

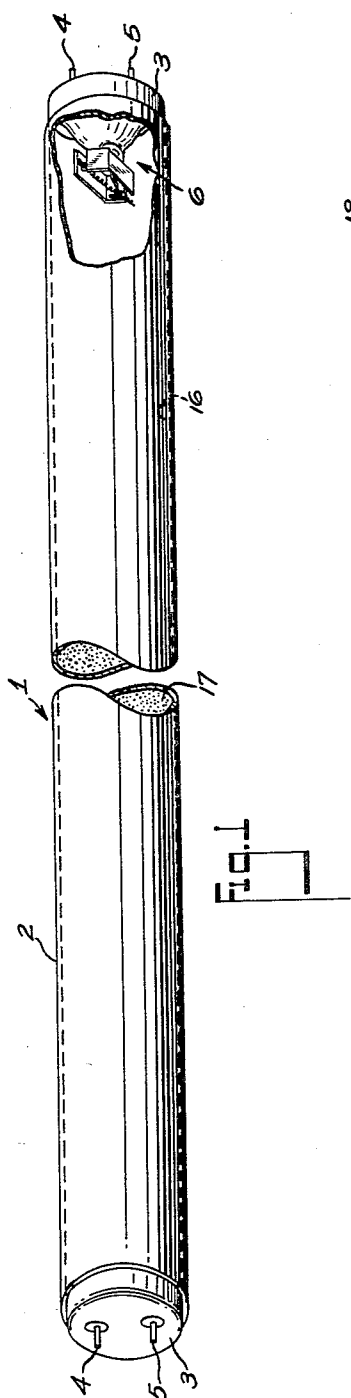
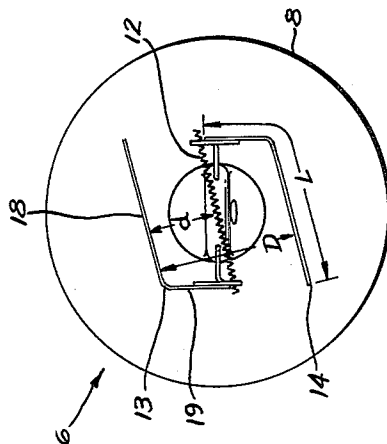
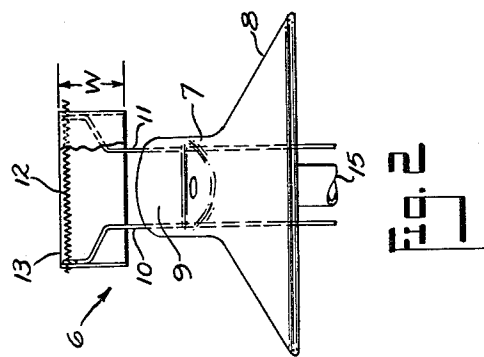
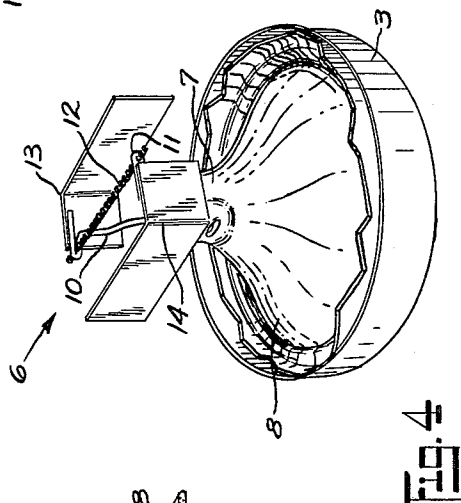
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DISCHARGE LAMP WITH CATHODE SHIELDS

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DISCHARGE LAMP WITH CATHODE SHIELDS
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This invention relates to low-pressure electric discharge lamps such as fluorescent lamps comprising a pair of thermionic electrodes sealed into opposite ends of an elongated tube containing mercury vapor and an inert gas as the ionizable medium. The invention is more particularly concerned with high efficiency fluorescent lamps utilizing shields or anode plates about the thermionic electrodes which are correlated in design to the thermal inertia and operating temperature of the electrodes so as to achieve reduction of the anode voltage drop and prevention of end darkening of the lamp without any acceleration of damage to the electrodes.

