium, to the tungsten from which the filament 22 is made to provide a thoriated tungsten filament, as is well known in the art.

Since each of the rectifying elements 46, 48 are in series with the coating 20 on alternate half cycles of the applied voltage during A.C. operation, as will be herein after more fully described, they must have sufficient current carrying capacity to handle the electron flow during this period. Furthermore, the elements 46, 48 must be able to withstand the voltage applied to the filament 22 with negligible leakage at relatively high ambient temperatures, and be of such physical size and configuration that they can be readily mounted within the base member or neck of the lamp envelope 12. Rectifying elements having the foregoing physical and electrical characteristics are marketed by the assignee under the trade designation "XP-5052 rectifying cells." They are fused junction type silicon diodes and are available with peak inverse voltage ratings from 50 to 600 volts. For domestic A.C. circuits diode "XP-5052-D" having a peak inverse voltage rating of 200 volts would be adequate whereas for higher line voltages a diode having a higher rating, such as "XP-5052-K" with a maximum allowable peak inverse voltage of 500 volts, may be employed. The cells, as illustrated Figs. 1, 2, 3 and 4, have cylindrical cartridge type cases provided with coaxial stud-like terminals and have an overall length of $\frac{5}{8}$ inch and an outside diameter of $\frac{3}{8}$ inch. The maximum instantaneous leakage current at rated peak inverse voltage and a temperature of 150° C. is 0.5 ma. and the maximum allowable D.C. output current ranges from 250 ma. at 150° C. ambient to 500 ma. at 100° C. ambient so that sufficient current carrying capacity and breakdown protection are provided thereby insuring reliable operation throughout the life of the lamp.

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As shown in Figs. 2 and 3, one convenient method of mounting the rectifying elements 46, 48 adjacent the sealed end portion of the envelope 12 in proper position for insertion into the base is to align them end for end in diagonal spaced relation between two upstanding and parallel guide panels 44 of electrically nonconductive material, such as mica or the like, through which the terminals of said elements protrude for electrical connection. The panels 44 are disposed to straddle the lamp axis and are held against the lip of the molded seal 42 by the auxiliary conductor 27 and main conductors 26, 28 which emerge from the stem tube 34 and are bowed to pass outwardly along the sides of the panels 44 to the terminals of the elements 46, 48 with which they are electrically connected, as by soldering or other suitable means. The panels 44 may be tapered inwardly and the ends of the conductors 26, 28 bent downwardly into coaxial alignment and upwardly at an angle, respectively, as shown in Fig. 3, so that the entire assembly may be conveniently inserted into and receive by the base. The foregoing construction not only provides an exceedingly simple and rugged structure and facilitates assembly of the lamp but also serves to electrically isolate the various components from each other thereby safeguarding against short-circuits or arcs which might otherwise possibly occur should the lamp be subjected to rough handling and severe mechanical impacts.

As shown in Fig. 5, the cathodes of the rectifying elements 46, 48 are tied together and connected by means of the auxiliary conductor 27 and contacting extension 40 to the phosphor-including coating 20 deposited on the inner surface of the envelope 12. The anodes or positive terminals of the rectifiers are joined to the main conductors 26 and 28 which in turn are connected to the filament 22 and base member. In this manner the coating 20 is always at a positive potential with respect to the filament 22 and the difference in potential is at all times substantially equal to the A.C. voltage applied to the main conductors 26, 28 from the supply line. Hence, electrons thermally emitted from the filament 22 during operation of the lamp are attracted toward the coating 20 and accelerated to a greater degree than was heretofore possible by virtue of the intensification of the electrostatic field therebetween effected by the increase in potential. The energy level of the electrons is thus increased causing them to strike the phosphor with greater force thereby effecting an attendant proportionate increase in the cathodoexcitation thereof and overall light output and efficiency of the lamp.

After striking the coating 20 the electrons flow toward the neck portion of the envelope 12, through the contacting extension 40, the auxiliary conductor 27 and through either rectifier 46 or 48 to the main conductor 26 or 28, whichever happens to be positive at their particular instant of time, thus completing the circuit. The rectifying elements 46, 48 are so disposed electrically with respect to the filament and main conductors 26, 28 and power line connected thereto that full wave rectification of the A.C. voltage is achieved. Thus, substantially the full line voltage appears across the filament 22 and coating 20 with the latter always being maintained positive, except when the voltage drops to zero between each half cycle. The elements 46, 48, in a manner of speaking, function as a virtual electronic switch which operates in timed sequence and is synchronized with the periodic voltage fluctuations of the power supply to constantly keep the coating 20 connected to the positive side of the line.

