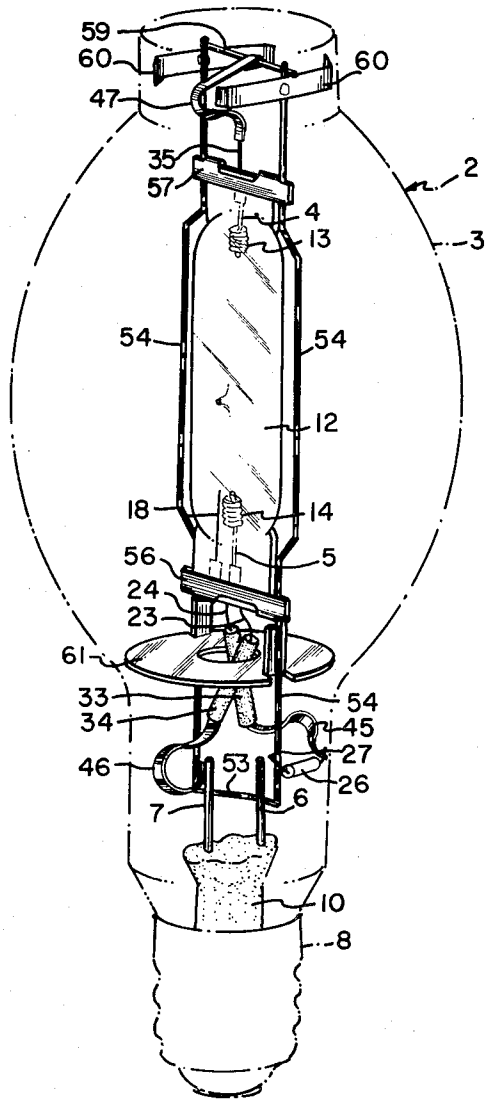
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HIGH PRESSURE DISCHARGE DEVICE CONTAINING MOLYBDENUM

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HIGH PRESSURE DISCHARGE DEVICE CONTAINING MOLYBDENUM

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This invention relates to high pressure electric discharge devices and particularly to the production of light of particular wavelengths from such devices.

High pressure electric discharge devices are well known to the art, however their emission is restricted to the emission lines of mercury, that is, lines of discrete, separate wavelengths at 4048, 4348, 5461, 5770 and 5790 A. Almost all of the radiation is contained in the blue region together with a line in the green and a line in the yellow. Hence, such devices could not be used for all lighting applications. In particular, the lamps were not suited for all types of photocopy work such as processes employing diazo dyes, which require an emission spectrum different than the mercury emission.

We have discovered that emission lines principally at 3798, 3864, 3132 and 3902 A and secondarily at 3170, 3193 and 3135 A can be obtained from a high pressure electric discharge if molybdenum is used in the fill of the arc tube. Such fills must include the conventional mercury together with a halogen, preferably iodine and except fluorine, either as the elements, the corresponding halides or mixtures thereof. Notably certain ratios of mercury atoms to iodine atoms must be maintained elsewise maximum light emission will not be realized.

Quite surprisingly when molybdenum is used much of the expected high peaking in the emission spectra due to mercury is depressed and the overall height of the spectrum is raised. The radiation which is produced from arc tubes using fills including molybdenum is a spectrum containing emission lines principally in the blue and rear ultraviolet regions.

As we have indicated, the quantities of mercury and iodide must be closely controlled to attain maximum efficiency. We prefer to use a ratio of iodine atoms of mercury atoms of 0.5 although it is possible to use ratios between 0.025 to 0.85; the preferred range of ratios being between 0.025 and 0.65. Irrespective of whether the mercury is added as the metal or the corresponding iodide, the quantity should be sufficient to allow complete vaporization at normal operating temperatures of the arc tube and to form a restricted arc therein.

Accordingly, the primary object of this invention is the production of a blue and near ultraviolet light from high pressure electric discharge devices for photocopy applications.

A feature of this invention is the incorporation of mercury, either as the metal or as the iodide, together with controlled quantities of molybdenum, also either as metal or as the iodide.

Many other objects, features and advantages of the present invention will become manifest to those conversant with the art upon making reference to the detailed description which follows and the accompanying drawing in which preferred embodiments of a high pressure electric discharge device which emits blue light are shown and described and wherein the principles of the present invention are incorporated by way of illustrative examples.

Of this drawing:

The figure is an elevational view of a high pressure electric discharge device illustrating the positioning of an electric discharge arc tube disposed within an outer bulbous envelope.