In copending application Serial No. 88,228 filed February 9, 1961, now Patent No. 3,069,581 by Eugene Lemmers, entitled Low Pressure Discharge Lamp and assigned to the same assignee as the present invention, which application is a continuation of an earlier application Serial No. 812,235 filed May 11, 1959, now abandoned, there is described and claimed a high efficiency low pressure discharge lamp such as a fluorescent lamp having shields or anode plates about the thermionic electrodes. Prior to the invention of said Lemmers' application, shields had been used about cathodes to trap sputtered or vaporized electrode material and prevent it from darkening the bulb wall. However the Lemmers invention determined that shields as used in the past actually shortened the life of the cathode, and that such shields while hiding the damage actually accelerated it. Lemmers taught that the reduction in cathode life entailed by the presence of a shield around the cathode can be avoided by reducing the size or thermal mass of the cathode so as to achieve the optimum cathode operating temperature despite the presence of the shields and their tendency to rob ions from the sheath and to subtract current from the cathode. According to the Lemmers invention, shields are used in combination with a smaller filamentary cathode which is designed to operate in the usual manner without shields at 50 to 62.5% of the normal discharge current. A cathode so designed may then be used with shields in a lamp operating at normal current, that is at 100% discharge current, and normal cathode life will be experienced. In effect, according to the Lemmers invention, the cathode is designed as regards resistance and thermal mass including its disposition to lose heat by radiation and otherwise, to achieve an emission spot temperature in the range of 1050 to 1200° C. while providing 100% of the electron emission on the cathode half-cycle and only 0 to 25% of the electron collection on the anode half-cycle. Since each half-cycle provides 50% of the normal discharge current, it follows that the filamentary cathodes are designed for normal operation without shields at 50 to 62.5% of the normal discharge current. The balance of electron collection on the anode half-cycle is made up for the most part by the shields with possibly a minor fraction by the inleads which support the cathode and the shield. The shields or anode plates are spaced far enough away from the cathode, a minimum of approximately 3 millimeters, that ion trapping has a negligible effect on cathode fall.

The object of this invention is to provide a further improvement in efficiency in a low-pressure electric discharge lamp utilizing a shielded cathode structure according to the principles of the aforementioned copending Lemmers' application.

In the preferred embodiment described and illustrated

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in the aforementioned copending Lemmers' application, the shield comprises a pair of anode plates disposed on either side of the filament and transversely to the longitudinal axis of the lamp and generally centered about the filament. The resulting configuration serves to more or less box in or encircle the electrode and a transverse plane through the filament would pass medially through the cathode shields. According to the invention, I have now discovered that a further improvement in efficiency may be achieved by displacing the shields rearwardly along the longitudinal axis of the lamp so that the front or leading edges of the shield plates are approximately even with a plane through the filament transverse to the longitudinal axis of the lamp. By so doing, a consistent improvement in efficiency of approximately 1% over the shield disposition centered on the filament has been observed in actual production. Furthermore whereas it might have been expected that by moving the shield plates rearwardly, the effectiveness of trapping of sputtered material would be drastically reduced, possibly by as much as 50%, in fact very little if any increase in bulb wall darkening has been observed.

For further features and advantages of the invention and for a more detailed description of a preferred embodiment thereof, attention is now directed to the following description and accompanying drawing. The features of the invention believed to be novel will be more particularly pointed out in the appended claims.

In the drawing:

FIG. 1 is a partially cutaway perspective view of a fluorescent lamp representative of the invention.

FIG. 2 illustrates the mount and electrode structure of the lamp in side elevation.

FIG. 3 illustrates the same mount and electrode structure in end view.

FIG. 4 illustrates pictorially the same mount as the lamp closure with attached base.

Referring to FIG. 1, the low pressure discharge lamp 1 embodying the invention may correspond, in regards to its size and general configuration, to the ordinary 40-watt rapid start fluorescent lamp of 48" nominal length and 1½" diameter. The lamp comprises an elongated cylindrical envelope 2 having shouldered ends to which are secured bases 3 each provided with a pair of insulated contact terminals or pins 4, 5. As shown at the end of the lamp where a fragment of the envelope wall has been broken out and in greater detail in FIGS. 2 to 4, electrode mount 6 comprises a relatively short stem tube 7 having its flared outer end 8 sealed peripherally into the shouldered tube end and having a press 9 at its inner end through which are sealed current inlead wires 10, 11. The inward projections of the inlead wires into the envelope support the filamentary cathode 12 transversely to the longitudinal axis of the discharge channel. The outward projections of the inleads are connected to the terminal pins 4, 5. In addition the transverse extensions of the inleads at the inner ends support the cathode shields 13, 14. The other end of the lamp is provided with a similar cathode and at least one of the stem flares is provided with an exhaust tube 15 which is sealed or tipped off in the usual fashion. The illustrated cathode consists of a multiple coiled tungsten filament coated with activating material such as alkaline earth oxides including barium oxide. The illustrated filament is double coiled; other forms of filamentary cathode may be used such as a triple coiled filament or a double coiled filament with overwind. In any event, the cathode is proportioned in size to achieve an emission spot temperature in the range of 1050 to 1200° C. while providing 100% of the electron emission on the cathode half cycle and 0 to 25% of the electron collection on the anode half cycle, as previously stated.