The potential difference between the coating 20 and the filament 22 is thus increased by a factor of two over the prior art arrangement whereby the coating 20 was connected to the mid-point of the filament 22, or, in contrast to the alternative prior art construction where the coating 20 was connected to one side of the filament 22, the full line voltage is applied twice as long. In either

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case, since the luminous output of a phosphor is roughly proportional to the length of time and intensity of excitation, it is obvious that the construction and operation of an incandescent-cathodoluminescent lamp in accordance with the above-stated principles of the invention will approximately double the luminous output of the phosphor and effect a substantial increase in the overall light output and efficiency of the lamp and improve the color of the light generated thereby. In addition, and of equal significance from a practical standpoint, the improvement is achieved by a relatively simple but most effective means which is integrally combined with the lamp.

In Fig. 4 there is shown an alternative embodiment of the invention wherein a regular incandescent lamp mount comprising a stem tube 34a with a conventional flat stem press 36a having two main conductors 26a, 28a hermetically sealed therethrough and a glass arbor 32a interposed therebetween is sealed to the neck portion of the envelope 12a in the usual manner. In this embodiment a pair of auxiliary leads 50 are secured to the main conductors 26a, 28a adjacent the stem press 36a and formed to provide laterally extending arms the end portions of which are bent downwardly, as viewed in Fig. 4, at substantially right angles toward the molded seal 42a which joins the flared stem tube 34a with the neck of the envelope 12a. The anodes of the rectifying elements 46a, 48a are fastened to the downwardly projecting end portions of the auxiliary leads 50 and the negative terminals tied together by a laterally extending conductive member 52 which carries a resilient contacting extension 40a thereby providing an arrangement which is electrically equivalent to that employed in the preferred embodiment previously described. A heat deflector disc 38a is desirably positioned on the stem press 36a in a manner similar to that described previously in connection with preferred embodiment so that the rectifying elements 46a, 48a are shielded from the intense heat generated by the filament. This type construction will be advantageous where it is desirable to base and finally assemble the lamp in the regular manner.

As will be obvious, other types of construction and voltage converting means may be employed, the only limitations being that they must be of such physical size that they can be integrally combined with the lamp and have the necessary electrical characteristic to permit the lamp to be operated from conventional sockets and standard A.C. power sources.

It will be recognized from the foregoing that the objects of the invention have been achieved by providing an incandescent-cathodoluminescent lamp with integral voltage converting means which not only increase the cathodo-excitation of the phosphor and resultant luminous output of the lamp and improve its color quality, but permit the lamp to be operated with optimum efficiency from standard type sockets and A.C. circuits now in use.

Although the best known mode of carrying out the invention has been shown and described in accordance with the patent statutes, it will be understood that other modifications may be made without departing from the spirit and scope of the appended claims.

I claim:

1. An incandescent-cathodoluminescent lamp comprising an envelope having a neck portion, an inwardly extending stem fused to said neck portion, conductors sealed through said stem and projecting into said envelope, an incandescent filament of thermionic material attached to the sealed-in portions of said conductors and held in spaced apart relation with said envelope, a light-transmitting electrically-conductive phosphor coating carried by the inner surface of said envelope responsive to the electrons thermally emitted by said filament and having an efficient light output in a selective region of the spectrum at the normal operating temperatures of said envelope under low-voltage electron bombardment, a heat deflecting disc carried by said stem and coextensive with

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said neck portion to provide a shielded end chamber within said envelope, and rectifying elements secured to the sealed-in portions of said conductors and disposed within the shielded end chamber in said envelope, said elements having their cathodes joined together and connected to said coating and their anodes connected to said conductors so that said coating is maintained continuously positive in polarity with respect to said filament at a potential substantially equal to the voltage applied to the filament when said lamp is operated from an alternating current power source.

