

[54] METAL HALIDE LAMP CONTAINING
MERCURY, LIGHT EMITTING METAL,
SODIUM AND ANOTHER ALKALI METAL

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[58] Field of Search 313/229, 184

[56]

References Cited

UNITED STATES PATENTS

3,398,312	8/1968	Edris et al.	313/229 X
3,514,659	5/1970	Gungle et al.	313/229 X
3,445,719	5/1969	Thouret et al.	313/229 X

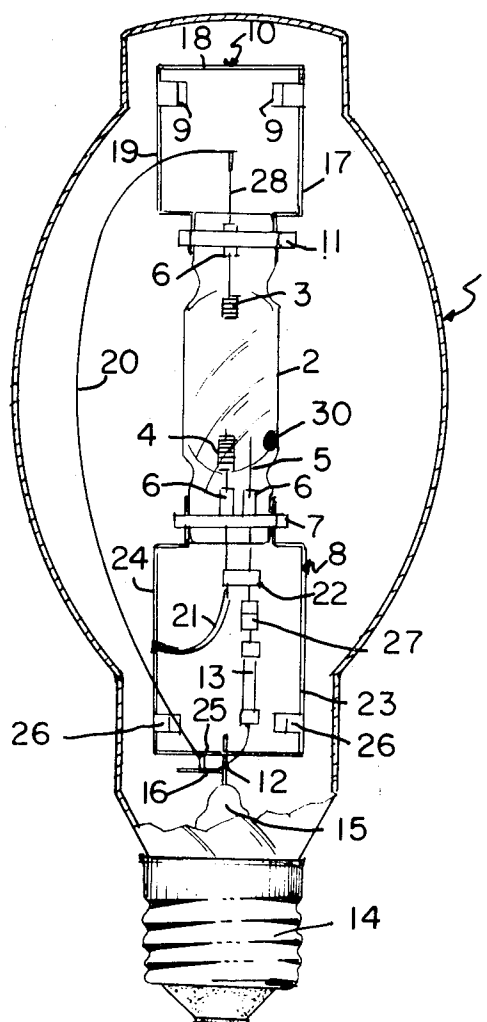
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[57]

ABSTRACT

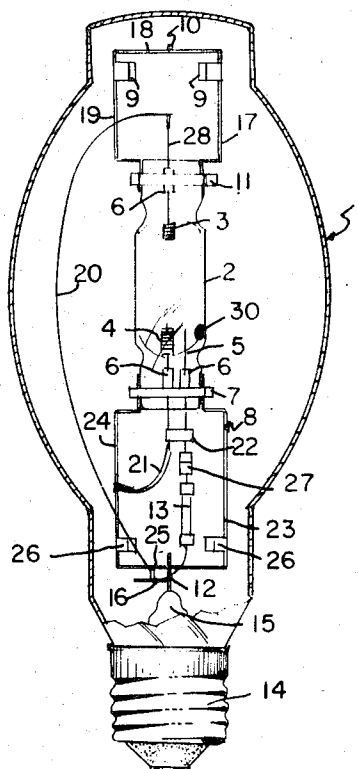
In a metal halide arc discharge lamp having an arc tube fill including mercury, halogen, sodium and a light emitting metal, controlled amounts of cesium, potassium or rubidium are added to the arc tube fill.

2 Claims, 1 Drawing Figure



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3,761,758



METAL HALIDE LAMP CONTAINING MERCURY, LIGHT EMITTING METAL, SODIUM AND ANOTHER ALKALI METAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to metal halide arc discharge lamps. Such lamps comprise an arc tube, usually made of fused quartz or other high silica glass, having electrodes disposed therewithin and containing a fill including mercury and a metal halide.

2. Description of the Prior Art

Metal halide arc discharge lamps of the type relating to this invention are shown in the following U. S. Pat. Nos.: 3,234,421; 3,250,940; 3,262,012; 3,279,877; 3,313,974; 3,324,332; 3,331,982; 3,334,261; 3,350,598; 3,351,798; 3,377,498; 3,379,916; 3,384,775; 3,385,645; 3,405,303; 3,407,327; 3,424,935; 3,452,238; 3,514,659; 3,521,110; 3,569,766; 3,575,630; and 3,634,721.

Such lamps usually contain a fill of mercury, metal halide and a small amount of ionizable gas. As pointed out in the above patents, metal halide lamps are more efficient and can yield a whiter light than mercury vapor lamps. Disclosed in the above patents as metal halides that can be added to arc tubes of metal halide lamps are the following: lithium, sodium, potassium, rubidium, cesium, beryllium, magnesium, calcium, strontium, barium, scandium, yttrium, lanthanum, titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum, rhenium, iron, ruthenium, cobalt, rhodium, iridium, nickel, palladium, zinc, cadmium, gallium, indium, thallium, germanium, tin, lead, antimony, bismuth, selenium, tellurium, cerium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, ytterbium, lutetium, thorium, and uranium.

