United States Patent

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[54] HIGH PRESSURE MERCURY VAPOR DISCHARGE LAMP CONTAINING ZIRCONIUM IODIDE

2 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **313/229,** 313/184, 313/223, 313/225
[51] **Int. Cl.** **H01j 61/18**
[50] **Field of Search** 313/223, 224, 225, 226, 227, 228, 229

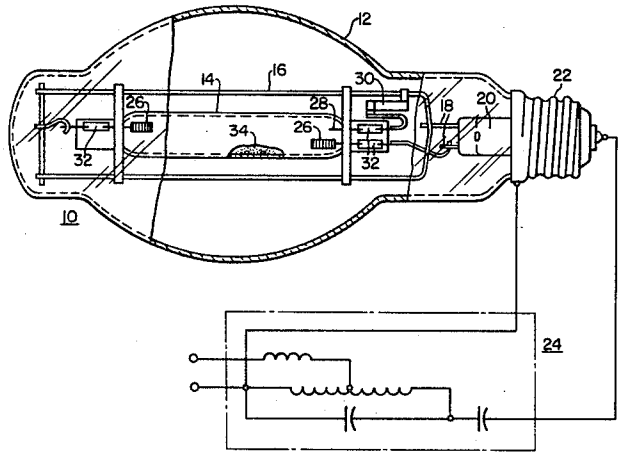
[56] **References Cited**

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3,262,012	7/1966	Koury et al.	313/227X
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ABSTRACT: A high pressure mercury vapor (HPMV) discharge lamp of the additive type having a discharge sustaining filling which includes mercury from about 2.0 to 4.0 milligrams per cubic centimeter of arc tube volume, thallium iodide and sodium iodide in a combined amount of from about 1.0 to 2.5 milligrams per cubic centimeter of arc volume, zirconium iodide in an amount of about .03 to 0.3 milligrams per cubic centimeter of arc tube volume and a small quantity of inert ionizable starting gas whereby upon operation of the lamp a spectral distribution is produced which includes in addition to the sodium and thallium peaks a substantial continuum from the blue to the red.

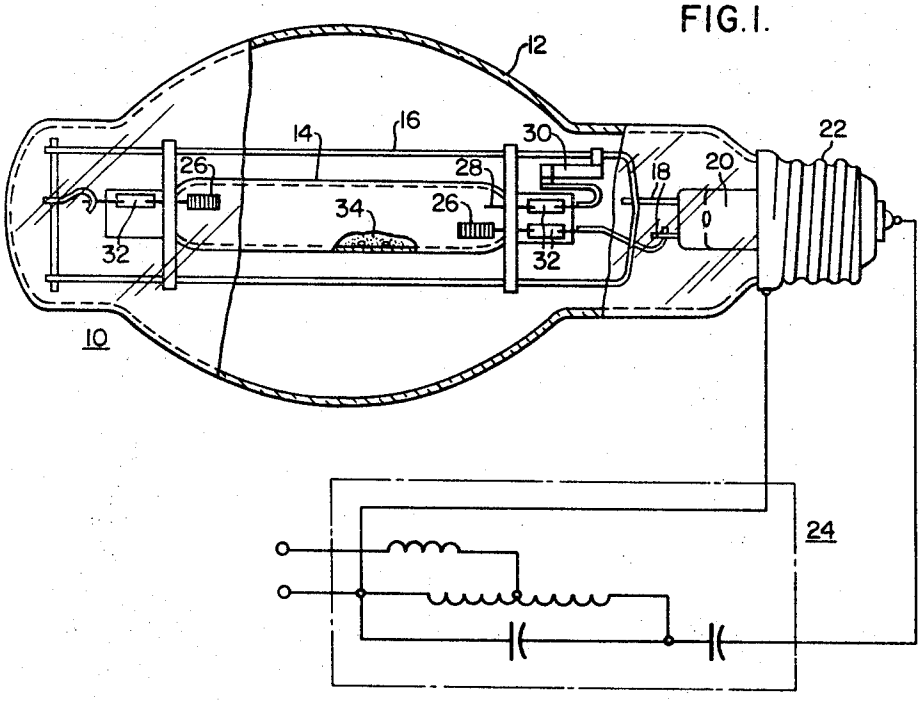


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SHEET 1 OF 2

FIG. 1.



