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REFLECTOR MERCURY LAMP

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Fig. 1.

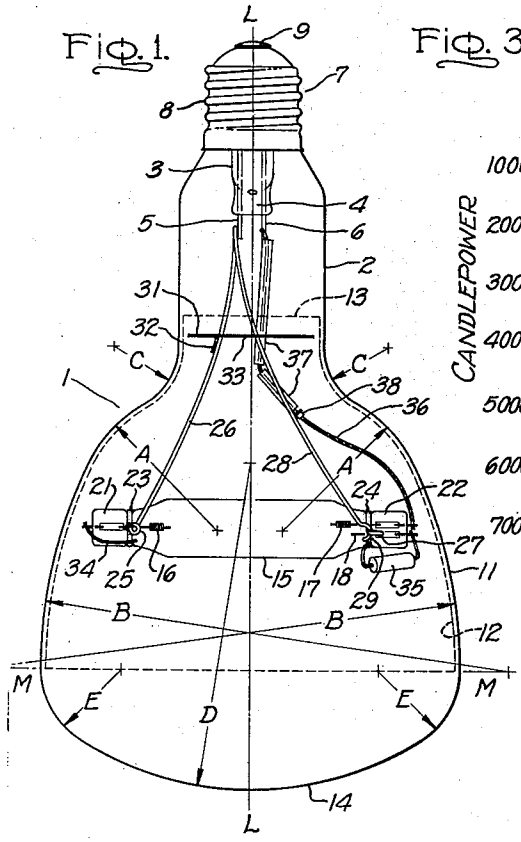


Fig. 3.

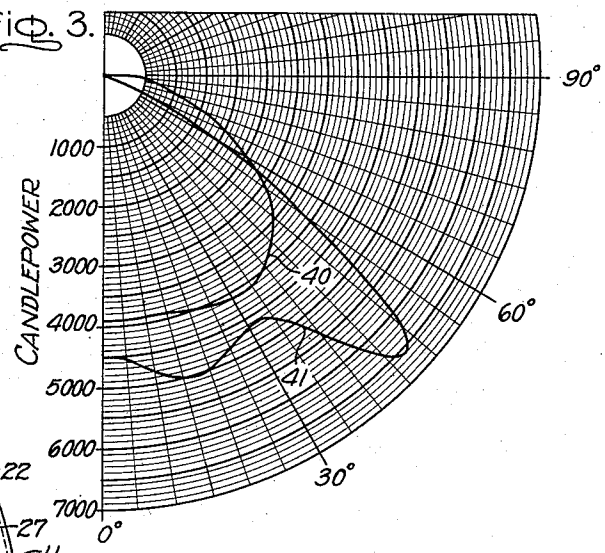
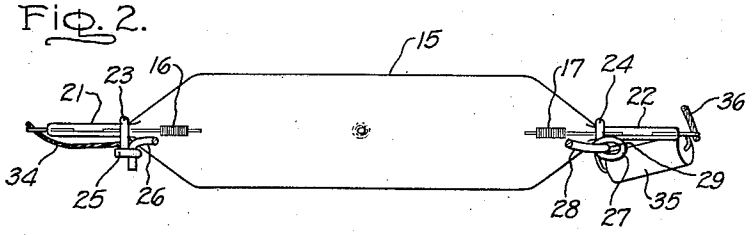


Fig. 2.



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REFLECTOR MERCURY LAMP

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4 Claims. (Cl. 313—25)

This invention relates to high-pressure mercury vapor lamps of the reflector type wherein an arc tube is mounted in a glass bulb provided with a reflecting coating for concentrating the light in a desired direction and pattern.

In high-pressure mercury vapor lamps used for general illumination, the bulb or outer jacket which encloses the arc tube keeps air away from the arc tube seals and provides mechanical protection while serving also as a heat conservator and short-wave ultraviolet filter. In the reflector type lamps, the glass bulb is formed to a bowl shape extended at one end into a reduced diameter tubular neck portion to which is generally attached a screw type base for accommodating the lamp in a standard socket. The bowl portion is silvered to reflect the light along the longitudinal axis in a controlled beam. The practice up to the present time in reflector type lamps has been to mount the arc tube along the longitudinal axis of the bulb in the same fashion as with non-reflector type bulbs. For convenience of description, this mode of mounting will be referred to as vertical mounting inasmuch as in normal usage for high bay lighting, the longitudinal axis is aimed down.

In high bay lighting it is desirable to concentrate the light downward and to reduce as much as possible the light radiated at angles just below the horizontal. Typically, it may be desirable to concentrate the light in the 0° to 60° zone, that is from the vertical up to 60° therefrom, and to reduce to a low value light radiated in the 60° to 90° zone. In the reflector type mercury vapor lamps which have been available up to the present time, for instance in that designated commercially H400R1, there has been substantial radiation in the 60° to 90° zone, for instance up to 25% of the total lumens from the lamp.

