United States Patent [19]

Fridrich

[11] **3,714,493**

[45] **Jan. 30, 1973**

[54] **COMPACT METAL HALIDE ARC LAMP CONTAINING PRIMARILY MERCURY IODIDE**

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[73] Assignee: **General Electric Company**

[22] Filed: **April 6, 1970**

[21] Appl. No.: **25,672**

[52] **U.S. Cl.** **313/184,** 313/217, 313/220, 313/225, 313/228

[51] **Int. Cl.**.....**H01j 61/20**

[58] **Field of Search**.....313/184, 217, 220, 225, 228

[56] **References Cited**

UNITED STATES PATENTS

3,234,421	2/1966	Reiling	313/225 X
3,259,777	7/1966	Fridrich	313/184
2,697,183	12/1954	Neunhoeffer et al.	313/225 X
2,272,467	2/1942	Kern et al.	313/184 X
2,275,768	3/1942	Kern et al.	313/184 X

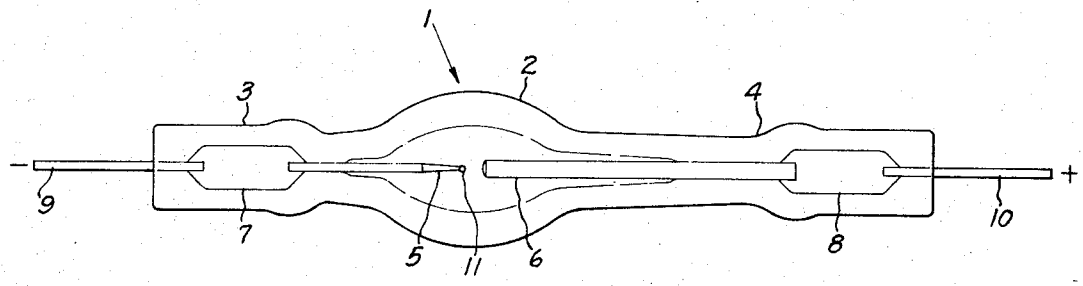
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[57] **ABSTRACT**

A compact very high brightness arc lamp operating with near molten electrode tips and using mercury iodide as the discharge medium, preferably with an excess of iodine. In the pressure range from 5 to 20 atmospheres, mercury iodide produces a high ratio of ultraviolet to visible radiation making the lamp particularly suitable for photochemical applications requiring a point source for high definition. As the pressure is increased, the spectrum first exhibits pronounced blue and green lines of mercury, and then gradually more red. At very high pressures in the range from 100 to 150 atmospheres, white light is produced with a sun-like continuum.

7 Claims, 2 Drawing Figures



PATENTED JAN 30 1973

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Fig. 1.

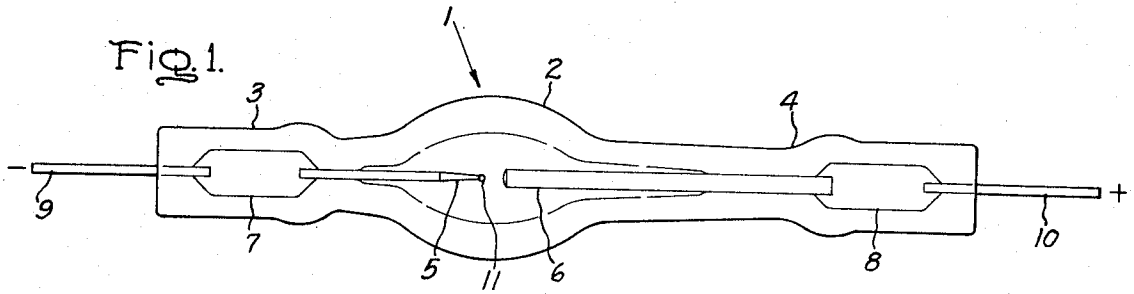
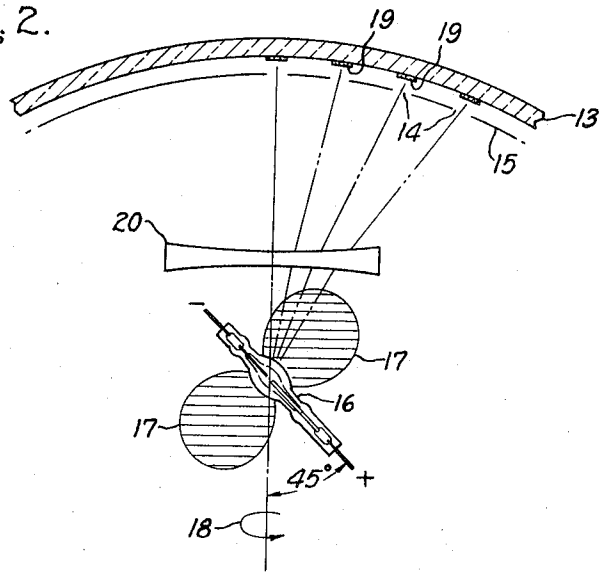


