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Fluorescent
LIGHTING SYSTEM

This invention relates to lighting systems. In particular, this invention pertains to fluorescent type lighting systems. More in particular, this invention relates to fluorescent type lighting systems which are operable from a standard 110 volt or 117 volt outlet line. Further, this invention pertains to fluorescent type lighting systems which do not necessitate the use of a starter and a choke, or ballast type mechanism within the overall lighting system structure while simultaneously being operable from the standard 110 volt or 117 volt outlet lines.

Lighting systems known in the art comprise two general types: incandescent and fluorescent. In prior art incandescent filament lighting systems, an electric current is directed through a conducting filament. Molecules of the filament become excited and upon heating up, the filament is caused to glow in the visible bandwidth of the electromagnetic radiation spectrum. The visible energy is radiated external to the structure of the prior art light bulb. However, the prior art type light bulb of this type is extremely inefficient and a vast amount of energy is necessitated to provide light within the visible region of the electromagnetic spectrum. This results in higher costs for use and is an unnecessary usage of energy resources.

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Fluorescent tubes or lighting systems generally include a mixture of a noble gas such as neon or argon and a secondary gas such as mercury. Within the fluorescent tube, there is generally provided a pair of filament type electrodes coated with a material which readily emits electrons when heated. When the electrical current is introduced to the filaments, the filaments heat up and emit electrons wherein one acts as an anode and one acts as a cathode at some particular time interval. In such prior fluorescent tubes, an extremely high voltage between the electrodes is necessitated in order to initiate the noble gas discharge. Thus, there is provided with such fluorescent tube, a starter and a choke or ballast type system. The starter is used for automatically breaking the circuit when the filaments have heated up which then causes the choke, generally an induction coil, to produce a pulse of high voltage electricity. This pulse of high

voltage electricity initiates the noble gas discharge and subsequently, the Mercury or other metal discharge. The latter is self-sustaining with a continuous flow of electrons being formed between the electrodes. The vapor of the mercury or other gas metal is ionized and radiation is produced in the ultraviolet region of the electromagnetic spectrum. The radiation then impinges a fluorescent material which is coated on the internal surfaces of the tube and such glows by absorbing the invisible ultraviolet and re-radiating it as a visible light. Fluorescent lighting has been found to operate at lower temperatures than incandescent filament light bulbs and additionally, more of the electrical energy goes into the emission of visible light and less into heat than that found in the incandescent filament type light bulbs. Such fluorescent tubes have been found to be relatively efficient and may be up to five times as efficient as filament light bulbs. However, such fluorescent lighting systems do necessitate a high initial input of electrical energy and further necessitate the use of starters and ballasts for

initiation of the self-sustaining discharge. This complicates and increases the costs of such systems.

In contrast, the present invention is directed to a fluorescent lighting system, i.e. a system which involves the production of energy within the ultraviolet bandwidth of the electromagnetic spectrum responsive to the ionization of metal atoms, but without requiring the use of a choke or ballast system. Additionally, a lighting system is proposed which can be operated over standard domestic or commercial electrical line inputs.

The lighting system of this invention comprises an outer sealed bulb of translucent material containing a gaseous composition comprising atoms capable of ionisation and concomitant emission of ultraviolet radiation upon bombardment by electrons emitted from a cathode and coated internally with a layer of material which fluoresces upon exposure to said ultraviolet radiation, a cathode assembly mounted in said sealed bulb and comprising a tubular sleeve closed at both ends to form a hermetically sealed cathode chamber in which is contained a cathode gas, the pressure of which, related to the diameter of the sleeve falls within the following formula: $2.0 < p \times d < 3.0$, where p = the pressure of the cathode gas in mm Hg, and d is the diameter of the sleeve in centimetres, a first anode located inside, but electrically isolated from said cathode sleeve and energisable to heat the sleeve so as to cause emission of electrons therefrom, and a second anode positioned in said bulb externally of the cathode sleeve for accelerating electrons emitted from the external surface of the cathode sleeve into the ionisable gaseous composition thereby to cause the ionisation thereof and emission

of said ultraviolet radiation and the consequent fluorescence of said coating.

