United States Patent

Yamane et al.

[15] **3,642,340**

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[54] HIGH-PRESSURE METAL VAPOR DISCHARGE LAMP

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[52] **U.S. Cl.**.....**316/20,** 316/24

[51] **Int. Cl.**.....**H01j 9/38**

[58] **Field of Search**.....316/20, 24, 3, 13, 18; 219/68; 313/220, 184

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[57] **ABSTRACT**

An improved method of sealing off exhaust tubes in the manufacture of high-pressure metal vapor discharge lamps comprising a translucent ceramic tube containing therein Na, Hg or like metal.

2 Claims, 4 Drawing Figures

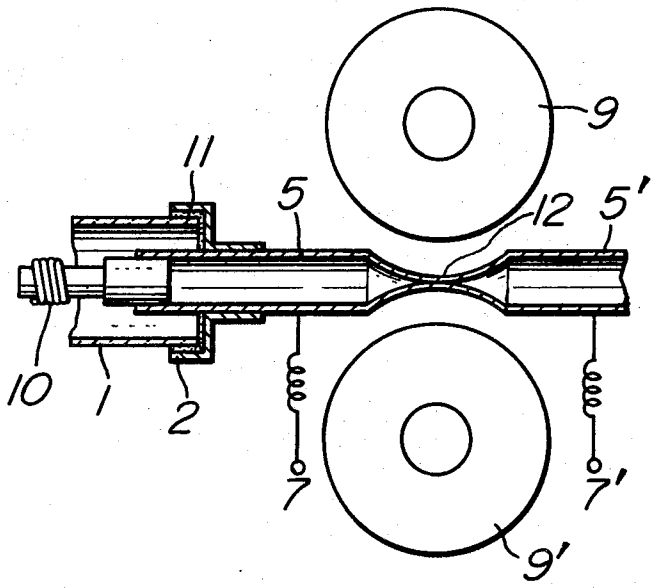


FIG. 1

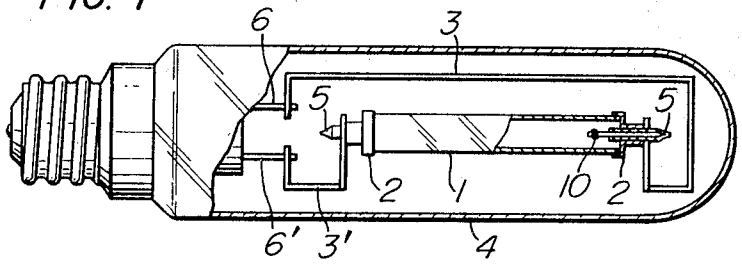


FIG. 2 PRIOR ART

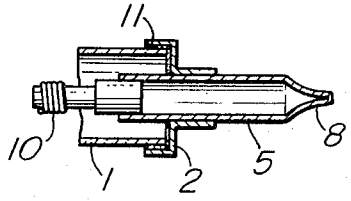


FIG. 3

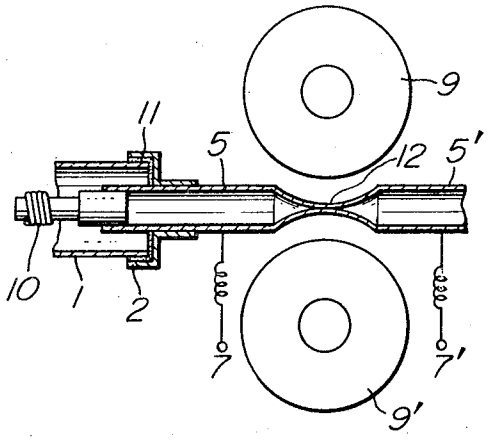
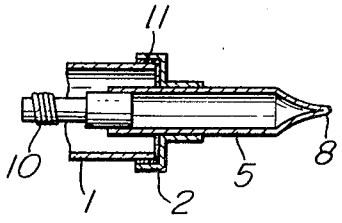


FIG. 4



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HIGH-PRESSURE METAL VAPOR DISCHARGE LAMP