WITNESSES

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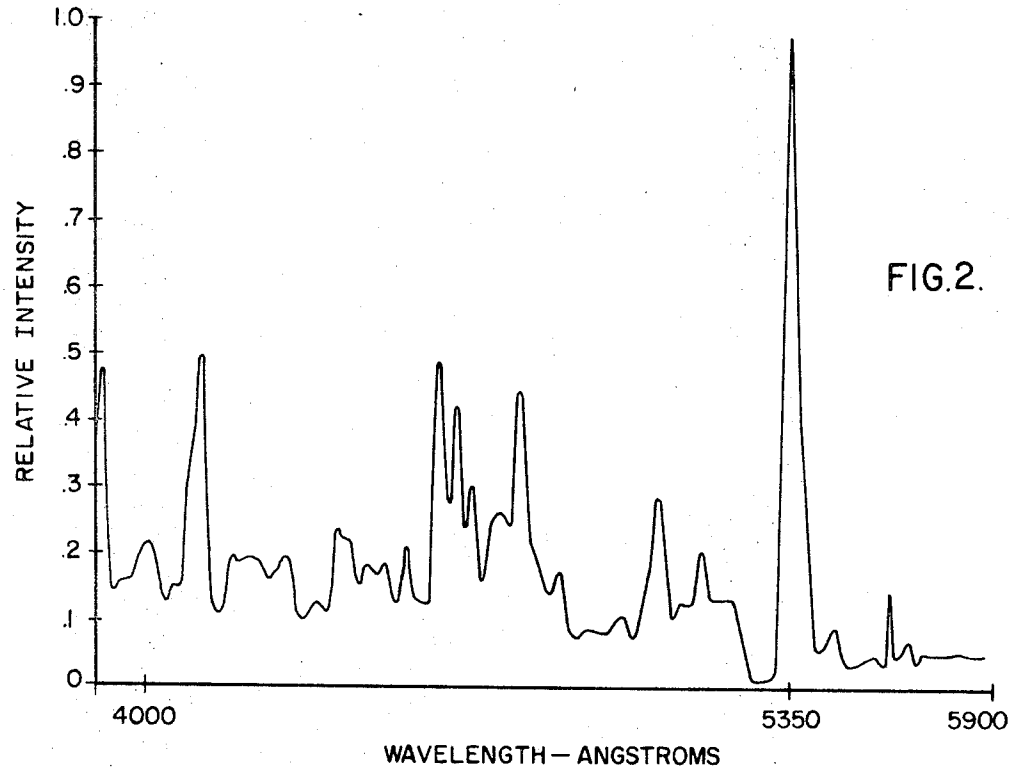

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FIG.2.

