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Cohen et al.

[11] **3,806,748**

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[54] **SODIUM VAPOR LAMP HAVING A GROOVED ALUMINA ARC TUBE WITH SIDE ROD HEATER RETAINER**

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[52] **U.S. Cl.** **313/15**, 313/180, 313/220, 313/229, 313/344

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

[58] **Field of Search** 313/15, 25, 27, 180, 184, 313/220, 225, 228, 229, 344

[56] **References Cited**

UNITED STATES PATENTS

2,765,416	10/1956	Beese et al.	313/15 X
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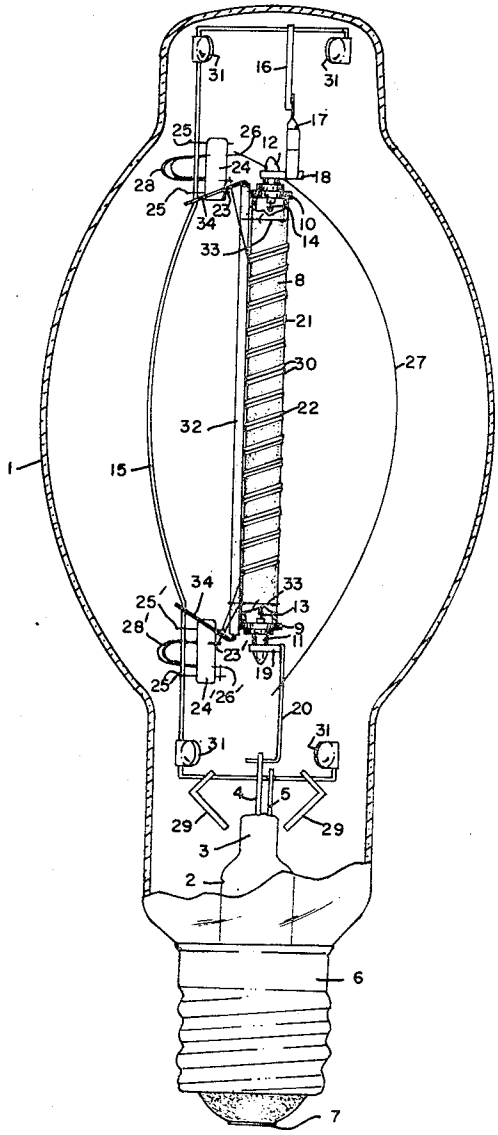
[57] **ABSTRACT**

The alumina arc tube of a high pressure 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. A ceramic rod, abutting the arc tube, prevents displacement of the heater wire from the groove throughout lamp life.