FIELD OF THE INVENTION

This invention relates to a method of manufacturing high-pressure metal vapor discharge lamps each of which comprises a translucent ceramic tube constituting a luminous tube, and metallic exhaust tubes formed of niobium or like material and attached to the translucent ceramic tube in hermetical manner. More particularly, it relates to a method of manufacturing high-pressure metal vapor discharge lamps, which method comprises attaching a metallic exhaust tube to a translucent ceramic tube in hermetical manner, evacuating the interior of the translucent ceramic tube and introducing a charge of gases thereinto, thereafter pressing the metallic exhaust tube at a portion thereof into joined walls of a small thickness, attaching power source terminals to the opposite sides of the pressed portion of the metallic exhaust tube, applying a voltage to the exhaust tube by means of the source terminals in an atmosphere of vacuum or inert gas, fusing the pressed portion of the exhaust tube with a current passing through the press-sealed portion, and thereby sealing off the metallic exhaust tube to ensure a reliable gastightness at the sealed portion of the exhaust tube.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partly broken-away front view of a high-pressure metal vapor discharge lamp;

FIG. 2 is an enlarged, fragmentary sectional view showing the essential part of the high-pressure metal vapor discharge lamp provided according to the prior art method;

FIG. 3 is an enlarged, fragmentary sectional view for illustrating the method of manufacturing the high-pressure metal vapor discharge lamp according to the present invention; and

FIG. 4 is an enlarged, fragmentary sectional view showing the essential part of the high-pressure metal vapor discharge lamp provided according to the method of the present invention.

DESCRIPTION OF THE PRIOR ART

It is generally known that a nearly white light can be provided by a high-pressure metal vapor discharge lamp which comprises a discharge tube constituted by a translucent ceramic tube, and metallic exhaust tubes attached to the discharge tube in hermetical manner, the discharge tube enclosing therein inert gases such as metal sodium, mercury and xenon gas. As sodium vapor is strongly chemically active, materials involved in the discharge tube will be readily corroded. Therefore, it is necessary to construct the discharge tube of sodium-resistive materials. An example of the discharge lamp so constructed is shown in FIG. 1, in which a discharge tube 1 is formed of translucent ceramics consisting of high density polycrystalline alumina. Metallic exhaust tubes 5 formed of niobium and having an electrode 10 are attached to the discharged tube 1 at the opposite ends thereof in hermetical manner by means of end member of metallic caps 2. Each metallic exhaust tube 5 is pressed at a portion thereof and sealed off after a charge of gases such as sodium, mercury and xenon gas is introduced into the discharge tube 1. The discharge tube 1 is then supported by support means 3 and 3'. These support means 3 and 3' secure at one end thereof the respective exhaust tubes 5 and are fixedly connected at the other end with lead wires 6 and 6' respectively. The assembly thus provided is enclosed in an outer tube 4 which is evacuated.

According to the prior art method, the high-pressure metal vapor discharge lamp has been provided by pressing the sealoff portion 8 of each metallic exhaust tube 5 into a flattened form with rollers of a material such as very hard metal, as shown in FIG. 2, then joining together the inner surfaces of the sealoff portion 8 in a gastight manner, and removing any excessive portion of the exhaust such as by repeated bending. However, the seal off portion 8 thus provided according to the known method has so small a press-sealed portion that the sealoff portion is poor in its mechanical strength as well as insufficient in its gastightness. Moreover, the pressing and sealing-off operations, if not carried out skillfully would result in unsatisfactory sealing effect at the sealed-off portion 8, which would permit the press-sealed portion to become apart and would cause gas leakage therethrough. This is fatal to life of the discharge lamp. Furthermore, the sealed portion of the exhaust tube is usually subjected to thermal stresses because a discharge lamp is frequently turned on and off, and such thermal stress often causes the sealed portion to be disjoined with a result that the discharge lamp cannot be lit up any further.

SUMMARY OF THE INVENTION

The present invention contemplates to overcome the above-described disadvantage of the prior art and provide a method of manufacturing improved high-pressure metal vapor discharge lamps.

To achieve this object, the method of manufacturing high-pressure metal vapor discharge lamps according to the present invention comprises the steps of attaching an electrode and a metallic exhaust tube to each end of a translucent ceramic tube in hermetical manner to thereby form a discharge tube, introducing a predetermined quantity of charge into said discharge tube, thereafter pressing said metallic exhaust tube at a portion thereof into joined walls of a small thickness, subsequently applying a voltage to the opposite sides of said pressed portion of said metallic exhaust tube in an atmosphere of a vacuum of an inert gas to thereby pass a current through said pressed portion so as to fuse the same, and thereby sealing off said exhaust tube.