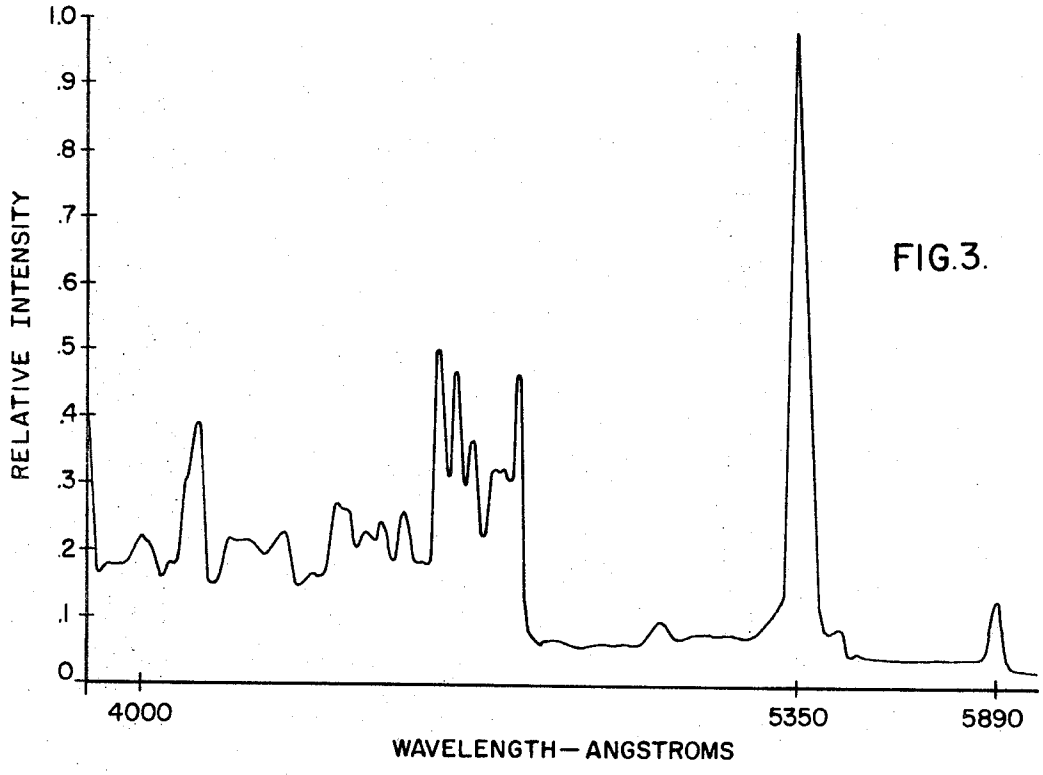

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FIG.3.

HIGH PRESSURE MERCURY VAPOR DISCHARGE LAMP CONTAINING ZIRCONIUM IODIDE

BACKGROUND OF THE INVENTION

This invention relates to discharge devices and more particularly to a high pressure, mercury-vapor, discharge lamp of the additive type wherein additive metal iodides of sodium, thallium and zirconium are utilized to supplement the usual mercury discharge.

The high pressure mercury vapor discharge lamp has been extensively adopted for highway, parking lot and industrial lighting purposes as well as a number of other applications. The pure, or noncolor corrected mercury lamp produces radiations which are concentrated primarily in the green and yellow areas of the spectrum and evidences a distinct lack of radiation in the blue-green as well as the orange and red spectral regions. Although the color emitted by the mercury lamp is not entirely displeasing, the color rendition of illuminated objects leaves something to be desired.

In recent years, the use of metal and/or metal iodide additives to the conventional mercury fill of the HPMV-type vapor lamp having in many cases improved considerably the color rendering ability of the discharge lamp. U.S. Pat. No. 3,234,421 to G. H. Reiling, issued Feb. 8, 1966 discloses a number of possible metallic halides which are said to improve both the efficiency and the color as compared with conventional mercury arc lamps. Additional metallic halides which may be used for this purpose are also disclosed by G. H. Reiling in an article entitled "Characteristics of Mercury Vapor Metallic Iodide Arc Lamps" appearing in the Journal of the Optical Society of America, Volume 54, No. 4, pages 532—540, Apr. 1964. The patentee and author states that the most efficient metal halides fall in the alkali metal group, the alkaline earth metal group and Group IIIB of the Periodic Table of elements.

A more recent development in the continuing effort to improve the color rendering ability of the mercury vapor lamp is the use of rare earth metal halides as an addition to the discharge sustaining fill of a high pressure mercury vapor discharge lamp. Many of the rare earth metal halides suitable for this purpose are disclosed in U.S. Pat. No. 3,334,261, issued Aug. 1, 1967 to K. H. Butler et al. The rare earth metal halides have been found to be particularly valuable in adding radiations in the red areas of the spectrum. Although color rendition has in many cases been substantially improved by the addition of metallic halides and rare earth halides to the discharge, some problems of even greater moment than lack of color rendition have been introduced. For example, some metallic iodides and rare earth iodides have a tendency to react with the arc tube and possibly with other arc tube parts during operation of the lamp causing the release of free iodine which in turn increases the voltage required to initiate the discharge and which will also attack other parts within the arc tube and hence reduce the lamp life considerably.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a high pressure gas discharge lamp of the additive-type which produces greatly improved color rendition of illuminated objects and maintains a high level of efficiency throughout its life as compared with the conventional HPMV lamp.

