May 19, 1970 D. A. LARSON 3,513,344

HIGH PRESSURE MERCURY VAPOR DISCHARGE LAMP CONTAINING LEAD IODIDE

Filed Dec. 19, 1967 2 Sheets-Sheet 1

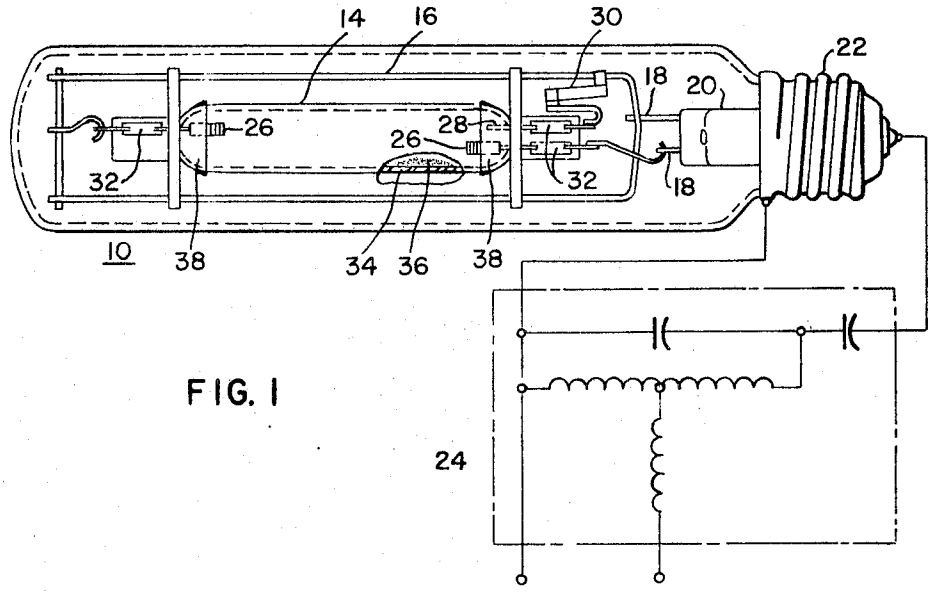


FIG. 1

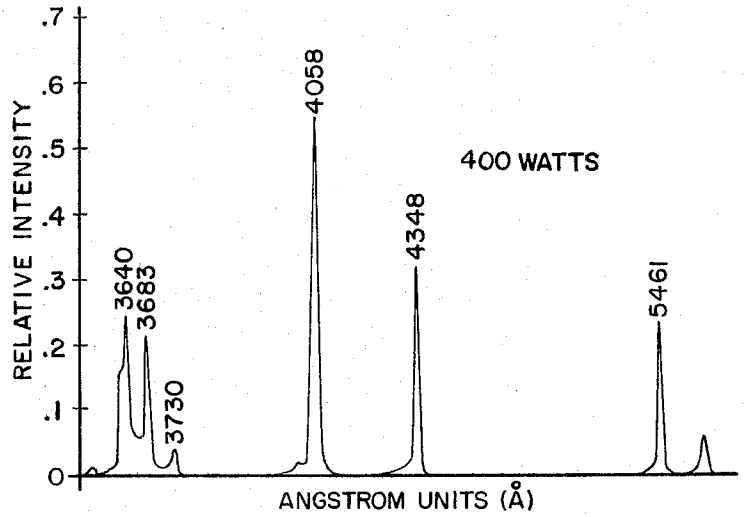


FIG. 2

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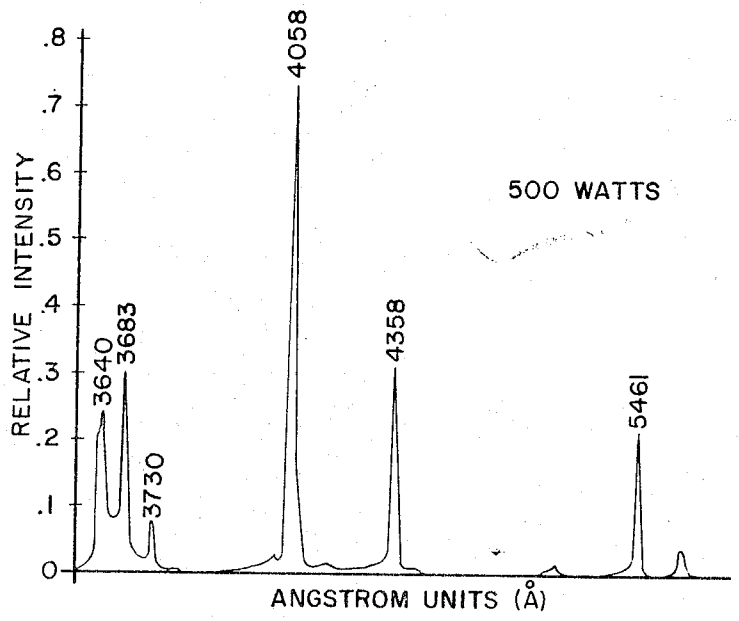

