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DOUBLE ENDED HIGH PRESSURE DISCHARGE LAMP

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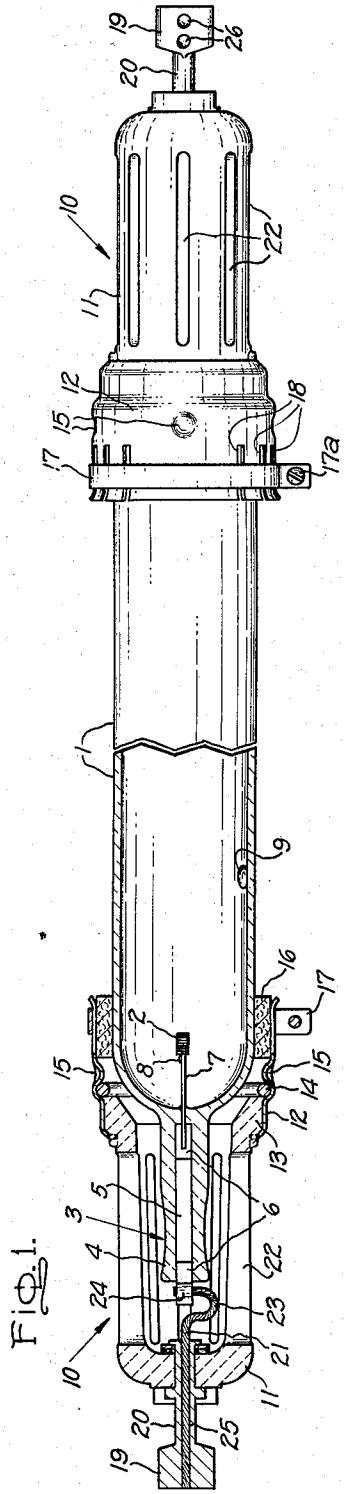


Fig. 1.

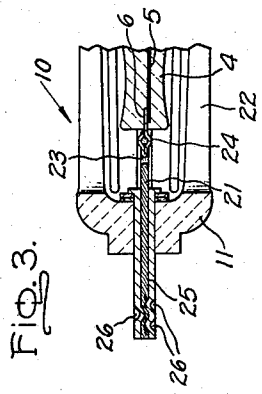


Fig. 3.

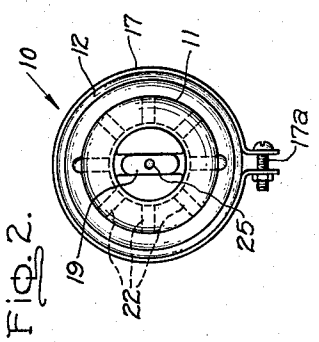


Fig. 2.

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DOUBLE ENDED HIGH PRESSURE DISCHARGE LAMP

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5 Claims. (Cl. 313—43)

This invention relates to elongated double-ended high pressure discharge lamps having bases at both ends for engagement in spaced sockets. The invention is particularly concerned with features of the lamp and of the bases aimed at a reduction in temperature of the seals to prevent oxidation thereof when the lamp is operated in ambient air.

The elongated double-ended high pressure mercury vapor lamps of the present invention generally have quartz envelopes with an arc chamber length at least six times the internal diameter and operating at mercury vapor pressures of one atmosphere or more, for instance in the range of 1 to 10 atmospheres. These lamps are efficient sources of ultraviolet radiation and up to the present time they have generally been used in photochemical applications, as in white printing machines for instance. However, they are also efficient sources of visible light and can be used for general illumination when enclosed in fixtures provided with suitable glass covers for cutting out the ultraviolet radiation which is harmful to the eyes.

One of the problems encountered with these lamps is that of cooling the seals to prevent oxidation thereof. In photochemical applications the problem is readily solved by forced air cooling. For general illumination, however, where the lamps are to be mounted in unattended fixtures such a solution is both too expensive and too fraught with maintenance problems to be practical. The arc tube could, of course, be mounted within an outer jacket which is then evacuated or filled with an inert gas to prevent oxidation of the leads, but this results in a rather expensive and cumbersome lamp and is hardly a desirable solution.

The object of the invention is to provide a new and improved double-ended elongated quartz mercury vapor lamp operable in ambient air.

Another object is to provide such a lamp suitable as a source of general illumination without forced cooling.

Yet another object is to provide a base for double-ended elongated electric lamps operating at high temperatures which provides effective cooling of the seal.