Fig. 2.



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COMPACT METAL HALIDE ARC LAMP CONTAINING PRIMARILY MERCURY IODIDE

BACKGROUND OF THE INVENTION

The invention relates to compact very high pressure arc lamps having small tungsten electrodes operating with their tips either molten or almost at the melting point in a metal halide discharge medium.

Lamps of the kind to which the invention pertains are described in my U.S. Pat. No. 3,067,357, "Electric Discharge Lamp Electrode," U.S. Pat. No. 3,259,777, "Metal Halide Vapor Discharge Lamp with Near Molten Tip Electrodes," and U.S. Pat No. 3,305,289, "Electric Lamp Manufacture." Such lamps in general comprise a thick-walled discharge envelope of vitreous silica which is of small volume in order to have a high input concentration. The inside diameter of the envelope or discharge cavity is usually less than 1 centimeter but may be greater in the lower pressure lamps. A pair of slender or rod-like tungsten electrodes are sealed into the ends of the envelope. They are correlated in heat-dissipating capacity to the energy loading of the lamp to operate with their tips either molten or at a temperature close to the melting point of the tungsten. The ionizable filling within the lamp includes an inert gas such as argon and either iodine or a metallic iodide which releases iodine at high temperatures. The metal iodides which have been used in these lamps are those of indium, gallium and thallium. Ordinarily, the lamps are operated with the electrode tips molten and a ball point forms on the top which is supported by surface tension. The iodine vapor within the envelopes serves to regenerate at the electrodes the tungsten which vaporizes from them.

For certain lamp applications it is desirable to have a source having very high surface brightness or intrinsic brilliancy and intense ultraviolet output. A lamp used for this purpose in the past is the so-called capillary very high pressure mercury arc lamp originally disclosed in U.S. Pat. No. 2.094,694 —Cornelis Bol et al. and designated FH6-1000W. These lamps were either cooled by an air blast or by a water jacket such as disclosed in U.S. Pat. No. 2,295,046 — **Noel. The cooling arrangements required by the capillary mercury lamp make it inconvenient for many applications and a lamp which more closely approaches a point source is desirable.**

Among the objects of the invention are to provide a source of high intrinsic brilliancy having the desired spectral distribution and high efficiency and which is convenient to use.

SUMMARY OF THE INVENTION

The preferred fillings in compact lamps of the present kind have been the iodides of difficulty vaporizable metals, particularly the iodides of indium, gallium and thallium. Mercury iodide was sometimes used in admixture with the iodides of the difficulty vaporizable metals but not by itself. I have now found that mercury iodide may be used as the main ingredient of the ionizable filling, preferably admixed with iodine, throughout a wide pressure range extending from about 5 atmospheres up to 150 atmospheres or even higher, the upper limit being set by the ability of the envelope to withstand the attack of the filling. The lamps have different characteristics and lend themselves to different applications at various pressures in the pressure range.

In the lowest pressure range extending from about 5 to 20 atmospheres, the arc has an intense ultraviolet output and exhibits a higher ratio of ultraviolet to visible radiation than a conventional compact source mercury lamp. The ultraviolet peaks at about 3,650 A when the pressure is about 10 atmospheres.

In the intermediate pressure range extending from about 20 to 70 atmospheres, the lamp's output shows pronounced blue and green lines of mercury and resembles the compact mercury vapor lamp in spectral quality.

