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MULTIPLE ENVELOPE HIGH PRESSURE MERCURY VAPOR DISCHARGE LAMP

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FIG. 1.

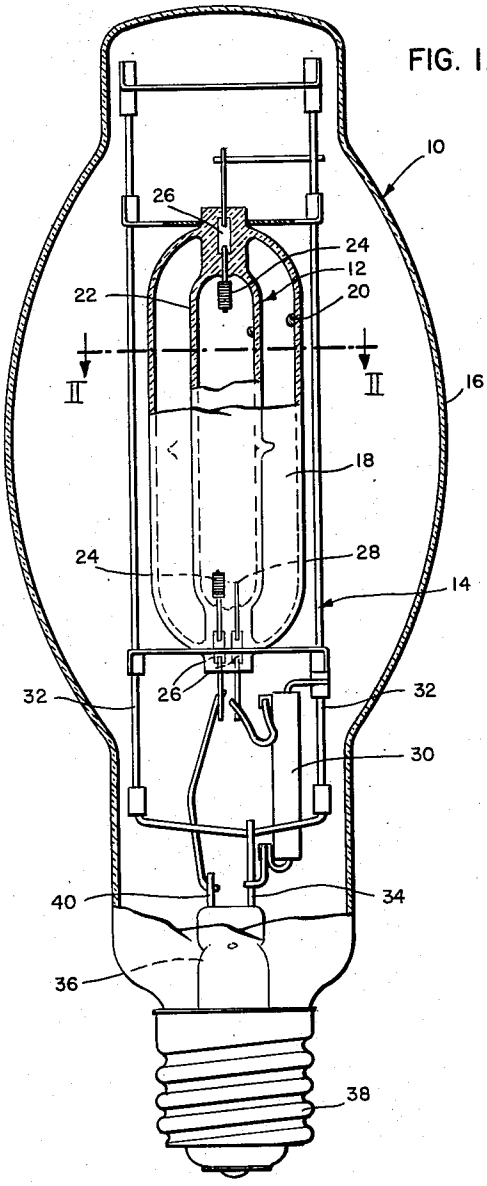


FIG. 2.

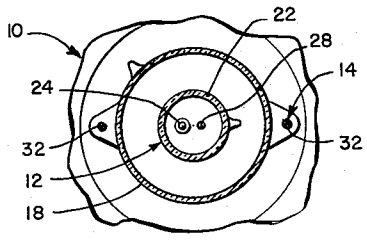
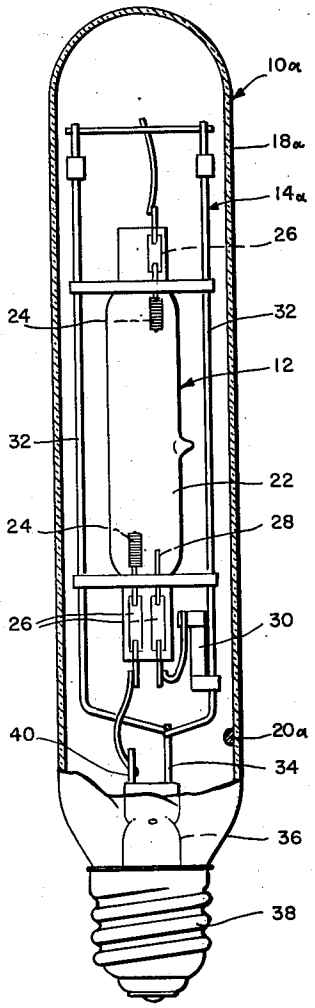


FIG. 3.



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MULTIPLE ENVELOPE HIGH PRESSURE MERCURY VAPOR DISCHARGE LAMP

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This invention relates to discharge devices and, more particularly, to discharge devices having improved light output.

Discharge devices such as high-pressure, mercury-vapor lamps (HPMV lamps) are extensively used for outdoor and factory illumination. The efficiency of these devices in generating visible light is excellent and a high-power source can be made relatively small, thereby eliminating the need for a large number of fixtures. The light which is generated by such devices is concentrated primarily in the yellow and the green.

It has been disclosed in U.S. Patent No. 2,748,303 granted to Thorington on May 29, 1956, to color correct an HPMV lamp by placing a phosphor material on the inner surface of the outer envelope which surrounds the arc tube. In addition to visible light, the arc tube generates an appreciable amount of ultraviolet radiations and infrared radiations. As is well known, about one-third of the total energy emitted from the arc tube in such HPMV lamps is in the ultraviolet range. In accordance with this aforementioned patent to Thorington, the phosphor material converts the ultraviolet radiations into red radiations, in order to color correct the output of the lamp and improve the color rendition of objects which are illuminated by the lamp. It is also desirable to improve the total light output for such HPMV lamps and some known phosphors, when coated onto the outer envelope, will increase the total light output.

When an HPMV lamp has phosphor material coated on the outer envelope, the effective light source is enlarged, since the phosphor tends to scatter the light which is emitted by the arc tube. Such modified HPMV lamps are not particularly adapted for use in the usual reflecting fixtures, since the effective light source is relatively large and impairs the optical efficiency of the reflector. In addition, no phosphor is completely transparent, with the result that some of the visible light which is generated by the mercury discharge arc tube is absorbed as it traverses the phosphor. It is desirable to maintain the effective light source as small as possible, while simultaneously augmenting the light output of HPMV lamps.

