

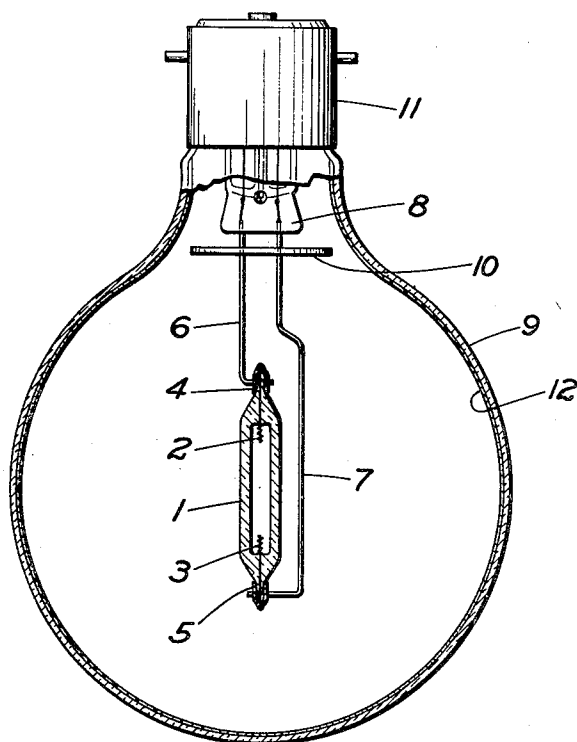
Nov. 8, 1938.

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2,135,690

GASEOUS ELECTRIC DISCHARGE LAMP DEVICE

Filed Sept. 14, 1937



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UNITED STATES PATENT OFFICE

2,135,690

GASEOUS ELECTRIC DISCHARGE LAMP
DEVICE

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Application September 14, 1937, Serial No. 163,850
In Germany September 24, 1936

4 Claims. (Cl. 176—124)

The present invention relates to gaseous electric discharge lamp devices generally and more particularly the invention relates to such devices having luminescent material associated therewith to complement and supplement the light emitted by the device. The light emitted by these devices has a line spectrum and phosphorescent materials, which transform the rays of shorter wavelength, particularly invisible rays, into rays of longer wavelength and in the visible range are useful in filling out the spectrum of the light emitted by the discharge device. Many of the phosphorescent materials are fluorescent as well as phosphorescent.

High pressure, mercury vapor discharge lamp devices comprising a sealed, tubular container of small bore having mounted in the ends thereof activated, thermionic electrodes heated to an elevated, arc discharge supporting temperature by the discharge incident thereat, a starting gas and a quantity of mercury in the container are now known in the art. Discharge lamp devices of this type are capable of operation at vapor pressures in the order of 10 atmospheres and higher and are highly efficient light sources of small size. A characteristic of this type of lamp is the high wattage consumption thereof per unit of surface of the container wall. This is referred to hereinafter as the specific load on the device and for the sake of simplicity the inner surface of that part of the container surrounding the discharge path between the electrodes is used for determining the specific load. Usually in discharge lamps of this type the specific load is greater than 10 watts/cm.². An example of a device having a specific load of this order is one having an inside diameter of 4 mm., a distance of 20 mm. between the electrodes, a current load of 80 watts and a mercury vapor pressure of about 20 atmospheres during the operation of the device. The specific load of a device of this structure is about 32 watts/cm.². In addition to a high efficiency and a continuous spectrum imposed upon a line spectrum such devices have a high surface brightness.

The invention relates particularly to lamps of the above type having a specific load greater than 10 watts/cm.² and mounted in a sealed bulb which serves as a heat conservator for the device which bulb has a coating of phosphorescent material on the inner surface thereof. The object of the invention is to provide a lamp unit of the above type which is a highly efficient, practical light source. Still further objects and advantages attaching to the device and to its use and operation will be apparent to those skilled in the art and from the following particular description.

It has been the practice heretofore in lamps of the above type to select for the outer bulb a bulb similar in size to an incandescent lamp bulb in

which is dissipated the same number of watts as in the discharge lamp device. We have discovered, however, that when phosphorescent materials are applied to the inner surface of said bulb the efficiency of the lamp increases as the dimensions of the bulb increase. This result is unexpected because with a larger bulb the phosphorescent material is at a lower temperature during the operation of the device than is the case with a smaller bulb. This lower temperature of the phosphorescent results in a delay of the reversion of the excited centers of the material into the normal condition. This would normally cause a reduction in the efficiency of the phosphorescent material and, of course, of the whole lamp device. We have discovered, and demonstrated, that such a reduced efficiency does not take place and that, in fact, the efficiency of the lamp increases as the phosphorescent surface of the bulb increases. This increase is not a uniform one and while a large increase takes place at first the increase in efficiency becomes smaller with a further increase of the phosphorescent surface of the bulb. Therefore, increasing the surface of the bulb indefinitely serves no useful purpose. Further, the advantages of the invention are obtained when the phosphorescent surface of the bulb exceeds a certain minimum. This minimum size of the phosphorescent surface of the bulb depends upon the specific load of the discharge device. According to the invention the surface of the phosphorescent surface of the bulb is at least $10 \times (B+15)^{2/3}$ cm.² where B represents the specific load of the device in watts. Preferably this surface is greater than $12 \times (B+15)^{2/3}$ cm.². The bulbs of the lamp units embodying the invention are considerably larger than those of incandescent lamps having the same wattage consumption. Preferably the phosphorescent surface of the bulb is smaller than $25 \times (B+15)^{2/3}$ cm.² since the increase in efficiency gained is offset by the difficulties in manufacture and transportation of the lamp device. Preferably the phosphorescent surface of the bulb conforms with the isolux-surface of the discharge device, that is, a surface on which the incident radiation is of uniform intensity.