The lamp contains a quantity of mercury indicated by droplet 16 exceeding in amount the quantity vaporized during operation of the lamp. In addition a filling of an inert gas, for instance argon with a minor proportion of neon, is provided at a total pressure of a few millimeters of mercury. At relatively low loadings in the range of 5 to 15 watts per foot, an increase in efficiency may be achieved by replacing up to approximately 50% of the argon filling gas by neon in the pressure range from 1.5 to 3 millimeters of mercury. At a pressure of approximately 2 millimeters, the preferred proportions of neon is in the range from 25 to 40%, the latter being preferred where the emphasis is on maximum output, and the former where the emphasis is on maximum life. For the instant 40-watt lamp having a nominal loading of 10 watts per foot, the preferred filling gas mixture consists of 70% argon and 30% neon at a total pressure of approximately 2.5 millimeters of mercury. A phosphor coating indicated at 17 on the inside of the envelope wall converts the ultraviolet radiation of the discharge through the mercury vapor into visible light.

As illustrated, the shield assembly comprises a pair of L-shaped metal plates 13, 14. Each plate comprises a main portion 18 which is disposed generally parallel to the filament 12 and transversely to the longitudinal axis of the lamp, and an auxiliary portion 19 which extends from the main portion at an angle slightly greater than 90°. The shield plates are located about at the boundary of the cathode glow and in any case at a distance greater than approximately 3 millimeters from the emitting surface of the cathode. In a preferred construction suitable for a 40-watt fluorescent lamp, a distance d is 5 to 7 millimeters and with this spacing, the ion trapping effect of the shield has negligible effect on the cathode fall. The flat surfaces of the plates extend parallel to the longitudinal axis of the discharge channel.

According to the present invention, the shield is located so that the front or leading edge of the shield plates 13, 14 are located approximately in a transverse plane passing through the filament. In other words, the shield plates, instead of being medially centered on a transverse plane through the filament, are moved back along the axis of the lamp a distance approximately half the width W by comparison with the preferred disposition shown in the aforementioned copending Lemmers' application. By so doing, I have found through large scale production tests a consistent improvement of approximately 1% in efficiency. Rather surprisingly, despite the fact that the filament is no longer more or less centrally located in the box-like enclosure formed by the shield plates, very little increase in bulb wall darkening has been observed. It appears that vaporized or sputtered material from the filament collects on the shield plate in preference to the bulb wall and that from the point of view of prevention of envelope darkening, the exact location of the shield plates is not too critical. On the other hand, from the point of view of achieving maximum efficiency or maximum light output, the present disposition of the shield is important and rather critical. By moving the shield plate rearwardly to place their leading edges in the transverse plane of the filament, the arc length on the anode half-cycle is lengthened so that light output is increased. On the other hand, on the cathode half-cycle, less of the radiation produced by the negative glow about the cathode is trapped by the shield plates so that again the light output is increased. Moving the cathode shield plates further back along the axis of the lamp, that is further to the rear of the transverse plane through the filament does not provide any further additional benefit, and may result in undesirable transfer of the anode current from the shield plates back to the filament.

As an example of cathode shields in accordance with the invention suitable for a 40-watt fluorescent lamp, the shield plates 13, 14 may consist of thin nickel strips each having a width W of approximately 9 mm. and a total

length L of approximately 21 mm. The short leg 19 of each strip welded to the inlead is approximately 6 mm. long and the long leg 18 approximately 15 mm. long. The distance D between the long legs of the strips is approximately 14 mm. and the long legs are preferably positioned parallel to the filament as illustrated. The distance d from the emitting surface of the filament to the long legs of the shield strip is approximately 6 mm., a distance substantially greater than the minimum of 3 mm. required to reduce ion trapping to the point where it has negligible effect on cathode fall. The total inside surface of the shield members 13, 14 surrounding the cathode is approximately 3.8 cm.². The cathodes in lamps of this configuration carry from 8 to 15% of the discharge current on the anode half-cycle, the exact figure depending upon the usual lamp variables such as quality of exhaust, inert gas fill pressure, and quality of cathode activation. Thus the cathodes carry from 54 to 57.5% of the total lamp current. The improvement in efficiency over similar prior lamps differing only by having the shields medially disposed on the transverse plane through the filaments is about 1%, or a gain in output of about 30 lumens in a 40 watt lamp producing 3000 lumens.

