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Kopelman

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[54] **SODIUM VAPOR LAMP HAVING A GROOVED ALUMINA ARC TUBE**

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[21] Appl. No.: **265,523**

[52] **U.S. Cl.** **315/47,** 313/15, 313/44, 313/225, 313/229

[51] **Int. Cl.** **H01j 7/24**

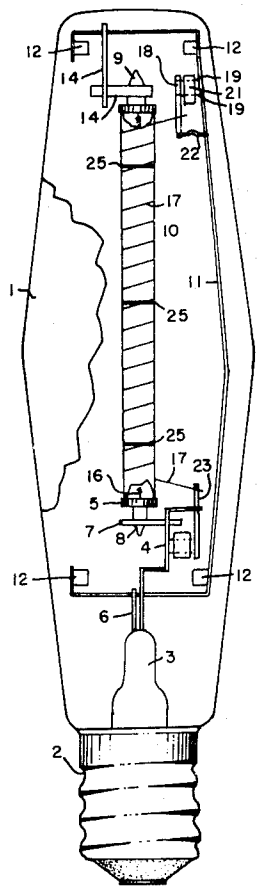
[58] **Field of Search** 315/46, 47, 48; 313/15, 17, 44

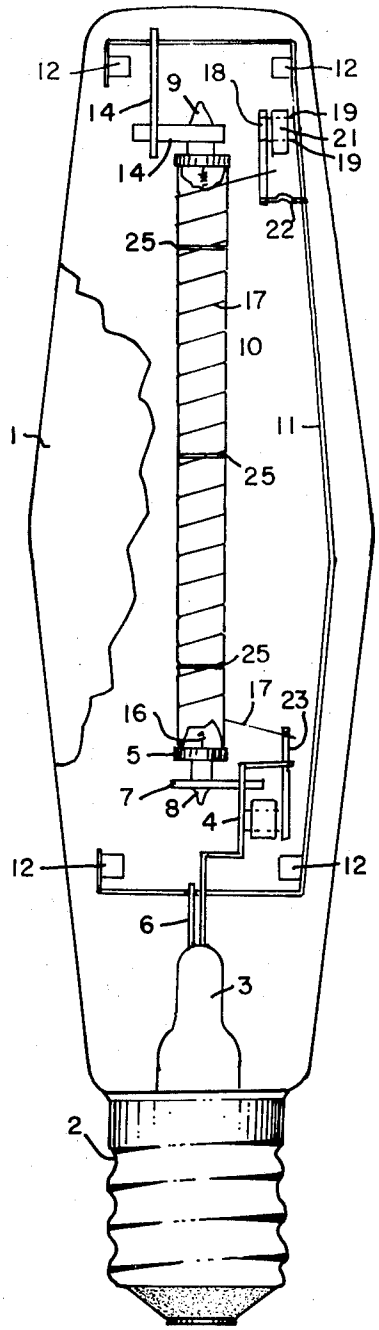
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[57] **ABSTRACT**

The arc tube of a sodium vapor arc discharge lamp has a spiral groove on the outer surface thereof. A refractory metal wire heater is wound around the arc tube and seated in the groove in order to maintain uniform spacing between the turns of the heater throughout the life of the lamp.

4 Claims, 1 Drawing Figure




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SODIUM VAPOR LAMP HAVING A GROOVED ALUMINA ARC TUBE

BACKGROUND OF THE INVENTION

1. Field Of The Invention

This invention relates to arc discharge lamps and, in particular, to high pressure sodium vapor lamps.

2. Description Of The Prior Art

Within the past few years, high pressure sodium vapor lamps have become commercially useful, especially for outdoor lighting applications, because of their high efficiency, generally in excess of 100 lumens per watt. The sodium operating vapor pressure in such lamps can vary from several millimeters to about 1,000 millimeters Hg.

Such lamps are called high pressure in order to distinguish them from low pressure sodium vapor lamps in which the sodium operating vapor pressure is in the order of a few microns. Low pressure sodium lamps have been in use for about thirty or forty years, but, although efficient, they produce an unattractive monochromatic yellow light. The color of light from high pressure sodium lamps is considerably improved over that from low pressure sodium lamps.

High pressure sodium lamps generally comprise an alumina ceramic arc tube and an arc tube fill of sodium, mercury and an inert gas. Examples of such lamps are shown in the following U.S. Pat. Nos.: 3,248,590; 3,384,798; 3,448,319; 3,453,477; 3,485,343; 3,519,406; 3,521,108; 3,558,963.

One of the problems of high pressure sodium arc discharge lamps relates to the stating thereof. Such lamps require a considerably higher starting voltage to initiate an arc discharge than do other types of arc discharge lamps, such as fluorescent, mercury or metal halide. This higher starting voltage requirement necessitates the use of a special ballast for high pressure sodium lamps.

SUMMARY OF THE INVENTION

Copending application Ser. No. 214,000, filed Dec. 30, 1971, entitled "Arc Discharge Tube With Surrounding Starting Coil," same assigneee as the instant application, the disclosure of which is incorporated herein by reference, discloses a lamp having a wire heater coiled around the arc tube for the purpose of reducing the lamp starting voltage. Unexpectedly, the turns of said heater tend to bunch up during lamp life, even when the arc tube is operated in a horizontal position. This may be due to the extreme smoothness of the outer surface of the arc tube coupled with expansion and contraction of the heater that occurs during lamp starts.