It is the general object of this invention to avoid and overcome the foregoing and other difficulties of and objections to prior-art practices by the provision of a discharge device having an improved output.

It is a further object to provide a high-pressure mercury-vapor discharge device having an improved output and a relatively small effective light source.

The aforesaid objects of the invention, and other objects which will become apparent as the description proceeds, are achieved by providing a high-pressure, mercury-vapor discharge device wherein the arc tube has an envelope positioned in close proximity thereto. This proximate envelope contains a predetermined amount of mercury. The size and location of this envelope, with respect to the arc tube, are so selected that when the arc tube is operated, the minimum temperature within the envelope is at least about 375° C. During operation, mercury which is contained within this envelope vaporizes and converts ultraviolet radiations emitted by the arc tube into visible radiations. These visible radiations augment the visible output of the HPMV arc tube and, in addition, the mercury vapor is transparent to visible radiations and does

not scatter them so that the size of the light source is not appreciably greater than that of the usual HPMV discharge source.

For a better understanding of the invention, reference should be had to the accompanying drawings wherein:

FIG. 1 is an elevational view, partly in section, illustrating an HPMV lamp constructed in accordance with the present invention;

FIG. 2 is a sectional view taken on the line II—II in FIG. 1, in the direction of the arrows, illustrating constructional details for the arc tube envelope and surrounding envelope;

FIG. 3 is an elevational view, partly in section, illustrating an alternative discharge device embodiment constructed in accordance with the present invention.

Although the principles of the present invention are broadly applicable to any high-pressure, mercury-vapor discharge device of any size, the invention is conveniently employed in conjunction with an HPMV arc tube designed to operate with a power input of 400 watts, and hence it has been so illustrated and will be so described.

With specific reference to the form of the invention illustrated in the drawings, the numeral 10 in FIGS. 1 and 2 indicates generally a high-pressure, mercury-vapor discharge device comprising a conventional mercury-discharge arc tube 12 supported by a conventional arc tube mount 14 within an outer envelope 16. An intermediate envelope 18 surrounds the arc tube 12 and a charge of mercury 20 is contained within the intermediate envelope 18 and exterior to the arc tube 12. In the device embodiment as shown, the arc tube 12 is adapted to be operated with a power input of 400 watts and is formed of a quartz tubular envelope 22 having electrodes 24 electrically connected to conventional ribbon conductors 26 sealed through either end of the tubular envelope 22. Adjacent one of the electrodes 24 is a starting electrode 28, which electrically connects through a starting resistor 30 to that electrode 24 which is disposed at the opposite end of the arc tube 12. The arc tube mount 14 includes two metallic, rod-like supports 32 which are electrically connected to a supporting lead-in conductor 34 and to one of the electrodes 24. The lead-in conductor 34 is hermetically sealed through a conventional reentrant stem 36 and electrically connects to the base 38 of the lamp 10. The other electrode 24 is electrically connected to a second lead-in conductor 40, which also is sealed through the stem 36 and electrically connects to the base 38. The foregoing construction is generally conventional, except for the intermediate envelope 18, and other known arc tube mounts and constructions can be utilized.

In accordance with the present invention, the size and location of the envelope 18 are so selected with respect to the arc tube 12 and the power input thereto that the minimum operating temperature encountered within the envelope 18 is at least about 375°, in order to provide sufficient vapor pressure for the mercury 20 which is contained therein. The amount of the mercury charge 20 is not particularly critical, but it desirably is present in sufficient quantity that during operation of the device, the atmosphere between the envelope 18 and the arc tube 12 contains as high a concentration of mercury as is permitted by the minimum temperature within the envelope 18.

The mercury vapor within the envelope 18 will convert ultraviolet radiations having a wavelength of approximately 2537 A.U. into longer wavelength ultraviolet radiations and visible radiations which are peaked in the green region of the spectrum. In order to enable the mercury vapor to absorb the ultraviolet radiations, it is necessary to provide an "optical path" of at least 2. This optical path is expressed in terms of atmospheres of pressure of mercury vapor multiplied by centimeters

of traverse of the ultraviolet radiations therethrough. Accordingly, the intermediate envelope 18 should have such dimensions and be so positioned with respect to the arc tube 12 that at least a substantial portion of all such optical paths through the mercury vapor have a value of at least 2. It should be pointed out that this value of 2 is a minimum and for better absorption, a higher pressure and longer traverse is desired.

As a specific example, the arc tube 12 has a power input of 400 watts, a bulb length excluding the press portions, of 89 mm., a diameter of 16.5 mm., and a spacing between the operating electrodes of 70 mm. Contained within the arc tube 12 is 66 mg. of mercury and argon at a pressure of 22 mm. The bulbous portion of the outer envelope 16 has a total length of 156 mm. and a maximum diameter of 118 mm. With such a construction, the intermediate envelope 18 can be formed of quartz having a thickness of 1 mm., a total length of 110 mm., and an outside diameter of 40 mm. This intermediate envelope 18 is hermetically sealed to the arc tube 12 proximate the press portion thereof. Such an envelope will operate with a minimum temperature of approximately 500° C., which will provide a mercury vapor pressure during operation of approximately ten atmospheres. Substantially all radiations which are generated by the arc tube and which traverse the intermediate envelope 18 will have an optical path of at least about ten atmosphere-cm.