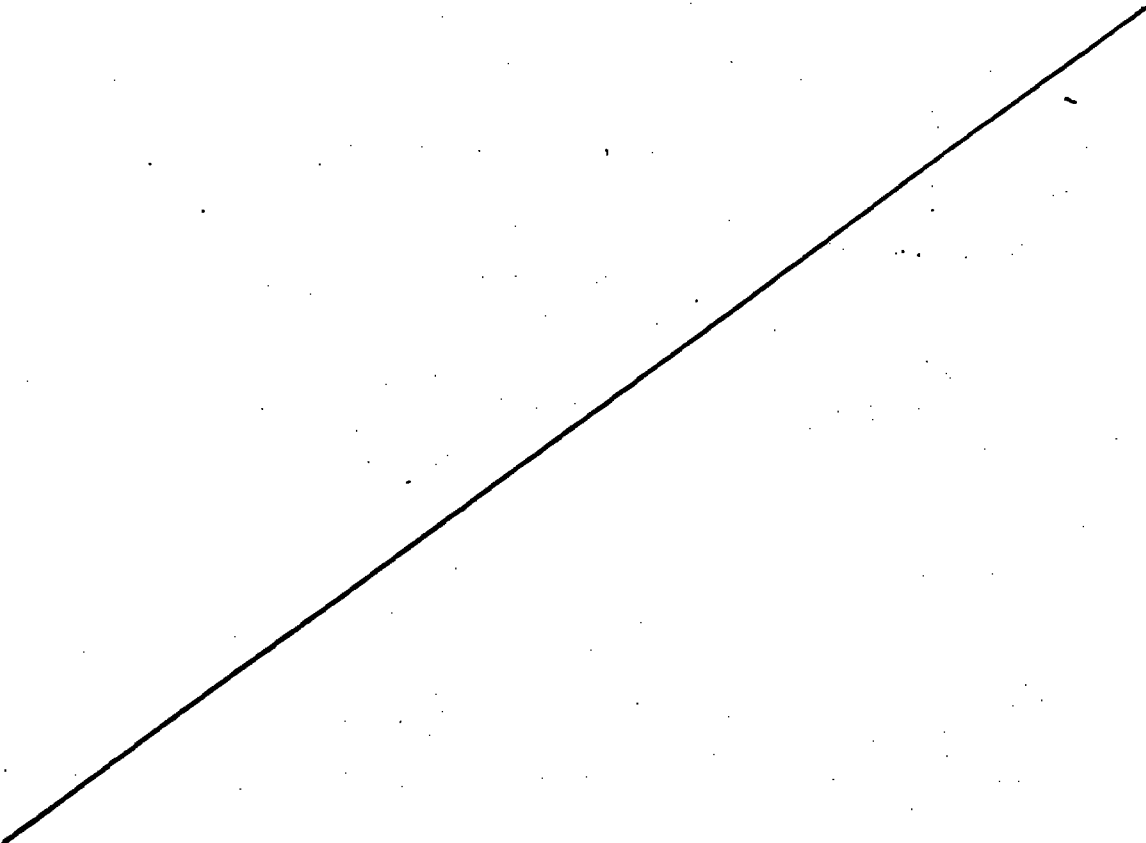
The lighting systems of the present invention will be further described with reference to the accompanying drawings:-

5 Fig. 1 is a sectional elevational view of the preferred embodiment of the lighting system showing the cathode mounted within the overall bulb housing member;

Fig. 2 is a perspective exploded view of the cathode and the first anode;

10 Fig. 3 is a section elevational cut-away view of the cathode showing the first anode mounted therein.

Referring now to Figs. 1-3, lighting system 10 of the present invention is based upon the concept of initiating electron flow from an external surface of cathode 12. Cathode 12 is heated
15 when a voltage is applied between first anode 14 and cathode 12. This



causes the release of electrons. Such release of electrons further ionize the internal gas in a cumulative fashion. The cumulative ionization results in the overall heating of cathode 12. Electrons are driven from the external surface of cathode 12 due to the heating process and are accelerated by second anode 16 mounted external to cathode 12. The electrons passing from cathode 12 impinge and interact with a gas metal vapour contained within bulb 18. The gas atoms are ionized and radiate in the ultraviolet bandwidth of the electromagnetic spectrum. The ultraviolet energy impinges on a coating of fluorescent material 20 coating the inner surface of bulb member 18. The fluorescent material then radiates within the visible bandwidth of the electromagnetic radiation spectrum.

Referring to the basic structural concepts of lighting system 10, such includes cathode 12 utilized for emitting electrons from an external surface thereof. Cathode 12 includes cathode sleeve member 22 and cathode base member 24. Cathode sleeve member 22 is generally cylindrical in contour having opposingly directed closed end 26 and open end 28. Cathode sleeve member 22 may include cathode flange 30 extending around the periphery of cathode open end 28 for purposes to be described in following paragraphs. As has been stated, cathode sleeve member 22 may be cylindrical in contour and additionally, is formed of metals or alloys commonly used in the fabrication of indirectly heated oxide cathodes which are well-known and commercially available. Sleeve member 22 may be formed of molybdenum, tantalum, zirconium

tungsten, nickel, or other alloys commonly used in such heated oxide cathode manufacturing. Cathode sleeve member 22 and associated cathode flange 30 may be fabricated in one-piece formation and would preferably be seamless in overall fabrication.