The invention disclosed in the instant application is an improvement thereover in that means are provided for maintaining uniform spacing of the heater turns throughout lamp life.

A high pressure sodium vapor lamp in accordance with this invention comprises an alumina arc tube having electrodes at its ends and containing a fill including sodium, mercury and an inert gas. The manufacture of such an arc tube is disclosed in U.S. Pat. No. 3,026,210 to Coble, issued on Mar. 20, 1962, entitled "Transparent Alumina And Method of Preparation."

In the instant invention the arc tube has a spiral groove on its outer surface extending from about one end of the tube to the other or, at least, for a distance about equal to the electrode spacing. The depth of the groove should be less than about one-third of the wall thickness of the arc tube in order to avoid weakening the arc tube.

Wrapped around the arc tube and seated in the groove is a heater made of refractory metal wire. It is not necessary that the wire be completely seated in the groove; however, at least about half of the wire should be seated in order to obtain substantial improvement in turn spacing throughout lamp life. That is to say, the depth of the groove should be greater than about 50 percent of the diameter of the heater wire.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE of the drawing is an elevational view, partly in section, of a high pressure sodium vapor lamp in accordance with this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A high pressure sodium vapor lamp in accordance with this invention comprises a conventional outer glass jacket **1** extending from a base **2**. A reentrant stem having a press **3** supports lead-in wires **4** and **6**, the first of which is connected by strap **7** welded to lower niobium tube **8** of alumina arc tube **10**. The other lead-in wire **6** is connected by a weld to C-shaped frame **11** extending to about the top of the outer jacket **1**. Straps **14** are connected by welds between the top of the frame and upper niobium tube **9** of arc tube **10**. The lower and upper niobium tubes **8, 9** are connected to electrodes **16** within arc tube **10**. Spring fingers **12** engage jacket **1** positioning frame **11** and arc tube **10**.

A typical arc tube **10** for a 400 watt lamp is manufactured of polycrystalline, high density, high purity alumina tubing resistant to sodium attack such as is described in previously mentioned U.S. Pat. No. 3,026,210. The tube has a length of 4½ inches with an outer diameter of 0.350 inches and a wall thickness of 0.030 inches. The arc tube has a gas fill argon at 23 torr, or xenon at 13 torr, and a chemical fill of 20 milligrams of mercury and 50 milligrams of mercury-sodium amalgam, approximately 1 part sodium to 3 parts mercury by weight.

A refractory wire conductor **17** of ohmic heating material is in coiled form around and supported in contact with arc tube **10** throughout a major portion, or preferably as shown, throughout substantially the entire length of the arc discharge space between the electrodes **16**. Typically the conductor is a tungsten filament, made of 3 mil wire, drawing 100 watts at 120 volt operation. The turns of the coil may be spaced approximately one-eighth to one-half inch apart, the end turns being about one-fourth inch from end caps **5** of the arc tube. The upper turn of filament **17** is welded to wire rod **18** which is insulatively supported on frame **11** by wires **19** separately imbedded in glass cylinders **21**. The electrical gap between rod **18** and frame **11** is completed at cold lamp temperature by bimetallic, thermostatic switch leaf **22** welded to rod **18** and contacting frame **11**. Similarly the lower turn of filament **17** is welded to rod **23** insulatively supported on lead-in wire **4**. One or both of the thermostatic switches may be replaced by a permanent connection, although with a loss of efficiency if both switches are omitted. The thermostatic switches open the filament circuit after arc ignition and during normal lamp warm up and operation.

While a thermally responsive mechanical switch is shown, other switches such as switches responsive to arc starting temperature or arc operating voltage or current including solid state and gaseous discharge switches may be used.

Arc tube **10** has a spiral groove about 5 to 10 mils deep extending along its outer surface in which heater **17** is seated. The groove is readily formed in the arc tube, such as by machining on a lathe, when the arc tube is in its green, pre-sintered state. After grooving, the arc tube is sintered at the usual firing temperature of 1,700° to 1,950° C.

In some cases, it may be desirable to tie heater **17** in place on arc tube **10** to ensure that the turns of the heater remain in place in the grooves. Short lengths **25** of refractory metal wire are used for this purpose. The wire is tightly wrapped around the arc tube for one revolution and the ends thereof are twisted together to secure the wire against the arc tube. When such tying is employed, it is advantageous to circumferentially groove the arc tube to prevent the tie wires from slipping, Such grooves are formed, as before, on the green, pre-sintered arc tube. Typically, tie wires are used at the center and ends of heater **17** as shown in the drawing.

I claim:

1. A high pressure sodium vapor lamp comprising: a glass envelope; an alumina arc tube disposed within said envelope and having electrodes sealed therein at the ends thereof and containing a filling including sodium, mercury and an inert gas, said arc tub having a spiral groove on its outer surface extending from about one electrode to the other; a heater or refractory metal wire wrapped around said arc tube and seated in said groove; and a thermal switch disposed within aid envelope and electrically connected to one end of said heater.

2. The lamp of claim **1** wherein the depth of said spiral groove is greater than about 50 percent of the diameter of said refractory metal wire.

3. The lamp of claim **1** wherein said heater is secured to said arc tube by means of short lengths of wire circumferentially wrapped around said arc tube.

4. The lamp of claim **3** wherein said arc tube has a plurality of circumferential grooves and said short lengths of wire are seated in said circumferential grooves.

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