7 Claims, 2 Drawing Figures



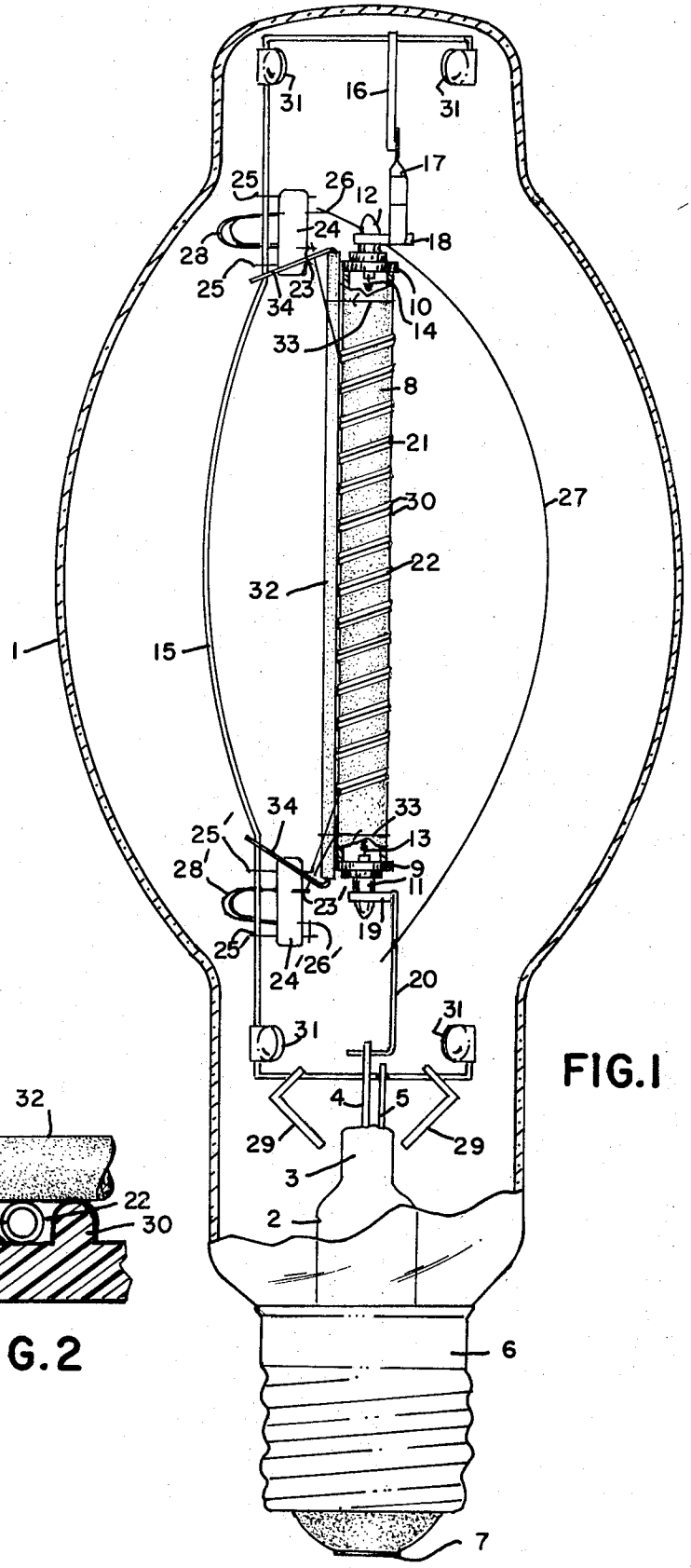

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FIG.1

32
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FIG.2

SODIUM VAPOR LAMP HAVING A GROOVED ALUMINA ARC TUBE WITH SIDE ROD HEATER RETAINER

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 1000 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 order of a few microns. Low pressure sodium lamps have been in use for about 30 or 40 years, but, although efficient, they produce an unattrative 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 and 3,622,217.

One of the problems of high pressure sodium arc discharge lamps relates to the starting 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.

It is an object of this invention to provide a high pressure sodium vapor lamp having a reduced starting voltage, thereby eliminating the high voltage requirements of the ballast. Thus, a simpler more economical ballasting arrangement becomes quite practicable and, in fact, conventional mercury lamp ballasts can often be used with the lamps of this invention. This permits, in many cases, direct replacement of such mercury lamps by high pressure sodium lamps of this invention without any changes in the mercury lamp ballasts or fixtures.

SUMMARY OF THE INVENTION

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. A wire wound heater is disposed in heat transfer relationship with the arc tube in order to effect a substantial reduction in arc tube ignition voltage, as shown in co-pending application Ser. No. 214,000 filed Dec. 30, 1971, now U.S. Pat. No. 3,746,914 assigned to the instant assignee, the disclosure of which is incorporated herein by reference.

In a co-pending application, Ser. No. 339,326, entitled "Sodium Vapor Lamp Having An Improved Grooved Alumina Arc Tube", filed on even date herewith, identified as Docket No. 7326–L, same assignee, the wire wound heater is seated in grooves formed by raised shoulders spirally encircling the arc tube in order to maintain uniform turn spacing of the heater throughout the life of the lamp. The shoulders defining the groove are raised above the normal outer surface of the arc tube in order that the arc tube wall thickness need not be reduced at the groove. The instant invention is an improvement thereover in that it permits vertical operation of the lamp, as well as horizontal operation.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an elevational view, partly in section, of a lamp in accordance with this invention.