According to our invention we have discovered that arc tubes having a filling of a combination of certain materials can produce a certain blue light without the necessity of a correctional phosphor. In particular, when mercury and iodide, either as the individual elements or as the corresponding compounds are added to the arc tube in very specific atomic ratios together with specific quantities of molybdenum, a blue light of significant value for photocopy applications can be obtained.

The relative energy radiated by standard mercury lamps in the 3650 A and 4047 A lines is about 17 watts whereas when molybdenum is present in the iodine-containing arc tube, the energy within this spectral range is about 52 watts; a threefold increase. The relative energy radiated by a standard mercury lamp in the 3650 A, 4047 A and 4358 A lines is about 26 watts while in the iodine and molybdenum containing lamp the energy radiated in this spectral range (3650 to 4358 A) is about 85 watts; again a threefold increase.

Referring to the figure, an elevational view of a high pressure electric discharge device is shown. For clarity of presentation, the outer bulbous envelope and the base of the lamp are shown in phantom lines surrounding the arc tube harness and the arc tube. The device, such as shown in the drawing, comprises an outer vitreous envelope or jacket **2** of generally tubular form having a central bulbous portion **3**. The jacket is provided at its end with a re-entrant stem having a press seal through which extend relatively stiff lead-in wires **6** and **7** connected at their outer ends to the electrical contacts of the usual screw type base **8** and at their inner ends to the arc tube and the harness.

The arc tube is generally made of quartz although other types of glass may be used such as alumina glass or Vycor, the latter being a glass of substantially pure silica. Sealed in the arc tube **12** at the opposite ends thereof are main discharge electrodes **13** and **14** which are supported on lead-in wires **4** and **5** respectively. Each main electrode comprises a core portion which may be a prolongation of the lead-in wires **4** and **5** and may be prepared of a suitable metal such as for example molybdenum or tungsten. The prolongations of these lead-in wires **4** and **5** can be surrounded by tungsten wire helixes.

An auxiliary starting probe or electrode **18**, generally prepared of tantalum or tungsten is provided at the base end of the arc tube **12** adjacent the main electrode **14** and comprises an inwardly projecting end of another lead-in wire.

Each of the current lead-in wires described have their ends welded to intermediate foil section of molybdenum which are hermetically sealed within the pinch sealed portions of the arc tube. The foil sections are very thin, for example approximately 0.0008 inch thick and go into tension without rupturing or scaling off when the heated arc tube cools. Relatively short molybdenum wires **23**, **24** and **35** are welded in the outer ends of the foil and serve to convey current to the various electrodes inside the arc tube **12**.

Metal strips **45** and **46** are welded onto the lead-in wires **23** and **24** respectively. A resistor **26** is welded to foil strip **45** which in turn is welded to the arc tube harness. The resistor may have a value of for example, 40,000 ohms and serves to limit current to auxiliary electrode **18** during normal starting of the lamp. Metal foil strip **46** is welded at one end to a piece of molybdenum foil sealed in the arc tube **12** which in turn is welded to main electrodes **13** and **14**. Metal foil strip **47** is welded to one end of lead-in **35** and at the other end to the harness. The pinched or flattened end portions of the arc tube **12** form a seal which can be of any desired width and can be made by flattening or compressing the ends of the arc tube **12** while they are heated.

A U-shaped internal wire supporting assembly or arc tube harness serves to maintain the position of the arc tube **12** substantially coaxially within the envelope **2**. To support the arc tube **12** within the envelope stiff lead-in wire **6** is welded to the base **53** of the harness. Because stiff lead-in wires **6** and **7** are connected to opposite sides of a power line, they must be insulated from each other, together with all members associated with each of them. Clamps **56** and **57** hold the arc tube **12** at the end portions and are fixedly attached to legs **54** of the harness. A rod **57** bridges the free ends of the U-shaped support wire **54** and is fixedly attached thereto for imparting stability to the structure. The free ends of the U-shaped wire **54** are also provided with a pair of metal springs **60**, frictionally engaging the upper tubular portion of the lamp envelope **2**. A heat shield **61** is disposed beneath the arc tube **12** and above the resistor **26** to protect the resistor from any excessive heat generated during lamp operation.