In order to enable the mercury vapor to convert ultraviolet radiations into visible radiations in a more efficient manner, it is desirable to provide within the intermediate envelope 18 an additional filling of inert gas at a pressure of at least 10 mm. mercury. In explanation, mercury atoms upon collision absorb energy in the 2537 A.U. region, forming an excited or energized molecule. This molecule is transient in nature, but upon colliding with another atom, visible light will be generated. In order to enhance the possibility of collisions between atoms and molecules, so as to enhance the efficiency of generation of light emission, the inert gas is desirably added at least to the minimum amount as specified. As a specific example, nitrogen at a pressure of 20 mm. and five grams of mercury are included within the intermediate envelope 18. Other inert gases such as the noble gases, or mixtures thereof, can be substituted for the nitrogen.

In FIG. 3 is shown an alternative device embodiment 10*a* wherein the arc tube 12, press 36, mount 14*a* and associated supports and energizing components are conventional and are generally as shown in the lamp 10 of FIG. 1. The mercury-containing envelope 18*a* is formed directly about the arc tube and the outer envelope 16, as shown in FIG. 1, is dispensed with. To cause the minimum temperature within the envelope 18*a* to be at least about 375° C., it is necessary to make this envelope 18*a* smaller than the envelope 16, as used in the embodiment 10. As an example, the envelope 18*a* can be fabricated of Pyrex and in the case of a 400 watt arc tube, the envelope 18*a* can have a length dimension of 150 mm. and an outside diameter of 50 mm. The envelope 18*a* also contains a filling of 10 gms. mercury 20*a* and a filling of inert gas, such as 500 mm. of nitrogen. In the operation of the foregoing devices, for a lamp with a power input of 400 watts, approximately 840 lumens of energy can be added in a region where there exists a color deficiency.

The higher the mercury vapor pressure generated within the envelopes 18 and 18*a* of the embodiments 10 and 10*a*, as shown in FIGS. 1 and 3 respectively, the greater the relative proportion of green radiations which are generated; apparently higher pressures favor the generation of the visible radiations, as compared to the generation of longwave ultraviolet radiations. The only practical limit to the maximum pressure of mercury is one of power input and the ability of the envelopes 18 and 18*a* to contain the generated pressures.

It will be recognized that the objects of the invention have been achieved by providing a high-pressure, mercury-vapor discharge device having improved output and a relatively small effective light source.

While best embodiments of this invention have been illustrated and described in detail, it is to be particularly understood that the invention is not limited thereto or thereby.

I claim:

1. The radiation-generating combination which comprises: a high-pressure mercury-vapor-discharge quartz arc tube adapted to be operated with a predetermined power input; an outer envelope surrounding said arc tube; said arc tube when operated emitting ultraviolet radiations, visible radiations and infrared radiations, with about one-third of the total energy emitted from said arc tube as ultraviolet radiations; an intermediate envelope positioned within said outer envelope and proximate said arc tube; a predetermined quantity of mercury contained within said intermediate envelope and exterior to said arc tube; the size and location of said intermediate envelope with respect to said arc tube being so selected that when said arc tube is operated, the minimum temperature within said intermediate envelope is at least about 375° C.; and during operation of said arc tube at least a substantial portion of all optical paths through said predetermined quantity of mercury having a value of at least 2, with such optical paths expressed in terms of atmospheres of pressure of said predetermined quantity of mercury times centimeters of traverse of arc-tube-generated ultraviolet radiations therethrough.

2. The radiation-generating combination which comprises: a high-pressure mercury-vapor-discharge quartz arc tube adapted to be operated with a predetermined power input; an outer envelope surrounding said arc tube; said arc tube when operated emitting ultraviolet radiations, visible radiations and infrared radiations, with about one-third of the total energy emitted from said arc tube as ultraviolet radiations; an intermediate envelope positioned within said outer envelope and surrounding said arc tube; a predetermined quantity of mercury contained within said intermediate envelope and exterior to said arc tube; the size and location of said intermediate envelope with respect to said arc tube being so selected that when said arc tube is operated, the minimum temperature within said intermediate envelope is at least 375° C.; and during operation of said arc tube at least a substantial portion of all optical paths through said predetermined quantity of mercury having a value of at least 2, with such optical paths expressed in terms of atmospheres of pressure of said predetermined quantity of mercury times centimeters of traverse of arc-tube-generated ultraviolet radiations therethrough.

3. The radiation-generating combination as specified in claim 2, wherein a filling of inert gas having a pressure of at least 10 mm. is also contained within said intermediate envelope and exterior to said arc tube.

4. The radiation-generating combination as specified in claim 3, wherein said inert gas filling is nitrogen.

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