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RELATIVE INTENSITY
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500 WATTS
3640
3683
4358
5461
3730
ANGSTROM UNITS (Å)

FIG. 3

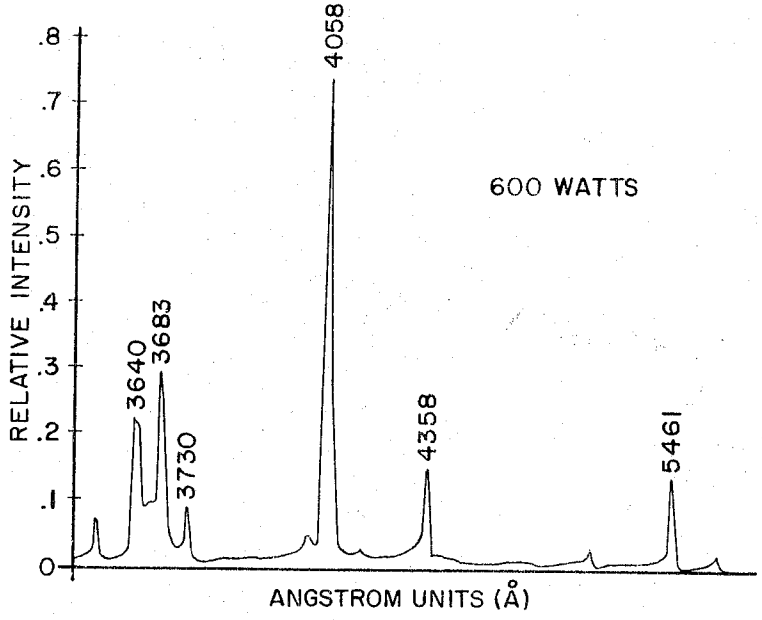

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RELATIVE INTENSITY
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ANGSTROM UNITS (Å)

FIG. 4

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3,513,344

HIGH PRESSURE MERCURY VAPOR DISCHARGE LAMP CONTAINING LEAD IODIDE

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U.S. Cl. 313—25 2 Claims

ABSTRACT OF THE DISCLOSURE

A high-pressure, mercury-vapor, (HPMV) discharge lamp of the additive type which includes, in addition to a small quantity of inert ionizable starting gas and about 3.0 milligrams of mercury per cubic centimeter of arc tube volume, a quantity of lead iodide (PbI) of about 0.5 to 1.5 milligrams per cubic centimeter of arc tube volume in the discharge sustaining fill. The lamp produces strong radiations at about 4058 angstrom units and between about 3600 and 3740 angstrom units and is particularly adapted for photocopying or as a black light radiator for the illumination of fluorescent signs.

BACKGROUND OF THE INVENTION

This invention relates to high pressure mercury vapor discharge lamps (HPMV lamps) and more particularly to a high pressure mercury vapor discharge lamp of the additive type which produces extremely strong radiations in the ultraviolet and blue spectral wavelengths.

High pressure mercury vapor discharge lamps (HPMV lamps) are well known and have been used extensively for highway and industrial lighting, as well as numerous other applications. Considerable effort has been expended in the recent past to improve both the color rendition and the efficiency of the high pressure mercury vapor arc lamp with a particular emphasis being placed on the utilization of metal and metal iodide additives to the mercury discharge. Several of the metal iodide additives have been found to produce a spectral continuum and hence the color rendition of the mercury vapor lamp has been to a large extent perfected into an excellent light source insofar as color rendition and efficiency are concerned. Little or no consideration has been given to the mercury additive lamp insofar as applications other than that of the area illumination are concerned. In this regard the major emphasis has been almost entirely on streetlighting, parking lot lighting, general outdoor lighting and interior industrial lighting. As will be seen the lamp of the present invention opens up entirely new fields to the HPMV lamp.