The arc tube **12** is provided with a filling of mercury which reaches pressures in the order of one half to several atmospheres during normal lamp operation at temperatures of 450 to 700° C. We have found that through the addition if iodine and/or certain mercury iodides to the mercury fill, the quantity of the latter can be reduced and possibly lower; arc length being measured as the distance between opposing tips of the main electrodes **13** and **14**. Although the amount of mercury added can be varied widely as we have indicated, we prefer to add approximately 2.5×10^{-5} to 4.1×10^{-5} gram atoms of mercury per centimeter of arc length. However, substantial light emission can be obtained at filling pressures less than the above stated limits. Furthermore, the blue light emission appears to be substantially independent of the amount of mercury metal added and hence the quantity of the latter can be reduced while lamp operation is still attained. As is conventional in the art, a quantity of rare gas such as helium, argon, neon, krypton or xenon at a pressure of about 25 millimeters of mercury is added to facilitate starting.

As we have indicated previously, in conjunction with the molybdenum, a halogen, preferably iodine must be added to the arc tube to attain the blue light formation. About 0.5 atom of iodine must be added for every atom of mercury irrespective of whether the mercury atoms are derived from the metal or from the mercury compound, although this ratio may be varied in reasonable tolerances between 0.025 to 0.65 atom of iodide per atom of mercury. The tolerance range is necessary since it is difficult, if not impossible, to produce lamps in production lines wherein the ratio of mercury to iodine atoms is exactly 0.5. Within such tolerances, reasonable blue light emission is still evidenced. It is quite important to use materials which are as anhydrous as possible in the arc tube since the incorporation of water tend to make the discharge hard to start.

We have found that about 5.2×10^{-7} to 1.6×10^{-5} gram atoms per centimeter of arc length of molybdenum should be added to the arc tube to attain the blue light emission which we discussed previously. Below the lower limit, the emission will not be apparent because insufficient quantities of metal are present and above the upper limit, the metals will condense upon the arc tube and blacken it.

The fabrication of the envelope, sealing techniques and positioning of the electrodes in the high pressure electric discharge device according to our invention takes place in a manner quite similar to that known to the art with conventional mercury lamps. And further, the mercury may be added to the arc tube by techniques well known to the art. To prepare the arc tube, we pump down an

envelope having a pair of electrodes disposed at either end thereof, and spaced about 7 cm. from each other, through an exhaust tubulation extending from the surface of the envelope and disposed in communication with the interior thereof. The envelope is then electrically baked and filled with argon to flush out residual impurities, it is quite important to eliminate or substantially eliminate hydrogen from the arc tube. Hydrogen is known to effect the starting of mercury lamps adversely but its effect appears to be greater in the lamps prepared according to our invention. The difficulty with hydrogen appears to be due to the formation of hydrogen iodide which has a much higher vapor pressure than any other iodide present. We believe that for every atom of hydrogen, that an extra atom of iodine is transferred into the vapor state. Presence of the iodine in the vapor state increases the voltage which must be applied to the lamps for starting. Hence, not only must hydrogen be substantially eliminated from the gases in the filling of the tube, but each and every part going into making up the arc tube must be free of residual hydrogen impurities. For example, the electrodes can be vacuum baked at 600 to 800° C. for a few hours before their use to eliminate hydrogen which might occur due to processing. Furthermore, care should be exercised when sealing the electrodes into the arc tube to prevent hydrogen-containing, combustion gases from seeping in or becoming absorbed upon the surface.

The pump and fill procedure above described is usually repeated three to four times and then an arc is struck between the electrodes while there is a filling of argon gas. This operation of the arc removes any residual impurities from the electrodes and these contaminants can be easily drawn from the system when the argon filling is pumped out. We then add approximately 32 mg. of mercury, 18.4 mg. of mercuric iodine and 10 mg. of molybdenum to an envelope having an arc length of approximately 7.1 centimeters. The arc tube is then filled to atmospheric pressure with argon gas which is slowly leaked out until a pressure of about 23 mm. of mercury is obtained. Subsequently, the exhaust tubulation is tipped off and the envelope is sealed. Testing of the lamp indicates that blue light is present; the emission of the lamp having the previously mentioned spectral emission lines.

It is apparent that modifications and changes may be made within the scope of the instant invention. It is our intention however to be limited only by he scope of the appended claims.

As our invention we claim:

1. A high pressure discharge device comprising: an arc tube having electrodes disposed at either end thereof and a vaporizable fill of halogen, mercury and atoms of molybdenum; said halogen and mercury respectively being present therein at an atomic ratio between 0.025 to 0.85 and said mercury being present in sufficient quantities to be completely vaporized at normal operating temperatures of said arc tube and to form a restricted arc therein, the atoms of molybdenum being present in quantities in the range of 5.2×15^{-7} to 1.6×10^{-5} gram atoms per centimeter of arc length.

2. The device according to claim **1** wherein iodine is the halogen.

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