Another object of the present invention is to provide a high pressure gas discharge lamp of the additive-type which, while maintaining a high luminous output and efficiency, generates a substantially continuous spectrum of visible light.

Yet another object of the present invention is to provide a high pressure gas discharge lamp of the additive-type which includes zirconium iodide as one of the principal arc sustaining ingredients.

The foregoing objects along with others are achieved in accordance with the present invention by providing, in a high pressure gas discharge lamp, a discharge sustaining filling which includes predetermined quantities of mercury, sodium iodide, thallium iodide and zirconium iodide. More particularly, the discharge sustaining filling of the lamp of the present invention includes from about 2.0 to 4.0 milligrams of mercury per cubic centimeter of arc tube volume, from about 1.0 to 2.5 milligrams per cubic centimeter of arc tube volume of a combination of sodium iodide and thallium iodide, and from about 0.03 to 0.3 milligrams per cubic centimeter of arc tube volume of zirconium iodide in addition to a small amount of inert ionizable starting gas.

BRIEF DESCRIPTION OF THE DRAWING

The foregoing objects and others, along with many of the attendant advantages of the present invention will become more readily apparent and better understood as the following detailed description is considered in connection with the accompanying drawing, in which:

FIG. 1 is a side elevation view of an HPMV lamp of the present invention with a portion of the outer bulb broken away and connected to a conventional energizing power source;

FIG. 2 is a spectral distribution diagram of a typical lamp constructed in accordance with the present invention and operated at 400 watts; and

FIG. 3 is a spectral distribution diagram of a typical lamp constructed in accordance with the present invention and operated at 500 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 (HPMV) 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** spaced from and surrounding an inner envelope or arc tube **14**. The inner envelope **14** is conventionally mounted within outer envelope **12** by means of a supporting frame **16** carried by one of two lead-in conductors **18**, each of which is sealed through the outer envelope **12** by a conventional reentrant stem press **20** connected to a standard mogel base **22**. The mogel base **22** facilitates electrical connection to a power source **24** in a 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**. The starting resistor **30** is connected between the starting electrode **28** and one of the lead-in conductors **18**. Ribbon seals **32** of the well-known type, are employed in facilitate the hermetic 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 the discharge sustaining filling **34** of the present invention. The discharge sustaining fill preferably includes from about 2.0 to 4.0 milligrams of mercury (Hg.) per cubic centimeter of arc tube volume, from about 1.0 to 2.5 milligrams of a combination of sodium iodide (NaI) and thallium iodide (TlI) per cubic centimeter of arc tube volume and zirconium iodide (ZrI_4) in an amount of about 0.03 to 0.3 milligrams per cubic centimeter of arc tube volume. Additionally, of course, a small charge of inert ionizable starting gas such as for example argon is disposed within the arc tube **14** to facilitate starting.

The predetermined amount of mercury is chosen so that when the mercury is fully vaporized during operation of the lamp, the proper voltage drop across the lamp and the proper power input to the lamp will be realized. The predetermined amounts of sodium iodide and thallium iodide in the combination may vary substantially but is preferably about 50 percent of one and 50 percent of the other but may be as little as 10 percent of either. Since zirconium iodide is very difficult

to handle because it is somewhat hygroscopic and in fact will react with the atmosphere, it is preferable when initially manufacturing the lamp that a predetermined amount of zirconium metal and a predetermined amount of mercuric iodide be added to the arc tube. These amounts should be such that a sufficient amount of zirconium iodide will be formed during the initial operation of the lamp with some excess of zirconium metal remaining in order to eliminate or substantially limit any free iodine from being present in the arc tube during operation of the lamp.