FIG. 2 is an expanded sectional view of the arc tube of the lamp of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A high pressure sodium vapor lamp in accordance with this invention comprises an outer glass envelope 1 which can be of elongated ovoid shape, such as is commonly used in high pressure sodium lamps, or of bulbous shape, such as is commonly used in mercury vapor and metal halide lamps. The neck of the envelope is closed by a reentrant stem 2 having a press 3 through which extend stiff lead-in wires 4,5 connected at their outer ends to a threaded shell 6 and center contact 7 of a conventional screw base.

Disposed within envelope 1 is an alumina arc tube 8, having raised shoulders 30 forming grooves 21, sealed at its lower end by niobium end cap 9 and at its upper end by niobium end cap 10. Niobium tubes 11, 12 are brazed or welded to end caps 9,10 and are used to support arc tube 8 as well as to conduct current to electrodes 13,14 within the arc tube. In addition, one of the niobium tubes serves as an exhaust tube during manufacture and is used to introduce a fill including an inert gas (e.g. argon or xenon), sodium and mercury into the arc tube, after which the niobium tube is sealed, such as by a cold weld.

Arc tube 8 is supported within envelope 1 by a structure consisting of side support wire 15, vertical support wire 16, metal strap 17 and horizontal metal strap 18. Support wire 15 is welded to lead-in wire 5, support wire 16 is welded to wire 15, strap 17 is welded to wire 16, strap 18 is welded to strap 17 and strap 18 is connected to upper niobium tube 12. Electrical connection between lead-in wire 5 and upper electrode 14 is established by said structure.

The lower end of arc tube 8 is supported by metal strap 19 which is connected between niobium tube 11 and support wire 20, with support wire 20 being welded to lead-in wire 4. Electrical connection is also established thereby between lead-in wire 4 and lower electrode 13.

Encircling arc tube 8 and seated in groove 21 is a wire wound heater 22 of the type disclosed in co-pending application Ser. No. 214,000. The upper and lower ends of heater 22 are electrically connected, respectively, to the lower and upper electrodes in order to further reduce the lamp starting voltage, as disclosed in co-pending application Ser. No. 266,294, now U.S. Pat. No. 3,721,846.

The upper end of a heater 22 is connected to a wire 23 which is embedded in glass rod 24. Glass rod 24 is

supported from side wire **15** by two wires **25** which are welded to side wire **15** and embedded in glass rod **24.** Also embedded in glass rod **24** is another wire **26** one end of which is connected to support wire **20** by a thin wire **27.** A U shaped bimetallic switch **28** makes electrical connection between wire **23** and wire **26.** The result of this electrical arrangement is that the voltage applied to lower electrode **13** is also applied to the upper end of heater **22.** Switch **28** has a predetermined opening which exceeds the temperature at which arc tube ignition occurs. Upon opening switch **28,** heater **22** is electrically removed from the circuit.

The lower end of heater **22** is electrically connected to side support wire **15** by a similar arrangement of wires **23'**, **25'** and **26'**, glass rod **24'** and switch **28'**. Switch **28'** also opens after arc tube ignition to electrically isolate heater **22.**

Attached to the upper and lower ends of side wire **15** are spring fingers **31** which press against the interior wall of envelope **1** and provide increased support for the arc tube. Also disposed on the lower end of side wire **15** are ring getters **29,** since envelope **1** contains a vacuum to reduce arc tube heat losses.

Shoulders **30** which form grooves **21** of arc tube **8** are raised, instead of machining a groove into the arc tube wall, in order to avoid thinning the arc tube wall at the grooves. The manufacture of such an improved grooved arc tube is described in co-pending application Ser. No. 339,326, Docket No. 7326–L.