In the drawing accompanying and forming part of this specification an embodiment of the invention is shown in a front elevational, partly sectional view.

Referring to the drawing the lamp unit comprises a gaseous electric discharge device having a tubular container 1 consisting of a vitreous material, such as quartz. Said tubular container 1 has an inside diameter of about 4 mm. and an outside diameter of about 7.5 mm. Said container 1 has activated, thermionic electrodes 2 and 3 mounted therein at the ends thereof, a starting gas, such as argon, and a quantity of

mercury therein. Said electrodes 2 and 3 consist of a tungsten core coated or impregnated with an electron emitting material, such as barium oxide, and are heated to an electron emitting, arc discharge supporting temperature by the discharge incident thereat. Said electrodes 2 and 3 are separated a distance of about 18 mm. The current leads for said electrodes 2 and 3 are connected to the metal caps 4 and 5 respectively mounted on the outside of the said container 1. Said container 1 is mounted in the bulb 9 and is supported therein by the current leads 6 and 7, which are fused into the press 8 of the bulb 9. Said current leads 6 and 7 are connected to the caps 4 and 5, respectively. A baffle 10 consisting of heat resisting, electrically insulating material, such as mica, is mounted on said leads 6 and 7 between the electric discharge device and the press 8 of the bulb 9. Said bulb 9 consists of one of the usual container glasses, such as lead glass or lime glass, and is provided with a bayonet base 11. The inner surface of the bulb 9 has a coating 12 thereon of phosphorescent material, such as zinc cadmium sulphide. This material is emissive in the yellow spectral ranges. Said coating 12 is applied to said bulb 9 by using a binding material, such as phosphorus pentoxide dissolved in methylalcohol. Said bulb 9 is evacuated after the coating 12 has been applied thereto and the discharge device mounted therein. When desired, the bulb 9 is filled with an inert gas, such as nitrogen, after evacuation.

The inner surface of the part of the container 1 surrounding the discharge path between said electrodes 2 and 3 has an area of 2.25 cm.². When 75 watts is dissipated in the arc the specific load of the tube is thus approximately 33 watts per cm.².

When the inside diameter of the spherical part of the bulb 9 is 10 cm. so that the area of the inner surface of the bulb 9 is about 314 cm.², the efficiency of the lamp unit, that is the number of international lumens of visible light per watt consumed by the device, is 51 lumens per watt. When the diameter of the bulb 9 is decreased to 9 cm. so that the inner surface of said bulb 9 has an area of about 255 cm.² the efficiency of the lamp is 47.5 lumens per watt. When the diameter of the bulb 9 is decreased until still further to about 8.5 cm. so that the inner surface of the bulb 9 with an area of about 225 cm.² the efficiency of the lamp is about 46 lumens per watt.

When the diameter of the bulb 9 is increased above 10 cm. the efficiency of the lamp unit does not increase as much as in the above examples. For example, with a bulb diameter of 11 cm. the efficiency of the lamp unit is 52 lumens per watt and with a diameter of 15 or 20 cm. the efficiency is 55 or 56 lumens per watt respectively.

Preferably the inner phosphorescent surface of the bulb 9 is increased by increasing the diameter of the bulb and retaining the spherical shape thereof and not by forming corrugations on said surface. When the spherical shape of the bulb is retained the phosphorescent material is more evenly applied than in the case of a corrugated surface and the light emitted by the lamp unit is evenly distributed.

While we have shown and described and have pointed out in the annexed claims certain novel features of the invention, it will be understood that various omissions, substitutions and changes

in the forms and details of the device illustrated and in its use and operation may be made by those skilled in the art without departing from the broad 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 in combination a high pressure mercury vapor discharge lamp device capable of operation with a current load higher than 10 watts per square cm. of the inner surface of that part of the container thereof surrounding the discharge path in said device, a sealed bulb having a phosphorescent inner surface enclosing said device, the area of said phosphorescent surface being greater than

$$10 \times (B + 15)^{1/2} \text{ cm.}^2$$

where B represents the specific load of the device in watts, and means to supply B watts to said lamp device.

2. An electric lamp comprising in combination a high pressure mercury vapor discharge lamp device capable of operation with a current load higher than 10 watts per square cm. of the inner surface of that part of the container thereof surrounding the discharge path in said device, a sealed bulb having a phosphorescent inner surface enclosing said device, the area of said phosphorescent surface being greater than

$$10 \times (B + 15)^{1/2} \text{ cm.}^2$$

and smaller than

$$25 \times (B + 15)^{1/2} \text{ cm.}^2$$

where B represents the specific load of the device in watts, and means to supply B watts to said lamp device.

3. An electric lamp comprising in combination a high pressure mercury vapor discharge lamp device capable of operation with a current load higher than 10 watts per square cm. of the inner surface of that part of the container thereof surrounding the discharge path in said device, a sealed bulb having a phosphorescent inner surface enclosing said device, the area of said phosphorescent surface being approximately

$$12 \times (B + 15)^{1/2} \text{ cm.}^2$$

where B represents the specific load of the device in watts, and means to supply B watts to said lamp device.

4. An electric lamp comprising in combination a high pressure mercury vapor discharge lamp device capable of operation with a current load higher than 10 watts per square cm. of the inner surface of that part of the container thereof surrounding the discharge path in said device and a sealed bulb having a phosphorescent inner surface enclosing said device, the area of said phosphorescent surface being greater than

$$10 \times (B + 15)^{1/2} \text{ cm.}^2$$

where B represents the specific load of the device in watts, and means to supply B watts to said lamp device, said phosphorescent surface being coincident with the isolux-surface of the discharge lamp device.

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