As a specific example, the arc tube **14** of the type normally used in a 400 watt lamp will have an outside diameter of **22** millimeters and enclose a volume of about 22 cubic centimeters. The arc tube is charged with argon as the inert ionizable starting gas at a pressure of about 20 millimeters of mercury. Mercury in an amount of about 66 milligrams, sodium iodide in an amount of about 25 milligrams and thallium iodide in an amount of about 10 milligrams along with about 3 milligrams of mercuric iodide and 2 milligrams of zirconium metal are added to provide the discharge sustaining fill. When this lamp is operated the zirconium and mercuric iodide will react to form about 2 milligrams of zirconium iodide within the lamp and when operated at 400 watts the lamp will draw about 2.68 amps and have a voltage drop thereacross of approximately 179 volts with a lumen efficiency of about 80 lumens per watt. This lamp will produce a spectral emission diagram substantially as illustrated in FIG. **2**.

When the same lamp is operated at 500 watts it will draw a current of 3.5 amps and have a voltage drop of about 170 volts with an efficiency of about 90 lumens per watt after about **18** hours of operation. This lamp at 500 watts will produce a spectral distribution diagram substantially as illustrated in FIG. **3**. At 174 hours this lamp was still running at an efficiency of about 80 lumens per watt at 400 watts. As illustrated in FIGS. **2** and **3** the lamp of the present invention operates with a strong background continuum in the visible area of the spectrum with the strong sodium and thallium lines superimposed thereon. The lamp provides good color rendition of objects illuminated thereby.

Some examples of other lamps, constructed in accordance with the present invention and having discharge sustaining fills in accordance with the following chart, have operated successfully and produced exceptionally good color rendition while maintaining a high level of efficiency:

Lamp	A	B	C	D	E	F	G	H
Argon, mg	20	20	20	20	20	20	20	20
Hg, mg	66	48	66	66	66	45	66	66
NaI, mg	20	20	25	25	10	20	10	25
TlI, mg	10	3	10	10	25	3	25	25
ZrI_4	2	2	3	3	3	2	0.6	5.2

In operation the lamp **10** is initially started by the establishment of a discharge between the tungsten starting electrode **28** and the adjacent operating electrode **26** through the argon or other starting gas. Thereafter a discharge will be established between the two operating electrodes **26** which will heat all of the mercury charge 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 sodium iodide, thallium iodide and zirconium iodide will have been vaporized and the discharge will assume the characteristics of the zirconium iodide discharge illustrated in FIGS. **2** and **3**.

As will be apparent from the foregoing, the extremely good color rendition obtained by the lamp herein disclosed can be produced in a conventional arc tube when charged initially with a small quantity of inert ionizable starting gas such as for example argon and predetermined quantities of mercury, sodium iodide, thallium iodide and zirconium iodide.

Since numerous changes may be made in the above-described invention and different embodiments thereof may be made without departing from the spirit thereof, it is intended that all matter contained in the foregoing description or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A discharge lamp for producing a substantially continuous spectrum in the visible range, said 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 sustaining fill within said arc tube, said discharge sustaining fill comprising mercury in an amount of from about 2.0 to 4.0 milligrams per cubic centimeter of arc tube volume, sodium iodide and thallium iodide in a combined amount of from about 1.0 to 2.5 milligrams per cubic centimeter of arc tube volume, and zirconium iodide in an amount of from about 0.03 to 0.3 milligrams per cubic centimeter of arc tube volume along with a predetermined amount of inert ionizable starting gas, wherein upon full vaporization of said mercury and substantial vaporization of said sodium iodide, thallium iodide and zirconium iodide a continuous radiation spectrum in the visible region is produced.

2. A discharge lamp for producing a substantially continuous radiation spectrum in the visible range, 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 discharge sustaining filling comprising, a minor quantity of inert ionizable starting gas, mercury in an amount of from about 2.0 to 4.0 milligrams per cubic centimeter of arc tube volume which when fully vaporized during normal operation of the lamp will provide a predetermined mercury vapor pressure within said arc tube, a combined quantity of sodium iodide and thallium iodide of from about 1.0 to 2.5 milligrams per cubic centimeter of arc tube volume, and zirconium iodide in an amount of from about 0.03 to 0.3 milligrams per cubic centimeter of arc tube volume whereby upon full vaporization of said mercury and substantial vaporization of said sodium iodide, thallium iodide and zirconium iodide a continuous radiation spectrum is produced.