In metal halide lamps of general commercial use, an alkali halide, mercury and one or more of the above mentioned metal halides are normally added. An alkali halide is added to obtain proper arc control and sodium is the preferred alkali since it yields higher efficiency and more chromatically satisfactory light than either potassium, rubidium or cesium.

In U. S. Pat. No. 3,234,421 the use of halides of three alkali metals — lithium, sodium and cesium — is disclosed. For maximum efficiency, the recommended amount of said metals is that amount that will yield a partial pressure during normal lamp operation of 1 to 200 mm of mercury pressure.

In U. S. Pat. No. 3,262,012 the use of sodium or cesium in an amount of 0.53×10^{-7} to 6.8×10^{-5} gram atoms per centimeter of arc length is disclosed for the purpose of establishing stable arc conditions in metal halide lamps.

In U. S. Pat. No. 3,331,982 the addition of 5.25×10^{-7} to 6.8×10^{-5} gram atoms of sodium, lithium, potassium, rubidium and/or cesium per centimeter of arc length is disclosed for the purposes of color correction, arc stabilization and voltage drop reduction.

In U. S. Pat. No. 3,514,659 the use of cesium iodide is disclosed for the purpose of reducing reignition voltage. The patent points out that cesium iodide reduces reignition voltage to a greater and more uniform extent than either potassium, lithium or sodium iodide.

In U. S. Pat. No. 3,521,110, alkali metal halides are disclosed as light emitting metal constituents of metal

halide lamps that yield efficient, chromatically satisfactory light, although it is disclosed therein that the halides of sodium, potassium and rubidium can result in wall blackening.

There is no disclosure or suggestion in the patents listed above that particular alkali metal combinations can result in longer life metal halide lamps.

SUMMARY OF THE INVENTION

As disclosed in the prior art, sodium halide is preferred over other alkali metal halides as a constituent of the arc tube fill of a metal halide lamp because of its improved efficiency and chromaticity. However, we have discovered that the addition of cesium, potassium and/or rubidium halide to a sodium halide containing lamp substantially increases the life of the lamp under normal operating conditions. Moreover the amount of added cesium, potassium and/or rubidium halide must be between about 2 and 20 mole percent of the amount of sodium halide in order to obtain longer lamp life without significantly reducing the efficiency of the lamp or impairing the chromaticity of the light emitted therefrom.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE is a perspective view of a metal halide lamp containing a fill of materials in accordance with this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawing, a metal halide lamp in accordance with this invention includes a generally tubular outer bulbous envelope 1 having a bulbous central portion and a conventional base 14 attached to the bottom thereof. Extending inwardly from the base and inside of the envelope 1 is a mount 15 having a pair of stiff lead-in wires 12 and 16 in electrical conducting relation with the base 14. Disposed upon one of the stiff lead-in wires 12 is a lower, U-shaped support 8 welded thereto. U-shaped support 8 comprises a pair of vertical wires 23 and 24 rising from a horizontal base wire 25. The upper ends of lower U-shaped support 8 are welded together with a lower strap 7 which in turn supports an arc tube 2. Preferably, the lower strap includes two sections abutting against either side of arc tube 2 thereby holding it firmly in place. They touch only the press seal of the arc tube and not the body. Generally, both sides of the lower strap 7 can be of identical construction. A pair of bumpers 26 are welded to lower U-shaped support 8 and abut against the tubular portion of walls of outer bulbous envelope 1 thereby stabilizing the structure within the lamp. Preferably, these bumpers are made of a resilient material so that if the lamp is jarred they will absorb much of the shock.

Since lower U-shaped support 8 is electrically connected to stiff lead-in wire 12, support 8 forms part of the circuit in the device. Current passes from base 14 into lower U-shaped support 8 and thence to lead-in wire 21 which in turn is connected to a cathode 4 in the arc tube. It is sometimes desirable to place an insulating shield about lead-in wire 21 to prevent arcing within the lamp and between the various elements. Current passes from lead-in wire 21 to cathode 4 through an intermediary molybdenum foil section 6.

The other side of the circuit is formed through stiff lead-in wire 16 which is preferably bent out of place so

that parts on one side of the line are insulated from those on the other side. A resistor 13 is attached to stiff lead-in wire 16 through a lead-in wire associated therewith and thence to a connector 27 which in turn leads through a molybdenum foil section 6 to a starting probe 5. A bimetal 22 is disposed between lead-in wire 21 attached to cathode 4 and lead-in wire 27 which is attached to starting probe 5. Bimetal 22 is biased open when the lamp is turned off but when the lamp starts, it biases closed against the lead-in wires to probe 5 thereby establishing the same current potential at probe 5 and cathode 4. Such closing prevents electrolysis between the probe and cathode.

At the other end of arc tube 2, an upper support 10 is mounted within the tubular portion of bulbous envelope 1. Support frame 10 includes a horizontal section 18 having vertical supports 17 and 19 depending downwardly therefrom and attached at the free ends to an upper strap 11 which surrounds the press seal of arc tube 2 and rigidly holds it in place. Preferably, the construction and disposition of upper strap 11 is similar to lower strap 7. A pair of upper bumpers 9 are mounted upon vertical sections 17 and 19 of upper support 10 and resiliently abut against the sides of the tubular portion of bulbous envelope 1. Such disposition prevents breakage of the lamp if the arc tube is shaken or dropped.