In accordance with the invention, the operation of elongated double-ended high pressure mercury vapor lamps is made possible in ambient air without forced cooling by reducing the rate of diffusion of heat to the seals and by increasing the rate of dissipation of heat from the seals. The rate of diffusion of heat to the seals is decreased by moving the thermionic electrode forward of the end wall of the envelope preferably a distance of the order of one third to two thirds the internal diameter of the envelope. The seals are protected from shock and at the same time the dissipation of heat from them is increased by the provision of a base at each end comprising a tubular ceramic insulator extending over the seal and having a plurality of perforations permitting convection flow of air around the seal. The base comprises a massive terminal extending outwardly from the outer end of the insulator and engageable in the contacts

of a lamp holder. The outer end of the lead-in conductor emerging from the seal is connected to this terminal by a short length of a stranded conductor of high heat conductivity which further reduces the temperature of the seal by conduction into the terminal and from the terminal into the lamp holder. This combination of features results in a lamp of the stated type which is practical for use as a general illumination source without forced air cooling.

For further objects and advantages and for a better appreciation of the features of the invention, attention is now directed to the following description and accompanying drawing. The features of the invention believed to be novel will be more particularly pointed out in the appended claims.

In the drawing:

Fig. 1 shows a high-pressure mercury vapor lamp embodying the invention. Part of the central body of the lamp has been removed to foreshorten the figure and one end of the lamp and its base has been sectioned to show the internal construction.

Fig. 2 is an end view of the same lamp.

Fig. 3 is a fragmentary plan section of the end of the lamp taken at right angles relative to the section of Fig. 1.

The illustrated lamp corresponds to a type designated commercially H1500A23 having a lighted length of approximately 12 inches, a rating of 1500 watts and drawing approximately 4.1 amperes at a voltage drop of 425 volts. The arc chamber is defined by a cylindrical quartz envelope or tube **1** which is filled with an inert gas such as argon at a low pressure, for instance at 25 millimeters of mercury and a quantity of mercury sufficient when vaporized to develop a vapor pressure in the range of 1 to 10 atmospheres, for instance 2 to 4 atmospheres. At each end of the lamp there is provided a thermionic electrode **2** to which current connections are made through vacuum foil seals **3**. Each seal comprises a quartz extension body **4** fused to the end of the envelope through which extends a thin metal foil **5** having thicker ribbon portions **6** welded to its ends. The foil is of a highly refractory metal, molybdenum being preferred for the purpose. At least the central portion thereof which makes the hermetic seal with the quartz is very thin, for instance less than one mil in thickness. Due to the thinness of the foil, it yields under tension to the quartz during cooling and does not rupture nor crack the quartz, thereby preserving the hermetic seals. The illustrated seal is generally known as a vacuum seal because a vacuum is used to collapse the originally hollow quartz body **4** onto the foil threaded therethrough while the quartz is heated by externally applied heat to the fusion point.

To the inner end of the foil, there is welded a support wire **7** which projects into the arc chamber and supports the electrode **2**. The electrode is formed of a tungsten wire helix wound around the support wire with a sliver of thorium metal **8** laid alongside. The electrode is of the self-heating thermionic emission type and the thorium serves to reduce the electrode loss and the voltage drop thereat. The quantity of mercury within the envelope is represented by the droplet **9** which is totally vaporized during normal operation.

The bases **10** mounted on the ends of the envelope are of the general type described in Patent 2,515,747—Vaughan for accommodating the lamp in sockets of the type described in Patent 2,338,835—Bryant. Each base comprises a hollow body portion **11** of insulating material, preferably a vitreous clay containing aluminum, silicon and magnesium and sold under the trade name Alsimag, or porcelain. The body portion is spaced from and surrounds coaxially the seal **3**. It is secured to the end of the envelope **1** by means of a metal skirt **12** having an

inturned rim which engages an enlarged shoulder **13** on the insulator. The shoulder is locked in place relative to the shell by means of a split metal snap ring **14** which is held in position by indentations or dimples **15** in the wall of the shell **12**. Before the shell **12** is slipped over the end of the envelope **1**, a thin strip **16** of asbestos cloth is wrapped about the tube. The shell **12** is secured firmly in place by a suitable clamping ring **17** and screw **17***a*, the inner periphery of the shell under the clamping ring being provided with parallel slits **18** to form tines or prongs readily compressible by the clamping ring. The outer end of the insulator **11** is provided with a massive contact terminal consisting of a flattened prong or spade **19** at the end of a stud portion **20** extending outwardly and longitudinally of the lamp envelope. The spade terminal is connected to the end of the ribbon **6** projecting from the seal **3** by a flexible conductor **21** the details of which will be more particularly described hereinafter.

The oxidation of molybdenum at temperatures above 350° C. is rapid. The end of the ribbon **6** projecting from the seal is first attacked, and as oxidation continues, either the connection is broken or the seal bond within the quartz is destroyed. Accordingly, it is essential to maintain the temperature of the end of the seal where the foil **5** or ribbon end **6** first meets the air, at less than 350° C.