Cathode base member 24 is mounted to cathode flange 30 and hermetically sealed to cathode sleeve member 22. As shown in FIG. 3, the combined structure of base member 24 and cathode sleeve member 22 form cathode internal chamber 32. Hermetic sealing between cathode sleeve 22 and cathode base member 24 may be provided by a number of well-known techniques utilizing adhesive mechanisms such as glass frit sealing, or some like fabrication not important to the inventive concept as is herein described.

Cathode base member 24 may either be formed of a dielectric material such as a ceramic composition, or may be formed of the same or similar metal composition of sleeve member 22. In the event that cathode base member 24 is formed of a metal similar to that of cathode sleeve member 22, then

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an insulation member must be placed around the surface of first anode 14 and cathode base member 24.

Subsequent to sealing of sleeve member 22 to base member 24, a cathode gas composition is inserted into cathode internal chamber 32 at a predetermined pressure. Inert gases such as helium, neon, argon, krypton, xenon, or hydrogen as well as combinations thereof, have been used successfully.

In actual practice, a minimum suitable pressure between 4.0 between 4.0 and 6.0 mm Hg (53 to 80 daN/mm²)

has been found useful where a diameter of 0.5 cm

is used on tubular sleeve member 22. Upon application of a potential between first anode 14 and cathode 12, there is a predetermined voltage corresponding to the breakdown which is described in Paschen's Law. This Law states that the breakdown potential between two terminals in a gas is generally proportional to the pressure multiplied by the gap length. It has been found advantageous that the gas composition predetermined pressure within cathode internal chamber 32 be maintained approximately in accordance with the formula:

$$2.0 < p.d < 3.0$$

where:

p = predetermined gas composition pressure in mm Hg

d = predetermined diameter of sleeve member in cm.

As is seen in FIG. 3, first anode 14 is mounted to cathode base member 24 and passes internal to chamber 32.

As is clearly seen in following paragraphs, heating of cathode 12 provides emission of electrons from cathode external surface 34.

In construction, first anode 14 may be an electrical wire or may be an electrode of electrically conducting composition.

First anode 14 is electrically coupled to first anode lead wire 36 which is directed to a standard domestic or commercial outlet line.

As can be seen, cathode 12 is also coupled to a standard outlet line through cathode lead wire 38.

In order to maximize efficiency of the overall system, a resistor may be inserted in series with cathode 12 on lead 38.

A resistor having a value of approximately 250 ohms has

been successfully used in this manner. When a voltage is applied

between first anode 14 and cathode 12, cathode 12 is essentially

made negative. A discharge is instantaneously established

and depending on the current allowed to flow in

the discharge by the magnitude of the source's internal heat

impedance, will quickly heat the metal walls of cathode 12.

Cathode external surface 34 is coated with oxide film 40. Cathode oxide film 40 may be an oxide of barium, strontium, calcium, or some like metallic oxide coating which emits a high density of electrons upon being heated.

Barrier member 42 is clearly seen in FIGS. 2 and 3 surrounding first anode 14 throughout a substantial length of the extension within internal chamber 32. Barrier element 42 is formed of a dielectric material composition such as glass. As is seen, barrier element 42 is in non-contact relation with first anode 14. Barrier element 42 is mounted on cathode base member 24 in fixed relation thereto to provide a screening effect for metallic atoms which may be displaced from cathode internal surface 44:

When a potential is initiated between first anode 14 and cathode 12, gas is ionized within chamber 32. Impingement on internal surface 44 causes atoms of metal to be displaced from the walls of cathode 12. The metal atoms will deposit on a random basis at any point within cathode 12. If the metallic atoms from internal surface 44 deposit in

a manner such that there is an electrical path between first anode 14 and base member 24, or cathode sleeve member 22, then there will be a shorting of these electrodes which are at different potentials. Thus, in order to minimize the probability of defining a short due to metal deposit within the cathode 12, barrier element 42 is inserted around first anode 14 in non-contact relation thereto.

In this case, metal deposit would have to pass internal to barrier element 42 through annular openings 46 and coat the internal surface of barrier element 42 before such reaches base member 24 in order to short the entire system. This has the effect of lengthening the life of lighting system 10 and provides a shorting screen for the entire system. Thus, barrier element 42 being mounted to cathode base member 24 surrounding first anode 14 maintains electrical insulation between first anode 14 and cathode base member 24 for the purposes and objectives as hereinbefore described.

Second anode 16 is positionally located external to cathode 12 and is used for accelerating electrons emitted

from external surface 34 and coating 40 when a potential is applied to second anode lead 48. Second anode 16 is actuated through a standard outlet as is the case in cathode lead 38 and first anode lead 36. Second anode 16 may be mounted to flange 30 through dielectric struts 50 or some like technique not important to the inventive concept as is herein described, with the exception that second anode 16 be electrically insulated from cathode 12.