The object of the invention is to provide a new and improved reflector type mercury vapor lamp which makes more effective utilization of the light generated by the arc tube.

A more specific object of the invention is to provide a reflector type mercury vapor lamp which provides a more effective concentration of light in the 0° to 60° zone and reduces glare by decreasing the light transmitted in the 60° to 90° zone.

As a result of extensive photometric tests, we have discovered that a substantial improvement in the utilization of light from reflector type mercury vapor lamps may be effected by mounting the arc tube horizontally, that is transversely to the longitudinal axis of the reflector bulb, rather than vertically as has been the practice up to the present. The reflector bulb commonly used for the present lamp is formed as a surface of revolution along the longitudinal axis. It has a narrow tubular neck portion extending along the axis which opens into a wide flaring bowl portion closed by a light-transmitting convex end face. The neck portion next to the bowl and the bowl portion out to its region of maximum diameter is coated with a light-reflecting layer. The arc tube has an overall length greater than the diameter of the neck

portion and less of course than the diameter of the bowl portion where it is located but amounting to at least a substantial proportion of the axial length of the bowl portion. The axial length of the bowl portion is equal to or less than its maximum diameter. With a reflector bulb and an arc tube of these relative dimensions, it is possible to reduce the light transmission in the glare producing 60° to 90° zone while maintaining the arc tube vertical by moving it further up towards or into the neck of the bulb. However, this result is achieved at the cost of a reduction in the total light output from the lamp. By mounting the arc tube horizontally in accordance with our invention, a reduction of light in the 60° to 90° zone is achieved, but advantageously combined with an increase of light in the 0° to 60° zone, and therefore with an actual improvement in the utilizable light output from the lamp.

For further objects and advantages and for a detailed description of a preferred embodiment of the invention, 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 front elevation view of a reflector type high-pressure mercury vapor lamp embodying the invention.

Fig. 2 is a plan view of the arc tube of the same lamp showing part of the supporting mount structure therefor.

Fig. 3 is a graph comparing the candlepower distribution curve of the lamp of Fig. 1 with that of a prior reflector type lamp.

Referring to Fig. 1 of the drawing, the lamp illustrated therein comprises a glass bulb **1** having a tubular reduced diameter neck portion **2** to the end of which is sealed a re-entrant stem **3** having a press **4** through which extend relatively stiff inlead wires **5**, **6**. To the upper end of the neck is cemented the usual screw type base **7**, the inleads **5**, **6** being connected respectively to the threaded shell **8** and insulated center contact **9** thereof.

The neck portion **2** extends downwardly into a flaring bowl portion **11** which terminates at the plane MM where it achieves its maximum diameter. The glass bulb **1** is symmetrical and formed as a surface of revolution about the longitudinal axis LL. The bowl portion **11** is formed principally of a minor radius A portion at the shoulder and a major radius B portion forming the sides down to the plane of maximum diameter MM. The shoulder is merged into the neck through a reverse curve formed with a relatively short radius C. The bowl portion is coated with a light-transmitting layer **12**, for instance an internal coating of silver, from the region **13** in the neck portion approximately to the maximum diameter plane MM. The light-transmitting convex end face **14** is formed to a relatively long radius D which is merged into the radius B of the bowl portion through shorter radii E.

The inner arc tube **15** within the bulb **1** is made of quartz and contains a small quantity of mercury and a starting gas such as argon. The arc discharge takes place through main thermionic electrodes **16**, **17** at opposite ends of the arc tube, an auxiliary electrode **18** being provided at one end to facilitate starting. The arc tube illustrated has its ends closed by pinch seals **21**, **22** through which extend molybdenum foils which have internal extensions into the arc tube to support the electrodes and external extensions to provide current terminals.

The arc tube has an overall length greater than the diameter of the neck portion of the reflector bulb, and comparable to the axial length of the bowl portion. The axial length may be taken as the distance measured

along the axis from the juncture of the bowl portion with the neck portion, to the maximum diameter plane MM. The juncture of the bowl and neck portions may also be taken as occurring where a smooth curve tangent to the shoulder curves of radius A would cut off the neck portion. In general the invention is most advantageous with bulbs having a reflecting bowl portion with an axial length in the range of 50% to 100% of its maximum diameter, and with an overall arc tube length not substantially less than the axial length of the bowl portion, for instance not over 30% less. In the illustrated embodiment, the axial length of the bowl portion is approximately ⅔ the maximum diameter, and the overall length of the arc tube is roughly equal to the axial length of the bowl portion, being in fact about 10% greater.