However, in the instant invention, there is an insulative rod **32** abutting arc tube **8** in order to prevent heater **22** from being displaced from groove **21.** It is possible, without rod **32,** for such displacement to occur if the lamp is subjected to vibration during operation. It is also possible for such displacement to occur if the lamp is operated in a vertical position, especially when heater **22** is a coiled coil and can sag out of the groove during the life of the lamp.

In order to permit heater **22** to be operated directly off the line voltage at which the lamp is operated, the length of heater wire necessary for satisfactory operation of heater **22** is sufficiently great that heater **22** preferably consists of a coiled coil. That is to say, the heater wire is primary coiled on a mandrel and then, after mandrel removal, the primary coiled wire is secondary coiled, that is, wound around arc tube **8** in grooves **21.** This minimizes the number of secondary turns on arc tube **8.** To illustrate, in one example, heater **22** consisted of 4880 mm of 2½ mil tungsten wire. If this wire were wound directly on arc tube **8,** it wound require winding at the rate of about 56 turns per inch (TPI). However, when the wire is first primary coiled on a 12 mil mandrel, it can then be wound on arc tube **8** at the rate of about 4 TPI. A winding rate of 4 TPI is considerably more preferable than 56 TPI for several reasons. There will be less interception of light from the arc tube by the heater wire itself. And there will be fewer numbers of raised shoulders **30** on arc tube **8**; an excessive number of such shoulders can reduce the light transmission of the arc tube wall by causing a significant increase in the effective wall thickness of the arc tube.

But the desirability of using a coiled coil for heater **22** results in disadvantages which this invention overcomes. A primary coiled wire cannot be wound on arc tube **8** as tightly as a straight wire can. And a primary coiled wire is more likely to sag during vertical lamp operation than a straight wire. Rod **32,** abutting arc tube **8,** solves these problems by retaining the heater wire, that is, preventing the heater wire from sagging out of grooves **21.** Rod **32** should be an insulative rod to prevent shorting out the turns of heater **22** and should be heat resistant, since the arc tube operating temperature is about 1200°C. The diameter of rod **32** should be small, say, less than 40percent of the diameter of arc tube **8,** in order to avoid interception of a significant amount of light from arc tube **8.**

In the embodiment shown in the drawings, rod **32** was an alumina ceramic rod slightly longer than arc tube **8.** Rod **32** was drawn against arc tube **8** by tie wires **33** which were wrapped around both rod **32** and arc tube **8** and securely tied, such as by twisting. In addition, rod **32** was supported by bent rods **34,** inserted into holes in the ends of rod **32.** The other ends of rods **34** were fastened, such as by welding, to side support wire **15.**

In this example, rod **30** had a diameter of **90** mils and arc tube **8** had a diameter of 345 mils. The lengths of rod **30** and arc tube **8** were five inches and 4 ⅜ inches respectively.

Lamps made in accordance with this invention were operated over 1000 hours in a vertical position under severe conditions of continuous shock with no significant movement of heater **22.** Without side rod **32** to retain the heater, lamps operated under the same conditions had excessive turn displacement in less than 50 hours.

We 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 tube having a spiral groove formed by raised shoulders on its outer surface extending from about one electrode to the other, the shoulders defining said groove being raised above the outer surface of said arc tube; a heater of refractory metal wire wrapped around said arc tube and seated in said groove; and an insulative heater-retaining side rod parallel to, and abutting, said arc tube.

2. The lamp of claim **1** wherein said groove is a channel between two parallel raised shoulders on said outer surface.

3. The lamp of claim **1** comprising, in addition, a thermal switch, one end of said heater being electrically connected to the electrode at the opposite end of said arc tube through said thermal switch, said switch being normally closed during non-operation of said lamp and opening after ignition of the arc tube and remaining open during normal lamp operation.

4. The lamp of claim **1** wherein said heater is a coiled coil.

5. The lamp of claim **1** wherein said side rod is less than about 40 percent of the diameter of said arc tube.

6. The lamp of claim **1** wherein said side rod is made of alumina.

7. The lamp of claim **1** wherein said side rod is tied to said arc tube with wire ties.

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