The shield plates are preferably made of a metal which forms a good base member for activation by barium or barium oxide which is vaporized from the filament during operation and which deposits on the shield plate. Suitable metals are tungsten, molybdenum, tantalum and nickel; nickel is preferred because it is cheapest. If desired, the shields may be made of perforated strip or of screening in order to reduce trapping of 2537 Å. radiation originating from the cathode glow, and the term plate as used in the claims to follow is intended to cover such variation. Also, instead of a pair of L-shaped plates at each cathode, a pair of C-shaped plates may be used forming a generally circular ring-like shield about the filament, the front or leading edges of the plates or segments being located approximately in a plane transverse to the longitudinal axis of the discharge channel and passing through the filament.

While a specific embodiment of the invention has been illustrated and described in detail, the same is to be taken as illustrative and not in order to limit the invention thereto. The invention is of course equally applicable to other styles of discharge lamps having an elongated discharge channel which may not be straight and linear, such as configured re-entrant cross-section lamps, curvilinear circline lamps, and labyrinthine panel type lamps. The scope of the invention is to be determined by the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A low pressure electric discharge lamp comprising a vitreous envelope defining an elongated discharge channel having a pair of filamentary activated cathodes supported on inlead wires sealed into opposite ends and mounted transversely to the longitudinal axis of said discharge channel, said envelope containing an ionizable medium comprising mercury vapor and an inert starting gas, said cathodes being proportioned in resistance and thermal mass to achieve an electron emission spot temperature in the range of 1050 to 1200° C. with 100% emission of discharge current on the cathode half-cycle and 0 to 25% collection on the anode half-cycle, and conductive shields fastened to said inleads encompassing the cathode glow region of said cathode and collecting substantially the balance of discharge current, said shields being arranged with surfaces extending substantially parallel to the longitudinal axis of the channel thereat at a distance greater than 3 mm. from the center of the filaments and with the leading edge of the shields approximately even with a plane through the filament transverse to said longitudinal axis.

2. A low pressure electric discharge lamp comprising a vitreous envelope defining an elongated discharge chan-

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nel having a pair of cathodes sealed into opposite ends and containing an ionizable medium comprising mercury vapor and an inert starting gas, each cathode comprising a multiple coiled tungsten filament coated with alkaline earth oxide activating material, supported at opposite ends by inlead wires sealed through said envelope, and mounted transversely to the longitudinal axis of the discharge channel thereat, said cathodes being proportioned in resistance and thermal mass to achieve in operation an electron emission spot temperature in the range of 1050 to 1200° C. with 100% emission of discharge current on the cathode half-cycle and 0 to 25% collection on the anode half-cycle, and conductive shields fastened to said inleads encompassing the cathode glow region of said cathode and collecting substantially the balance of discharge current, said shields consisting of plates of metal subject to activation by said activating materials, said plates being arranged with surfaces extending substantially parallel to the longitudinal axis of the channel thereat at a distance greater than 3 mm. from the center of the filaments and with the leading edges of the shield plates approximately even with a plane through the filament transverse to said longitudinal axis.

3. A low pressure electric discharge lamp comprising a vitreous envelope defining an elongated discharge channel having a pair of electrode structures sealed into opposite ends and containing an ionizable medium comprising mercury vapor and an inert starting gas at a low

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pressure, each electrode structure comprising a multiple coiled tungsten filament coated with activating material and supported at opposite ends by inlead wires sealed through said envelope, said filaments being proportioned in resistance and thermal mass to achieve in operation an electron emission spot temperature in the range of 1050 to 1200° C. with 100% emission of discharge current on the cathode half-cycle and 0 to 25% collection on the anode half-cycle, said filaments being mounted to extend transversely to the longitudinal axis of the discharge channel thereat, conductive shields fastened to said inleads and encompassing the cathode glow region of said electrodes and consisting of a pair of generally L-shaped metal plates subject to activation by deposition of said activating material thereon and of a total area sufficient to collect substantially the balance of discharge current, said shield plates being disposed with the long leg of the L approximately parallel to the filament and such that the flat portions thereof are located in planes parallel to the longitudinal axis of the channel and the leading edges thereof are located to lie approximately in a plane transverse to the longitudinal axis of the discharge channel thereat and passing through the filament.

References Cited in the file of this patent

UNITED STATES PATENTS

2,930,919 Wainio ----- Mar. 29, 1960