The arc tube must be inserted axially through the neck portion and thereafter tilted into a horizontal position. This may be achieved through the mount structure shown which comprises wire collars **23**, **24** wrapped around seals **21**, **22** at the regions where they are necked slightly next the ends of the arc tube proper. The ends of wire collar **23** are formed into an eyelet **25** which provides a hinge connection to the laterally offset end of mount support rod **26** welded to inlead **5** of the bulb. The ends of wire collar **24** are formed into a loop **27** which make a sliding fit on mount support rod **28** likewise welded to inlead **5**.

To insert the arc tube and mount structure into the bulb, the arc tube is pivoted at **25** on mount support rod **26** and loop **27** is slid up mount support rod **28**. Rods **26** and **28** are manually squeezed together with the arc tube pivoted into an acute angle to the axis of the stem. In this position, the arc tube and mount assembly can be inserted through the neck of the bulb. Once inside the bulb, the arc tube is pivoted into a horizontal position by reaching in through the neck with a slender rod and forcing the uptilted end of the arc tube down so that loop **27** slides down along mount support rod **28** until it latches into the open hook **29** formed in the end thereof. The rods **26**, **28** are thus forced apart and their tendency to spring back together exerts pressure on eyelet **25** and loop **27** which holds the arc tube in horizontal alignment intermediate the maximum diameter of the bowl portion and its juncture with the neck portion. A heat disk **31** of polished metal previously welded by tab **32** to support rod **26** and provided with a slotted aperture **33** accommodating support wire **28**, is then bent down normal to the axis of the lamp so as to close the neck of the bulb and reflect both radiant heat and light back into the bowl portion **11** of the bulb.

The electrical connections to the arc tube are made through inlead **5** and mount support rod **26** to wire collar **23** and thence through flexible strap **34** to main electrode **16**; and through mount support rod **28** to wire collar **24** and thence through current limiting resistor **35** to auxiliary starting electrode **18**. The connection from inlead **6** to the other main electrode **17** is made through a flexible wire **36** which is sheathed with glass tubing insulators **37** in the region where the wire goes through slot **33** in heat disk **31**, the insulators being retained in place on the wire by a crimped tab **38**.

For best results, the arc tube **15** should be supported in a plane about midway between the maximum diameter region of the bowl portion at MM where the reflecting coating terminates and the upper end of the bowl portion or its juncture with the neck portion about where heat disk **31** is located. If the arc tube is lowered too much into the bowl portion, there is more spreading of light beyond the 0° to 60° zone and more glare in the 60° to 90° zone. On the other hand, if the arc tube is raised too high into the bowl portion towards the neck, trapping of light occurs resulting in a reduction in the total utilizable light output from the lamp.

By mounting the arc tube horizontally as illustrated, the improved efficiency of the reflector system more than compensates for the fact that there are some losses in the total lumens produced by the arc tube when changing from a vertical to a horizontal mounting. It is known that when an arc tube is operated horizontally, there is a loss of about 4.5% in efficiency, for example from 44.7 to 43.0 lumens per watt (these figures have reference to the total light output from the arc tube mounted in a clear container and without reference to a reflector type envelope). It is also known that horizontal operation causes a decrease of about 2.6% in lamp wattage when operated from a typical ballast due to increase of the voltage drop across the arc tube at a given current. These results are due to the tendency of the arc or luminous chord within the arc tube to bend upward closer to the side wall of the tube, resulting in lengthening of the arc and operation at a cooler temperature where the efficiency of generation of light is less. Thus previous studies lead to the expectation of a total reduction in light output of approximately 7% in changing over from vertical to horizontal operation of the arc tube. Despite these unfavorable indications, we have found in the reflector type lamps of the present invention an increase in utilizable light output, that is in the light radiated in the 0° to 60° zone, of approximately 24%. Further, we have found a reduction of light in the 60° to 90° zone of approximately 75%, thereby reducing the glare by a factor of almost 4 to 1.

Table 1 below gives the percent lumens obtained in the various zones with comparable reflector type lamps, in the one case with a vertically mounted arc tube according to prior practice, and in the other with a horizontally mounted arc tube according to the present invention.

Table 1

Zone (Degrees)	Percent Total Lumens	
	Vertical	Horizontal
0-30	21.0	24.1
0-40	36.9	42.0
0-60	71.2	91.8
0-90	95.7	98.1
0-180	100.0	100.0
60-90	24.5	6.3

The reflector bulb in each case has the configuration illustrated in Fig. 1 with an overall length of approximately 11½″, a maximum diameter of the bowl portion of 6.5″, and an axial length of the bowl portion of approximately 4.4″. The arc tube in each case has an overall length of 4.8″ measured to the ends of the seals, an outer diameter of 0.8″ and an arc gap length between the tips of the electrodes of approximately 2.5″. In the case of the vertically mounted arc tube, the lamp has a light center length, that is a distance measured from the center contact **9** of the base to the center of the arc tube of 7¾″; for the horizontally mounted arc tube, the light center length is 7¼″.