According to the present invention, the metallic exhaust tube attached to the translucent ceramic tube in hermetical relationship therewith is pressed at at portion thereof into joined walls of a small thickness, and the thus pressed portion of the exhaust tube is then fused by a current supplied thereto to thereby seal off the same portion. This ensures the sealoff of the exhaust tube and prevents any disjoining of the press-sealed portion which might result in defective gastightness, and thus no failure of operation would occur in the discharge lamps provided by the method of the present invention. Moreover, the fusing effected by the current causes the sealoff portion of the exhaust tube to be recrystallized and thereby the press-sealed portion thereof are fused together, so that the sealed portion of the exhaust tube is highly resistive to thermal shocks caused by the turning on and off of the discharge lamp and thus can prevent any defective gastightness at the sealed portion resulting from the thermal stresses. This ensures a greatly improved life for the discharge lamp. Also, the fusing of the pressed portion can be achieved in a very short time to thereby obviate the brittle of the exhaust tube, which in turn results in a simplified fusing and sealing procedure which is suited to the mass production of discharge lamps.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As embodiment of the present invention will now be described with respect to FIGS. 3 and 4.

According to the present invention, the high-pressure metal vapor discharge lamp is provided by the method described below. As shown in FIG. 3, an and member 2 of a metallic cap having a metallic exhaust tube 5 and an electrode 10 secured thereto is hermetically attached to a translucent ceramic tube constituting a discharge tube 1, at each end thereof, by means of a bonding solder 11 composed of glassy material or the like. Subsequently, the discharge tube 1 is evacuated through the exhaust tube 5, through which a predetermined quantity of metal sodium, mercury and xenon gas is inject into the luminous tube 1. Thereafter, a pair of rollers 9 and 9' formed of a very hard metal and arranged so as to hold and press the metallic exhaust tube 5 therebetween are operated to hold the exhaust tube 5 therebetween and then a pressure is applied to the roller 9 and 9' so as to press the metallic exhaust tube 5 at the portion thereof which is held by the rollers. Thereby the

metallic exhaust tube 5 is formed with a press portion 12 of a small thickness and thus the exhaust tube is divided into two sections 5 and 5' by the pressed portion 12 as shown in FIG. 3. Thereafter, power source terminals 7 and 7' are attached to the exhaust tube sections 5 and 5' respectively. The discharge tube 1 comprising the translucent ceramic tube and exhaust tube 5 is then housed in a vacuum or a vessel containing an inert gas. A voltage is applied to the source terminals 7 and 7' to pass a current through the pressed portion 12 of the exhaust tube 5 so that the pressed portion 12 may be fused to complete the sealoff of the exhaust tube section 5 at its outer end 8, as shown in FIG. 4. In this way the sealed end 8 of the exhaust tube 5 is formed by fusing after the tube is pressed by the rollers, and this results in no defective gastightness or no disjoining at the press-sealed portion.

The subsequent assemblage is carried out in the known manner. The exhaust tube 5 of the discharge tube 1 is secured to support means 3 and 3' which are fixedly connected with lead wires 6 and 6' respectively. The assembly thus provided is then housed in an outer tube 4, which is evacuated and sealed off into a state of vacuum. There is thus provided a high-pressure metal vapor discharge lamp which has no defective sealoff of the exhaust tube 5 that might lead to a short life of the discharge lamp. Moreover, such a high-pressure metal vapor discharge lamp can always provide a satisfactory nearly white light.

Examples of the method of the present invention will now be described.