Second anode 16 is shown as an annulus type structure. However, it is to be understood that second anode 16 may be a lead wire or some other type of contour which only has as its criteria, the fact of being displaced from cathode 12. The object of second anode 16 is to accelerate electrons passing from coating 40. When a voltage is applied to second anode 16 which makes it positive with respect to cathode 12, then a discharge occurs between cathode 12 and second anode 16. Due to the fact that the pressure of gas maintained within bulb member 18 (as will be described in following paragraphs) is less than that within internal chamber 32,

the mean free path of the emitted electrons is much larger.

As is the usual case in light bulb systems, cathode 12, second anode 16, and first anode 14 may be mounted on stem member 52 positionally located and maintained in fixed securement to internal surfaces of bulb member 18. Stem member 52 may be formed of a glass or some like composition not important to the inventive concept as is herein described. Stem member 52 is merely used as a mounting base for the elements of lighting system 10.

Bulb member 18 encompasses cathode 12, second anode 16, and first anode 14 as is clearly seen in FIG. 1. A hermetic seal is formed to provide bulb member internal chamber 54 which has a predetermined gas composition such as mercury vapor contained therein at a predetermined pressure. Bulb member 18 may be formed of a glass composition, as is standard in commercial lighting systems. Additionally, bulb member internal surface 56 is coated with fluorescent material 58 as is shown. Fluorescent material 58 may be a standard phosphor composition. Minute quantities of metallic

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compositions are introduced into chamber 54 and as an example, when mercury is introduced, a pressure approximating 10^{-3} mm Hg (0.13 Nmm^2) is provided for internal chamber 54. In overall concept, gas composition atoms of mercury or like metal are ionized and radiate in the ultraviolet bandwidth of the electromagnetic spectrum. Fluorescent material 58 intercepts the ultraviolet energy responsive to the ionization of gas composition atoms and re-radiates in the visible light region.

Thus, when a voltage is applied between second anode 16 and cathode 12, there is a high current density source of electrons passing from coating 40 on external surface 34. The voltage difference between cathode 12 and second anode 16 causes a discharge and since the pressure within enclosure or chamber 54 is substantially less than the chamber 32, the mean free path of the electrons is greater. In such an instance, the entire volume of internal chamber 54 is filled with radiation from electrons traveling a longer distance to produce collisions with atoms of mercury or like metallic

gas filling chamber 54. Collision of the electrons with atoms of gas within chamber 54 causes ultraviolet radiation to be expended and such impinges on fluorescent material 58 for re-radiation within the visible light region.





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CLAIMS

1. A fluorescent lighting device comprising an outer sealed bulb of translucent material containing a gaseous composition comprising atoms capable of ionisation and concomitant emission of ultraviolet radiation upon bombardment by electrons emitted
5 from a cathode and coated internally with a layer of material which fluoresces upon exposure to said ultraviolet radiation, a cathode assembly mounted in said sealed bulb and comprising a tubular sleeve closed at both ends to form a hermetically sealed cathode chamber in which is contained a cathode gas, the pressure of which, related
10 to the diameter of the sleeve falls within the following formula:
 $2.0 < p \times d < 3.0$, where p = the pressure of the cathode gas in mm Hg, and d is the diameter of the sleeve in centimetres, a first anode located inside, but electrically isolated from said cathode sleeve and energisable to heat the sleeve so as to cause emission of
15 electrons therefrom, and a second anode positioned in said bulb externally of the cathode sleeve for accelerating electrons emitted from the external surface of the cathode sleeve into the ionisable gaseous composition thereby to cause the ionisation thereof and emission of said ultraviolet radiation and the consequent
20 fluoreseence of said coating.

2. A device according to Claim 1, wherein the cathode comprises a integral tubular member closed at one end and mounted in hermetic sealing engagement with a base member at the other, with said first anode extending through and being fixedly secured to
25 said base member.



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3. A lighting device according to Claim 2, where said base member is formed of a dielectric material.

4. A lighting device according to Claim 1 or 2 wherein said cathode sleeve is formed of electrically conductive material, and
5 said first anode is electrically insulated from said base member.

5. A device according to 1,2,3 or 4 wherein the cathode gas is argon, neon, krypton, xenon, hydrogen or helium.

6. A device according to any one of Claims 1 - 5, wherein the second anode is in the form of an annulus concentrically
10 mounted about, but spaced outwardly from said cathode sleeve.

7. A device according to Claim 1, substantially as hereinbefore described with reference to Figures 1 - 3 of the accompanying drawings.