In the higher pressure range extending from about 70 to 100 atmospheres, the spectral output resembles that of a high pressure mercury vapor lamp but with more red so that the color is appreciably whiter.

In the very high pressure range extending from about 100 to 150 atmospheres, the arc produces a flat spectrum white light and exhibits a sun-like continuum.

According to a feature of the invention, a large excess of iodine is provided along with the mercury iodide within the lamp envelope. The iodine cycle is thereby enhanced resulting in sparkling clean chamber walls throughout life even along the shanks of the electrodes. Also the volatility of the dose is increased which permits operation of the lamp under conditions of more vigorous cooling. With increased cooling, the lamp can be operated at a higher wattage for increased radiant output with little increase in the effective size of the source.

DESCRIPTION OF DRAWINGS

In the drawing:

FIG. 1 is a side view of a high pressure mercury iodide lamp embodying the invention.

FIG. 2 illustrates schematically a photochemical application of the lamp involving phosphor dot printing.

DETAILED DESCRIPTION

Referring to FIG. 1, the illustrated lamp 1 comprises a vitreous silica envelope having a bulb portion 2 provided with generally cylindrical extensions or necks 3,4. Electrodes 5,6 consisting of short lengths of tungsten wire or rod extend through the necks into the bulb cavity and are welded to molybdenum foils 7,8 which are hermetically sealed within the necks. External inleads 9,10 penetrate into the necks and are welded to the outer ends of the molybdenum foils. The illustrated lamp is intended for D.C. operation and the cathode electrode 5 is more slender and includes a tapered front portion which attains its smallest diameter immediately before the ball point or spherical tip 11. The lamp may operate with substantially molten cathode tip and the ball end 11 may be formed after completion of the lamp by operating it at a current or loading sufficient to melt back the electrode to the desired extent. The anode 6 is made of heavier tungsten wire or rod than the cathode in order to increase its heat dissipating capacity. The gap between the electrode tips is quite small, less than half the least diameter of the bulb cavity.

The illustrated lamp has no exhaust tip and the envelope may be processed into a lamp by the tipless sealing and flush filling method disclosed in my U.S. Pat.

No. 3,305,289, "Electric Lamp Manufacture." The filling is mercury iodide along with argon for an inert starting gas. In a preferred embodiment, a substantial excess of iodine is added to the filling of mercury iodide. By way of example, in a lamp such as illustrated in FIG. 1 wherein the overall length of the quartz body was 2.9 inches and the arc chamber volume was 0.12 cc, the dosage consisted of argon at 500 torr, 7 to 8 milligrams of HgI_2, and from 0.2 to 1.0 milligrams of iodine in excess over stoichiometric HgI_2 . The lamp had an electrode gap of 1 millimeter and was operated at about 10 atmospheres total pressure under 700 watts input, voltage 50 volts, current 14 amperes. The lamp provided a point source of 3,650 A radiation of high intrinsic brilliancy.

With excess iodine, the iodine regenerative cycle is enhanced and the chamber walls remain sparkling clean throughout life. In the cycle, free iodine reacts with tungsten at the bulb wall to form tungsten iodide which is decomposed at the electrode with redeposition of the tungsten thereat and liberation of the iodine to start the cycle over again. In addition, the excess iodine increases the volatility of the dose which permits operation of the lamp under conditions of more vigorous cooling. With increased cooling, the lamp can be operated at higher wattage which increases the radiant output including ultraviolet. The excess iodine does not cause any increase in the rate of foil or electrode corrosion.

Lamps according to the invention utilize an input load concentration between 1,000 and 15,000 watts per cubic centimeter of discharge volume. The discharge volume generally does not exceed 1 cc but may exceed it in the lower pressure lamps for producing ultraviolet radiation. The mercury iodide filling is entirely vaporized during operation and exerts a pressure above 5 atmospheres and extending up to 150 atmospheres or even higher. In order to have high intrinsic brilliancy and a compact arc which can be used as a point source to achieve high definition, a short arc gap not exceeding the maximum transverse dimension of the discharge volume or arc chamber is used.