EXAMPLE 1

A translucent ceramic tube having an outer diameter of 10 mm. and a length of 100 mm. was used as the discharge tube 1. An exhaust tube 5 formed of niobium and having an outer diameter of 3.5 mm. was hermetically attached to the translucent ceramic tube 1 at each end thereof by means of a cap 2 formed of niobium. The interior of the discharge tube 1 was evacuated, whereafter a predetermined quantity of sodium, mercury and xenon gases was introduced into the discharge tube 1. The niobium exhaust tube 5 having an outer diameter of 3.5 mm. was held and pressed at a predetermined portion thereof by and between rollers 9 and 9' each having a diameter of 4.0 mm. so that the predetermined portion of the exhaust tube 5 formed the pressed portion 12 having a thickness of about 30. Thereafter, power source terminals 7 and 7' were attached to the exhaust tube sections 5 and 5' separated by the pressed portion 12, and then an assembly of the discharge tube 1 and exhaust tube 5 was housed in a vacuum vessel. A voltage was applied to the source terminal 7 and 7' to supply a current of about 140 amperes to the pressed portion 12, which was thereby fused and sealed over a substantial length within about one-third of a second. The sealed portion 8 thus provided in the exhaust tube 5 of the discharge tube 1 was recrystallized due to the fusing and the fused portion of the exhaust tube 5 was sealed to such a complete degree that no defective gastightness or no disjoining occurred at the sealed portion. None of the lamps thus provided failed to operate even after they had been running for 4,000 hours. Moreover, the measurement of the gastightness at the sealed end 8 showed no gas leak or other abnormal results.

EXAMPLE 2

As in Example 1, the discharge tube 1 was formed by assembling a translucent ceramic tube having an outer diameter of 10 mm. and a length of 100 mm. and a niobium exhaust tube 5 having an outer diameter of 3.5 mm. The assembly was subjected to evacuation and other processes, thereafter the predetermined portion of the exhaust tube 5 was pressed into a thickness of about 30 microns by the rollers 9 and 9' each having a diameter of 6.4 mm. The assembly was then housed in a vacuum means, whereupon source terminals 7 and 7' were attached to the respective exhaust tube sections 5 and 5'. A voltage was applied to the source terminals 7 and 7' so as to pass a current of 400 amperes through the pressed portion 12 of the exhaust tube, whereby this portion was fused and sealed over a substantial length within about one-fifth of a second. Niobium in the fused area of the pressed portion 12 was recrystallized by fusing, whereby the inner surfaces of the pressed wall portion were fused and joined together. The sealed end 8 of the exhaust tube 5 thus provided showed no disjoining or no defective sealing at the sealed portion. In this example the same result was obtained as in the previous example, and moreover, the time required for fusing the pressed portion 12 was shorter than that in Example 1.

While the present invention has been described by way of example, the experiments carried on by the inventors have shown the following facts. The fusion of the exhaust tube may be effected not only in a vacuum atmosphere but also in such an inert gas atmosphere that does not make the tube material brittle. Also, the thickness of the pressed portion 12 in the exhaust tube 5 may be various. However, too small a thickness of the pressed portion 12 tends to cause that portion to be broken during the manufacture and disables the same portion to be fused by the power supply. According to the present invention, 10 microns is the minumum possible thickness of the pressed portion. Conversely, too great a thickness requires an unnecessarily large power for fusing the pressed portion, which in turn would mean a bigger size of fusing means as well as a lower production efficiency and a longer fusing time, and accordingly uniformity and reliable gastightness could not be ensured. For this reason, the order of 150 microns is the maximum possible thickness of the pressed portion allowed by the present invention. Also, the current to be supplied to the pressed portion of the exhaust tube 5 should advantageously range from 130 to 500 amperes. A smaller current than this range would elongate the fusing time and accordingly cause such a temperature rise of the pressed portion as might lead to the breakage of the portion connecting the translucent tube with the end member. A greater current than 500 amperes causes the pressed portion to fuse in so short a time that uniformity of fusion is lost or fusing takes place also in other parts of the exhaust tube, with a result that no hermetical sealing could not be achieved in the sealoff end portion of the exhaust tube.

What we claim is

1. A method of manufacturing high-pressure metal vapor discharge lamps comprising the steps of attaching an electrode and a metallic exhaust tube to at least one end of a translucent ceramic tube in hermetical manner to thereby form a discharge tube, introducing a predetermined quantity of operating material into said discharge tube, thereafter pressing said metallic exhaust tube at a portion thereof so as to reduce the thickness of the pressed portion to 10 to 150 microns, subsequently applying a voltage to the opposite sides of said pressed portion of said metallic exhaust tube in an atmosphere of a vacuum or an inert gas to thereby pass a current in the range of 130 to 500 amperes through said pressed portion so as to fuse said pressed portion and thereby seal off said exhaust tube.

2. A method of manufacturing high-pressure metal vapor discharge lamps according to claim 1, wherein the pressing is achieved using rollers so that a tapered pressed portion results, the thickness of the center of the pressed portion falling in the range of 10 to 150 microns.

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