2. An incandescent-cathodoluminescent lamp comprising an envelope having a neck portion, a re-entrant stem fused to said neck portion, an auxiliary and two main conductors sealed through said stem and projecting into said envelope, a coiled tungsten filament transversely attached to the sealed-in portions of said main conductors and held in spaced apart relation with said envelope, a light-transmitting coating on the inner surface of said envelope comprising a phosphor-including electrically-conductive material responsive to the electrons thermally emitted by said filament and having an efficient light output in a selective region of the spectrum at the normal operating temperatures of said envelope under low-voltage electron bombardment, a hollow base member secured to and enclosing the end of said neck portion and connected to said main conductors, a heat deflecting disc carried by said stem and coextensive with said neck portion to shield said base member and adjacent section of the neck portion from the filament, means interiorly connecting said auxiliary conductor with said coating, and a pair of silicon diode rectifiers mounted within said base member connecting said auxiliary conductor with each of the said main conductors, said diodes having their cathodes joined together and connected to said auxiliary conductor so that said coating is maintained continuously positive in polarity with respect to said filament at a potential substantially equal to the voltage applied to the filament when said lamp is operated from an alternating current power source.

3. In combination with an incandescent-cathodoluminescent lamp having an envelope with a sealed-in portion from which two main conductors and an auxiliary conductor protrude into a hollow base secured to and enclosing said sealed-in portion, a plurality of voltage converting elements electrically arranged and connected to effect full-wave rectification of an alternating potential, and means for mounting said voltage converting elements within said base comprising two panels of insulating material axially disposed in said base and held in spaced apart relation therein proximate the sealed-in portion of said envelope by said main and auxiliary conductors said voltage converting element being located between and supported by said panels and electrically connected to said main and auxiliary conductors.

4. The combination which comprises, means for converting an alternating voltage to a unidirectional potential; and an incandescent-cathodoluminescent lamp comprising an incandescible source of radiant energy and electrons, a sealed radiation-transmitting envelope enclosing said source, and a radiation-transmitting electrically-conductive coating on the inner surface of said envelope comprising a cathodoluminescent phosphor having an efficient output in a predetermined region of the spectrum at the normal operating temperature of

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said envelope under the exciting influence of electrons emanating from said source when operated, and conductor means connected to said source and sealed through said envelope; said voltage converting means being mounted within said lamp and electrically connected to said coating and conductor means and electrically oriented with respect thereto to effect full wave rectification of alternating voltage applied to said source through said conductor means and thereby maintain said coating positive in polarity with respect to and at substantially the same potential as that applied to said source.

5. The combination which comprises, means for converting alternating voltage to a unidirectional potential; and an incandescent-cathodoluminescent lamp comprising an incandescible source of radiant energy and electrons, a light-transmitting envelope enclosing said source, a light-transmitting electrically-conductive coating on the inner surface of said envelope comprising a cathodoluminescent phosphor having an efficient output in a predetermined region of the visible spectrum at the normal operating temperature of said envelope under the exciting influence of electrons emanating from said source when operated, and conductor means connected to said source and sealed through said envelope; said voltage converting means comprising rectifying elements mounted within said envelope at a location therein remote from said source and connected to said coating and conductor means, said rectifying elements being electrically oriented to effect full wave rectification of alternating voltage applied to said source through said conductor means and to maintain said coating positive in polarity with respect to and at a potential substantially equal to that applied to said source.

6. The combination which comprises, means for converting alternating voltage to a unidirectional potential; and an incandescent-cathodoluminescent lamp comprising an incandescible source of radiant energy and electrons, a light-transmitting envelope enclosing said source, a light-transmitting electrically-conductive coating on the inner surface of said envelope comprising a cathodoluminescent phosphor having an efficient output in a predetermined region of the visible spectrum at the normal operating temperature of said envelope under the exciting influence of electrons emanating from said source when operated, main conductor means connected to said source and sealed through an end of said envelope, and a hollow base member secured to the said end of said envelope and electrically connected to said main conductor means; said voltage converting means comprising rectifying elements mounted within the base member and electrically connected to said main conductor means and coating through auxiliary conductor means, said rectifying elements being electrically oriented to effect full wave rectification of alternating voltage applied to said source through said main conductor means and to maintain said coating positive in polarity with respect to and at a potential substantially equal to that applied to said source.

References Cited in the file of this patent

UNITED STATES PATENTS

1,963,963	Barclay	June 26, 1934
2,759,119	Thorington	Aug. 14, 1956
2,763,814	Navarre	Sept. 18, 1956
2,780,746	Arnott	Feb. 5, 1957