A lead-in wire 28 extends to the outside of arc tube 2 and is attached at its inner end to a molybdenum foil section 6 and thence to a cathode 3. An electrical connection is made between stiff lead-in wire 16 and lead-in wire 28 through a thin conducting lead 20 which may be of any suitable conducting material. Preferably, conducting lead 20 is distantly removed from arc tube 2, generally by bending it around the perimeter of outer bulbous envelope 1.

Disposed within arc tube 2 is the usual inert starting gas, such as neon, argon, xenon and the like, and a filler substance 30 which generally exists in the form of a globule during quiescent non-operating condition of the lamp. Filler 30 is composed primarily of mercury and includes, in addition, a light emitting metal in element or compound form, sodium halide and a halide of cesium, potassium or rubidium. Mercury is present in the usual amount, that is to say, so that under normal operating conditions, the mercury is totally volatilized and produces a pressure within arc tube 2 of about $\frac{1}{2}$ to 10 atmospheres. The light emitting metal can be one or more of scandium, indium, thallium, gallium, dysprosium or any light emitting metal commonly used in metal halide lamps, such as disclosed in the patents cited above under "Description of the Prior Art."

Sodium halide is present in an amount that will stabilize the arc and/or yield chromatically pleasing light, as mentioned previously. Such amount is generally about 0.1 to 3.0 milligrams per cubic centimeter of arc tube volume or about 5×10^{-7} to 7×10^{-5} gram atoms per centimeter of arc length, although, as pointed out in Waymouth, J. F., *Electric Discharge Lamps*, Mass., M.I.T. Press, 1971, pages 231, 266, most of the sodium halide is present in a condensed phase during normal lamp operation.

A halide of cesium, potassium or rubidium is present in an amount that is between about 2 and 20 mole percent of the quantity of sodium halide. There is no sig-

nificant increase in lamp life when said amount is less than about 2 mole percent; and above about 20 mole percent, lamp efficiency is reduced to a commercially unacceptable level.

In U. S. Pat. No. 3,424,935 the problem of sodium migration through an arc tube wall is disclosed. It is believed that increased lamp life results from the instant invention because cesium, potassium and rubidium migrate through the arc tube wall at a considerably lower rate than does sodium. Thus after, say, several thousand hours of lamp operation, where there might be insufficient sodium halide remaining in the arc tube fill to prevent arc restriction, there is sufficient cesium, potassium or rubidium halide present to prevent arc restriction. Arc restriction can cause premature lamp failure by local overheating of the arc tube.

The migration rates of sodium, cesium, potassium and rubidium in 400 watt lamps were compared under accelerated life test conditions. Charge 30 in all the lamps consisted of 50 mg mercury, 5 mg mercuric iodide, 0.5 mg scandium and, in respective order 20 mg sodium iodide, 18 mg sodium iodide plus 2 mg cesium iodide, 18 mg sodium iodide plus 2.1 mg potassium iodide, and 18 mg sodium iodide plus 3 mg rubidium iodide. The migration rates of cesium, potassium and rubidium were found to be negligible while the sodium migration rate was substantial.

In another accelerated life test on 400 watt metal halide lamps, charge 30 contained 50 mg of mercury, 5 mg of mercuric iodide, 0.5 mg of scandium and 1.3×10^{-4} gram atoms (equal to 3×10^{-5} gram atoms per cm of arc length) of alkali iodide. In one set of lamps the alkali iodide was sodium iodide; in a second set of lamps it was 95 percent mole percent sodium iodide and 5 mole percent cesium iodide; in the third and fourth sets of lamps the cesium iodide concentration was 15 and 25 mole percent respectively. The lamps containing 25 mole percent cesium iodide had an efficiency less than 80 lumens per watt while the lamps containing 0 percent, 5 percent and 15 percent cesium iodide all had efficiencies between 85 and 95 lumens per watt. After 125 hours of accelerated life testing, the lamps without cesium iodide failed, while all lamps with cesium iodide continued to operate satisfactorily.

We claim:

1. A metal halide arc discharge lamp comprising: an arc tube having sealed ends and electrodes disposed in said ends; and a fill within said arc tube comprising mercury, a light-emitting metal, sodium halide in the amount of about 5×10^{-7} to 7×10^{-5} gram atoms per centimeter of arc length and a quantity of an arc-restriction-preventing metal halide which diffuses through the arc tube wall at a significantly lower rate than sodium and thus prevents arc restriction in an operating lamp after sodium, because of gradual diffusion through the arc tube wall, no longer effectively prevents arc restriction, said arc-restriction-preventing metal halide being cesium, potassium or rubidium, said quantity being between 2 to 20 percent of sodium halide.

2. The lamp of claim 1 wherein said light emitting metal is scandium, indium, thallium, gallium or dysprosium.

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