SUMMARY OF THE INVENTION

It has been discovered that an appropriate addition of lead iodide to a conventional high pressure mercury vapor discharge lamp's discharge sustaining filling will produce a very strong blue light in the area of 4058 angstrom units along with considerable energy in the 3650 angstrom unit region and provides a light source which has particular utility as a photocopying lamp or a black light source for illuminating fluorescent signboards.

The light source of the present invention is produced in a conventional HPMV lamp by employing within the arc tube a minor quantity of an inert ionizable starting gas along with a predetermined amount of mercury and a predetermined amount of lead iodide (PbI) which, when operated with a predetermined power input, will cause to occur complete vaporization of the mercury and substantial vaporization of the lead iodide to produce a strong blue light in addition to substantial radiations in the 3650 angstrom unit region of the ultraviolet.

BRIEF DESCRIPTION OF THE DRAWING

The foregoing attributes along with many other advantages of the present invention will become readily apparent as the following detailed description is considered in connection with the accompanying drawing, in which:

FIG. 1 is an elevational view with part of the outer envelope broken away of an HPMV lamp constructed in accordance with the present invention and connected to a conventional power source;

FIG. 2 is a spectral distribution diagram of the lamp of the present invention operated at 400 watts;

FIG. 3 is a spectral distribution diagram of the lamp of the present invention operated at 500 watts; and

FIG. 4 is a spectral distribution diagram of a lamp of the present invention operated at 600 watts.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The specific form of the invention illustrated in the drawing is generally similar in construction to the usual high pressure mercury vapor discharge lamp such as that described in U.S. Pat. No. 2,748,303 dated May 29, 1956, to Thorington. The lamp, generally designated **10**, includes a radiation transmitting sealed outer envelope **12** based from and surrounding an inner envelope or arc tube **14**. The inner envelope **14** is conventionally mounted within the outer envelope **12** by means of a supporting frame **16** carried by one of the two lead-in conductors **18**, each of which is sealed to the outer envelope **12** by a conventional reentrant stem press **20** connected to a standard mogal base **22**. Mogal base **22** facilitates the electrical connection of the lamp to a conventional power source **24** in the well known manner.

Sealed within the inner envelope **14** and disposed at opposite ends thereof are a pair of tungsten operating electrodes **26**. Adjacent one of the operating electrodes **26** is a tungsten starting electrode **28**. Each of the electrodes **26**, **26** and **28** are electrically connected to lead-in conductors **18**. A starting resistor **30** is connected between the starting electrode **28** and one of the lead-in conductors **18**. Ribbon conductors **32** are employed to facilitate the hermetically sealing of the electrodes **26**, **26** and **28** through the ends of the inner envelope **14**.

Within the inner envelope or arc tube **14** there is disposed a predetermined amount of mercury **34**, small charge of an inert ionizable starting gas, and a predetermined amount of lead iodide **36**. The charge of mercury is such that when the mercury is fully vaporized, during operation of the lamp, the proper voltage drop across the lamp and proper power input to the lamp will be realized. The mercury is preferably in an amount of about 3.0 milligrams per cubic centimeter of arc tube volume. The predetermined amount of lead iodide is preferably about 0.5 to 1.5 milligrams per cubic centimeter of arc tube volume and is such that when substantial vaporization of the lead iodide occurs, during operation of the lamp, a radiation spectrum similar to that illustrated in FIGS. 2 through 4 will be produced.

In order to provide for substantial vaporization of the lead iodide, it is desirable that the cold spot temperature (i.e. the coldest spot on the surface of the arc tube) be in excess of 600° C. Since normally the coldest spot on the surface of the arc tube is that portion of the arc tube behind the electrodes **26**, the ends of the arc tube may be coated as indicated at **38** to provide some insulation and hence maintain the desired temperature levels. One material which provides a satisfactory end coating for arc

tubes is a homogeneous mixture of zirconium oxide and Cab-O-Sil. Cab-O-Sil is a finely aerated silica sold under the trade name Cab-O-Sil by the Cabot Corporation of Boston, Mass. The need for an end coating is of course dictated by the particular arc tube configuration and more importantly the volume and spacing between the electrode and the adjacent end of the arc tube.