The reduction of heat diffusion into the seal is achieved by moving the electrodes **2** forward into the arc chamber. With prior art lamps generally used for photo-chemical purposes, it has been the practice to mount the electrode **2** right up against the end wall of the arc chamber. This has the advantage of eliminating any cool spot behind the electrode where the mercury would be slow to vaporize and shortens the warm-up time of the lamp. However, we have found that the electrode may be moved forward into the arc chamber a substantial distance while still maintaining the warm-up time within acceptable limits. In lamps with arc loadings per inch in the range from 100 to 200 watts to which the present invention is applicable, we have found that the electrode may be moved forward so that the distance from the front face of the helix to which the arc attaches to the end wall of the envelope is in the range of ⅓ to ⅔ the internal diameter of the envelope. In the illustrated lamp having an inside diameter of 25 millimeters, the electrode **2** is moved forward approximately ½ diameter, that is a distance of 12.5 mm. (½ inch) measured between the front face of the helix and the inside surface of the end wall behind the electrode. The resulting warm-up time is from 5 to 10 minutes which is acceptable for the lighting purposes intended.

If the electrode is moved forward a greater distance than the stated range, the warm-up time increases rapidly and there may, in fact, occur permanent condensation of mercury behind the electrode which would prevent the lamp from attaining its design vapor pressure, resulting in faulty operation. Actual tests made with the present lamp operating at an arc loading of 125 watts per inch have shown that moving the electrode forward as described results in a reduction of the seal temperature measured at the point where the ribbon end **6** emerges from the quartz body **4**, from 450° C. to 380° C. whereas the temperature of the bulb at the end of the arc chamber remains substantially constant at approximately 830° C. It is thus seen that the feature in question is unexpectedly effective in lowering the temperature of the seal and of the foil, without at the same time appreciably reducing the temperature of the end of the arc chamber with the adverse results of excessive warm-up time or permanent mercury condensation which such would entail.

The dissipation of heat from the seal is increased in part by providing apertures through the base insulator **11** to allow free convection flow of air around the seal. In the illustrated embodiment this is achieved by providing longitudinal slots **22** in the insulator body. The particular configuration of these slots illustrated has the advantage of providing free access of air without mechanically weakening the base insulator to an undesirable extent. Actual tests conducted on the same basis as those previously described for the case of a slotted base insulator as compared with a non-slotted insulator show a reduction in foil temperature at the end of the seal of approximately 30°, that is from 380° C. to approximately 350° C.

The rate of dissipation of heat from the seal, or in this case from the foil **5** and ribbon end **6** since these are in fact the parts as to which a low temperature is essential, is further increased by providing a connection between the ribbon end **6** and the spade **19** of the base which assures a high rate of flow of the heat. To this end, the nickel wire formerly used as the connector is replaced by a short length **21** of heavy stranded wire of high heat conductivity. By a metal of high-heat conductivity it is intended to signify a metal having at least the conductivity of copper or silver. The connector should permit a temperature differential between the spade terminal and the end of the foil no greater than approximately 130° C.

In the illustrated embodiment, a stranded copper wire **21** having a total cross section equivalent to a 25-mil solid wire connects the spade terminal to the end of the foil. In order to prevent flexing and eventual breakage of the end of the foil due to thermal expansion and contraction, the lead **21** is provided with a short loop **23** in the space between the inner end of the terminal and the seal and is welded athwart the end of the foil or ribbon, that is from a direction approaching it at right angles to the axis of the lamp, the ribbon end **6** being folded over the lead as shown at **24**. With this disposition, the stranded wire will flex during thermal expansion and contraction, rather than the end of the foil with attendant ill effects. To facilitate assembly of the base to the lamp, the stranded connector **21** may first be welded to the ribbon end, and assembly then made by threading it through an axial aperture **25** extending through spade terminal **19** and stud **20**. The connector wire may then be soldered in place using a hard high temperature solder, or by staking through the spade terminal at **26** as shown in the illustrated embodiment.

This arrangement is successful for the desired purpose inasmuch as it pulls down the temperature of the end of the foil close to that of the spade terminal, the measured difference in temperature being only approximately 65° C. for the particular lamp which has been described. Actual tests have shown the temperature at the end of the foil to be reduced by the use of the instant highly heat-conductive connector from approximately 350° C. to approximately 285° C., the spade being at a temperature of approximately 220° C. The seal temperature thus is well below the 350° C. upper temperature limit for avoiding oxidation of the seals, and allows an adequate margin of safety for uncontrolled variables.

It will be seen from the foregoing description that an improved elongated double-ended high pressure mercury vapor lamp and base assembly has been provided which, by reducing the diffusion of heat to the seal and by increasing the dissipation of heat from the seal, has made possible for the first time a jacketless lamp of the kind described operating without forced cooling and suitable for general illumination. It will be appreciated that while a preferred embodiment of the invention has been described, modifications of the details thereof, for instance as to the seals which could be of the pinch type, will readily occur to those skilled in the art and it is intended to cover any such modifications as fall within the scope of the appended claims.