One photochemical application in which the lamp has been found particularly useful is phosphor dot printing in the production of color television picture tubes. In phosphor dot printing, a phosphor layer is retained by a photosensitive binder on a glass plate **13** as shown schematically in FIG. **2**. The binder is initially soluble in water and exposure to ultraviolet causes it to polymerize and become insoluble. The binder is exposed through apertures **14** in a mask **15** to ultraviolet radiation originating from a source which ideally should be a point located at the same place as one of the three (green, blue, red) electron guns of the picture tube. A 90° cone of radiation is required which should be 20 percent more intense at the outer edge than in the center.

The foregoing requirements are met by lamp **16** previously described as an example of the invention which produces an intense spot of radiation less than 0.160 inch in diameter with a polar radiation distribution pattern of the familiar round wing shape illustrated by the hatching **17**. By rotating the lamp as indicated by curved arrow **18** with its longitudinal axis inclined at approximately 45° to the vertical axis of rotation, the non-uniform round wing shape radiation pattern may be utilized to obtain a time-averaged, circularly symmetrical radiation distribution close to the optimum desired. After exposure, the phosphor and binder layer is washed off and a dot pattern **19** remains where exposure took place. The procedure is repeated for each color and the location of the source **16** relative to the mask **15** is shifted appropriately. A lens **20** modifies the light distribution to achieve the same pattern as the electron guns. The lamp of the invention has a more favorable spectrum for the control of dot size and adhesion and an equivalent wattage compact mercury lamp would not fit into the physical confines of the optical system. This system using the lamp of the invention provides a tenfold increase in phosphor dot printing speed over a prior system using the capillary very high pressure mercury lamp, and is described and claimed in copending application Ser. No. 155,727 filed June 23, 1971, entitled "Optical System for Providing Uniform Exposure of a Photosensitive Surface," and assigned to the same assignee as the present invention.

THe lamp of the invention by reason of its long wave ultraviolet radiation and the small size and high intrinsic brilliancy of the source is also useful in other photochemical applications such as offset printing and printing of electronic printed circuits wherein it assures more precision and better definition than other available sources.

The higher pressure lamps according to the invention are particularly useful as light sources for optical applications where small source size and high intrinsic brilliancy are desired, and generally they are superior in such applications to conventional compact source mercury lamps.

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

1. A compact electric discharge lamp comprising a sealed envelope of refractory light-pervious material, electrodes projecting into said envelope of which at least one is a small tungsten rod serving as cathode correlated in heat-dissipating capacity to the input loading of the lamp whereby to operate with its tip at a temperature close to the melting point of tungsten, the input loading into said lamp being in the range of 1,000 to 15,000 watts per cubic centimeter, and an ionizable medium in said envelope consisting of an inert starting gas and a quantity of mercury and iodine forming mercury iodide exerting a pressure in the range of 5 to 150 atmospheres when totally vaporized in normal operation of said lamp.

2. A lamp as in claim **1** wherein the cathode electrode and the opposite main electrode define a short arc gap not exceeding the maximum transverse dimension of the arc chamber within said envelope.

3. A lamp as in claim **1** wherein there is an excess of iodine in said filling over the stoichiometric quantity in mercury iodide.

4. A lamp as in claim **1** wherein the transverse diameter of the arc chamber is less than 1 centimeter and wherein the operating pressure is in the range of 5 to 20 atmospheres to provide a point source of ultraviolet radiation of high intrinsic brilliance.

5. A lamp as in claim **1** wherein there is an excess of iodine in said filling over the stoichiometric quantity in mercury iodide and wherein the cathode electrode and

the opposite main electrode define a short arc gap not exceeding the maximum transverse dimension of the arc chamber within said envelope.

6. A lamp as in claim 1 wherein there is an excess of iodine in said filling over the stoichiometric quantity in mercury iodide and wherein the transverse diameter of the arc chamber is less than one centimeter and wherein the operating pressure is in the range of 5 to 20 atmospheres to provide a point source of ultraviolet radiation of high intrinsic brilliance.

7. A lamp as in claim 1 wherein there is an excess of iodine in said filling over the stoichiometric quantity in mercury iodide and wherein the transverse diameter of the arc chamber is less than one centimeter and wherein the operating pressure is in the range of 70 to 150 atmospheres to provide white light with substantial continuous spectrum.

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