Fig. 3 illustrates the comparative candlepower distribution obtained with the lamps. Curve **40** gives the candlepower distribution of the reflector type lamp with the vertically mounted arc tube, whereas curve **41** gives that of the lamp having the horizontally mounted arc tube in accordance with the present invention. It will be observed that curve **40** shows substantial candlepower above the 60° angle, whereas curve **41** for the horizontally mounted arc tube shows only negligible candlepower above the 60° angle. It will be appreciated that curves **40** and **41** represent substantially equal total lumens despite the smaller area enclosed by the former. In integrating the candlepower distribution curves through the various zones to determine the total lumens, the zonal constant which is proportional to the periphery of the zone at the unit sphere surface, increases from 0°

to 90°, and equalizes the total lumens represented by the two curves.

Curves 40 and 41 were determined with the lamp rotating within a photometer in order to obtain the mean candlepower around the axis of the lamp at the various angles of elevation. With the horizontally mounted arc tube, the beam patter is not perfectly circular but shows a slightly elliptical distribution of intensity in a horizontal plane with the major axis oriented in the plane of the axis of the arc tube. By providing a light frosting to the convex end face 14 of the bulb, the distribution of intensity in a horizontal plane can be made more nearly uniform and patterns and shadows in the light cone substantially eliminated. For this purpose we prefer to use a frost known in the trade as a No. 4 frost just sufficient to blur the outlines of the arc tube when seen through the end face of the bulb.

While a certain specific embodiment of the invention has been shown and described in detail, it is intended primarily as illustrative and not as limitative of the invention. Various modifications for adapting the present construction utilizing a horizontally mounted arc tube within a reflector type bulb to other sizes and ratings of arc tubes with appropriate reflector bulbs will readily suggest themselves to those skilled in the art. It will be understood furthermore that the invention is not to be regarded as limited to the specific tilting frame and mount support combination which has been described for allowing the arc tube to be inserted through the narrow neck of the bulb. The appended claims are intended to cover any modifications coming within the true spirit and scope of the invention.

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

1. An electric lamp comprising a glass bulb generally symmetrical about its longitudinal axis and having a tubular neck portion extending along said axis and opening into a flaring bowl portion closed by a light-transmitting convex end face, said bowl portion being coated with a light-reflecting layer approximately up to its region of maximum diameter and having an axial length from 50% to 100% of its maximum diameter, an elongated mercury vapor arc tube within said bulb having an overall length greater than the diameter of said neck portion and not over 30% less than the axial length of said bowl portion, and a mount supporting said arc tube within the bowl portion transversely to said longitudinal axis and in a plane about midway between the maximum diameter of the bowl portion and its juncture with the neck portion.

2. A reflector type mercury vapor lamp comprising a glass bulb forming a surface of revolution about its longitudinal axis and having a narrow tubular neck portion extending along said axis terminated at one end by a base and opening at the other into a flaring bowl portion, a light-transmitting convex end face closing the maximum diameter end of said bowl portion, said bowl portion being coated with a light-reflecting layer approximately up to its region of maximum diameter and having an axial length from 50% to 100% of its maximum diameter, a high pressure mercury vapor arc tube within said bulb comprising an elongated vitreous tube having an overall length greater than the diameter of said neck portion and approximately equal to the axial length of said bowl portion, and a mount supporting said arc tube within the bowl portion transversely to said longitudinal axis and in a plane about midway between the maximum diameter region of the bowl portion and its juncture with the neck portion.

3. A reflector type mercury vapor lamp comprising a glass bulb forming a surface of revolution about its longitudinal axis and having a narrow tubular neck portion extending along said axis terminated at one end by a base and opening at the other into a flaring bowl portion, a light-transmitting convex end face closing the maximum diameter end of said bowl portion, said bowl portion being coated with a light-reflecting layer approximately up to its region of maximum diameter and having an axial length about ⅔ its maximum diameter, a high-pressure mercury vapor arc tube within said bulb comprising an elongated vitreous tube having an overall length greater than the diameter of said neck portion and approximately equal to the axial length of said bowl portion, and a mount supporting said arc tube within the bowl portion transversely to said longitudinal axis and in a plane about midway between the maximum diameter region of the bowl portion and its juncture with the neck portion.

4. A lamp as defined in claim 3 having a light frosting on the convex end face.

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