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

1. A high pressure mercury vapor lamp comprising an elongated tubular quartz envelope having a pair of thermionic electrodes at opposite ends and containing a quantity of mercury, seals at the ends of said envelope each comprising a quartz extension to the envelope having a refractory metal foil sealed longitudinally therethrough, a support wire extending from the foil into the arc chamber and supporting the electrode forwardly of the end wall of the envelope for reducing the heat loss to the seal, and bases fastened to the ends of said envelope each comprising a tubular insulator surrounding the quartz extension of the seal and having a plurality of perforations permitting convection flow of air around the seal to cool same, a massive terminal extending outwardly from the outer end of said insulator, and a short length of conductor of high heat conductivity extending from said foil next to the end of said seal to said terminal to provide rapid conduction of heat therebetween.

2. A high pressure mercury vapor lamp comprising an elongated tubular quartz envelope having a pair of thermionic electrodes at opposite ends and containing a quantity of mercury developing a vapor pressure of at least one atmosphere with an arc loading from 100 to 200 watts per inch, seals at the ends of said envelope each comprising a quartz extension to the envelope having a refractory metal foil sealed longitudinally therethrough, a support wire extending from the foil into the arc chamber and supporting the electrode forwardly of the end wall of the envelope a distance in the range of ⅓ to ⅔ the internal diameter of the envelope for reducing the heat loss to the seal, and bases fastened to the ends of said envelope each comprising a tubular insulator extending over and surrounding the quartz extension of the seal and having a plurality of perforations permitting convection flow of air around the seal to cool same, a massive terminal extending outwardly from the outer end of said insulator and engageable in the contacts of a lampholder, and a short length of conductor of high heat conductivity extending from said foil next to the end of said seal to said terminal to provide rapid conduction of heat therebetween and maintain the temperature differential between them below 130° C.

3. A high pressure mercury vapor discharge lamp comprising an elongated tubular quartz envelope defining an arc chamber and having a pair of self-heating thermionic electrodes at opposite ends, said arc chamber containing a starting gas and a quantity of mercury developing a vapor pressure of at least one atmosphere with an arc loading from 100 to 200 watts per inch, seals at the ends of said envelope each comprising a quartz extension to the envelope having a refractory metal foil sealed longitudinally therethrough, a support wire extending from the foil into the arc chamber and supporting the electrode forwardly of the end wall of the envelope a distance in the range of ⅓ to ⅔ the internal diameter of the envelope for reducing the heat loss to the seal, and bases fastened to the ends of said envelope each comprising a tubular ceramic insulator extending over and surrounding the quartz extension of the seal and having a plurality of perforations permitting convection flow of air around the seal to cool same, a massive terminal extending outwardly from the outer end of said insulator and engageable in the contacts of a lampholder, and a short length of a stranded conductor of high heat conductor of high heat conductivity welded athwart the foil next to the end of said seal and extending in a short loop of said terminal to prevent fracture of the end of the foil while maintaining the temperature differential between the foil and terminal below 130° C.

4. A high pressure mercury vapor discharge lamp comprising an elongated tubular quartz envelope defining an arc chamber and having a pair of self-heating thermionic electrodes at opposite ends, said arc chamber containing a starting gas at a low pressure and a quantity of mercury developing a vapor pressure between 2 and 4 atmospheres with an arc loading of approximately 125 watts per inch, seals at the ends of said envelope each comprising a generally cylindrical quartz extension of reduced diameter having a molybdenum foil sealed longitudinally therethrough, a support wire extending from the foil into the arc chamber and supporting the electrode forwardly of the end wall of the envelope a distance of approximately half the internal diameter of the envelope for reducing the heat loss to the seal without appreciable reduction of the end wall temperature below that of the remainder of the arc chamber, and bases fastened to the ends of said envelope each comprising a tubular ceramic insulator extending coaxially over and surrounding the quartz extension of the seal and having a plurality of axial slots therethrough permitting convection flow of air around the seal to cool same, a massive spade terminal extending outwardly from the outer end of said insulator and engageable in the contacts of a lamp holder, and a short length of stranded conductor of high heat conductivity extending from said terminal into a short loop whereof the end is welded athwart the end of the foil next to the end of said seal to prevent fracture of the end of the foil while maintaining the temperature differential between the foil and terminal below 130° C.

5. A lamp as defined in claim 4 wherein said envelope has an internal diameter of approximately 25 millimeters and wherein said stranded conductor is a copper wire, said lamp operating in ambient air with a temperature at the ends of the seals approximately 65° C. higher than the temperature of the spade terminals and below 350° C.

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