While the teachings of the present invention are applicable to lamps and discharge devices of varying size and designed wattage inputs, a specific example of a lamp constructed in accordance with the present invention is illustrated as a standard 400 watt quartz arc tube **14** having a 22 millimeter outside diameter and about 22 cubic centimeters of internal volume. Such a lamp when charged with a discharge sustaining filling of about 66 milligrams of mercury, 25 milligrams of lead iodide and about 25 millimeters of an inert ionizable starting gas such as, for example argon, will produce the spectral distributions illustrated in FIGS. 2, 3 and 4 when respectively operated at 400, 500 and 600 watts. When the lamp is operated at 400 watts, the voltage drop across the lamp is approximately 158 volts and the output approximately 12,500 lumens. When operated at 500 and 600 watts, the voltage drop is 162 volts and 175 volts respectively with a lumen output in each case is about 13,500 lumens. Lamps of similar geometry have been operated with lead iodide charges varying from about 10 milligrams up to about 30 milligrams with outputs up to 22,500 lumens and in each case a spectral energy distribution similar to that illustrated in FIGS. 2 through 4 has been produced.

As illustrated in FIGS. 2, 3 and 4 a very strong energy level is achieved at about 4058 angstrom units which is attributed to the lead and provides a portion of the very strong blue light produced by the lamp of the present invention. Additionally, as will be seen from FIGS. 2 through 4 a broad band energy level is produced between 3640 and 3730 angstrom units in the ultraviolet. With the very strong lead line at 4058 and the broad band radiations on each side of about 3683 angstrom units, a light source is available which is particularly adapted for photocopying and for illuminating fluorescent signboards of both the after dark and daylight types.

Referring again to FIG. 1 of the drawings, in operation, when the lamp **10** is initially started a discharge will be established between the tungsten starting electrode **28** and the adjacent operating electrode **26** through the argon or other starting gas. A straight tungsten wire is employed for the starting electrode to minimize any reaction between the starting electrode and the lead iodide which can produce a black deposit on the walls of the inner envelope **14**. Thereafter, a discharge will be established between the two operating electrodes **26** which will heat all of the mercury charge **34** to a fully vaporized condition. As the mercury becomes fully vaporized the operating temperature of the arc tube **14** will increase to a point at which the coolest point on the inner wall of the arc tube is in excess of 600° C., at which time a substantial portion of the lead iodide will be vaporized. With a substantial portion of the lead iodide vaporized, the lamp will produce a strong bluish light and evidence a spectral distribution substantially as illustrated in FIGS. 2 through 4.

As will be readily apparent from the foregoing, the lamp of the present invention is quite similar to a conventional high pressure mercury vapor discharge lamp with the exception of the additive, lead iodide, which when substantially vaporized produces a light source having strong blue radiations as well as upper scale ultraviolet radiations in the area of 3683 angstrom units and is

particularly adapted for photocopying processes since most conventional photocopy paper is activated by radiations between about 3600 and 4100 angstrom units and is lamp of the present invention is also a fine black light source for illuminating fluorescent signboards.

While the preferred embodiment of the present invention has been illustrated and described in detail, it is to be particularly understood that the invention is not limited thereto or thereby.

I claim as my invention:

1. A discharge lamp comprising:

a radiation transmitting elongated arc tube enclosing a predetermined volume;

arc supporting electrodes disposed within said arc tube adjacent the ends thereof;

lead-in conductors connected to said electrodes and sealed through said arc tube; and

a discharge substaining filling within said arc tube comprising, a minor quantity of inert ionizable starting gas, a predetermined amount of mercury, and from about 0.5 to 1.5 milligrams of lead iodide per cubic centimeter of arc tube volume, whereby upon full vaporization of said mercury and substantial vaporization of said lead iodide a spectral distribution particularly adapted for photocopying and illumination of fluorescent signboards is produced.

2. A discharge lamp of the high pressure mercury vapor type, said lamp adapted to be operated with a predetermined power input and comprising;

a radiation transmitting elongated arc tube enclosing a predetermined volume;

a light transmitting envelope spaced from and surrounding said arc tube;

arc supporting electrodes disposed within said arc tube adjacent the ends thereof;

lead-in conductors connected to said electrodes and sealed through said arc tube; and

a discharge sustaining filling within said arc tube, said filing comprising a minor quantity of inert ionizable starting gas, about 3.0 milligrams of mercury per cubic centimeter of arc tube volume and from about 0.5 to 1.5 milligrams of lead iodide per cubic centimeter of arc tube volume, whereby upon full vaporization of said mercury and substantial vaporization of said lead iodide during operation of said lamp said predetermined power input bears such relationship to the thermal conductivity of the arc tube that the minimum temperature on said arc tube is at least 600° C. producing strong spectral radiations in the areas of 4058 and 3683 angstrom units.

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C. R. CAMPBELL, Assistant Examiner

U.S. Cl. X.R.

313—47, 184, 226, 229