United States Patent

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Original application July 11, 1967, Ser. No. 652,556, now abandoned. Divided and this application Mar. 1, 1970, Ser. No. 23,116

[54] **METHOD OF MAKING A VAPOR DISCHARGE LAMP**
9 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **316/19,** 316/17, 316/18, 316/20
[51] **Int. Cl.** **H01j 9/18**
[50] **Field of Search** 316/17, 18, 19, 20, 1

[56] **References Cited**

UNITED STATES PATENTS

2,391,572	12/1945	Herzog	316/19
3,088,201	5/1963	Lauden et al.	313/220 UX
3,205,395	9/1965	Buchwald	316/17 X
3,211,511	10/1965	Levand, Jr.	316/19
3,363,133	1/1968	Harris et al.	313/221 X
3,384,798	5/1968	Schmidt	313/184
3,385,463	5/1968	Lange	313/221 X
3,390,296	6/1968	Smith	313/220 UX

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ABSTRACT: A metal vapor discharge lamp and method of making the same in which the lamp comprises a partially evacuated translucent ceramic tube containing a charge of metal and a starter gas and hermetically sealed at either end by means of a suitable end cap and electrode assembly which does not have an exhaust tubulation. According to the method of manufacture the evacuation of impurities and residual gases from the lamp and the introduction of the starter gas into the lamp is carried out in the same environment as the sealing of the end cap and electrode assemblies to the ends of the translucent ceramic tube.

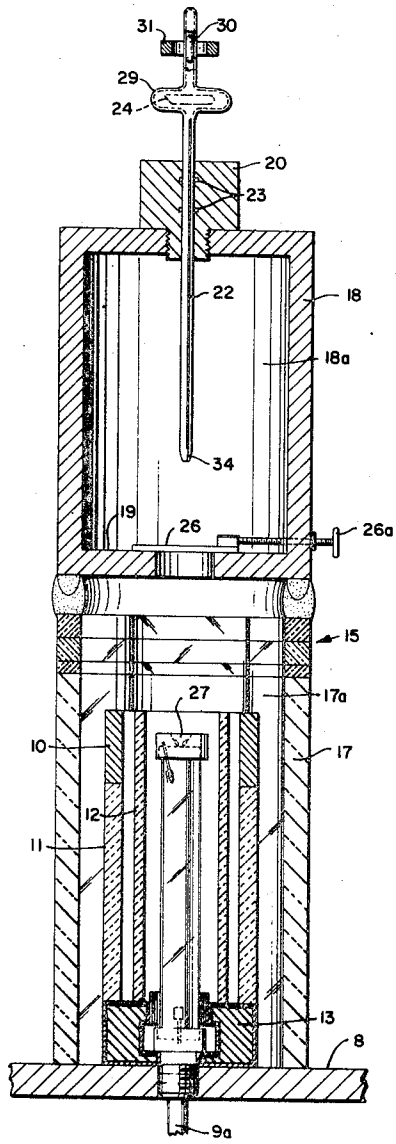


FIG. 1

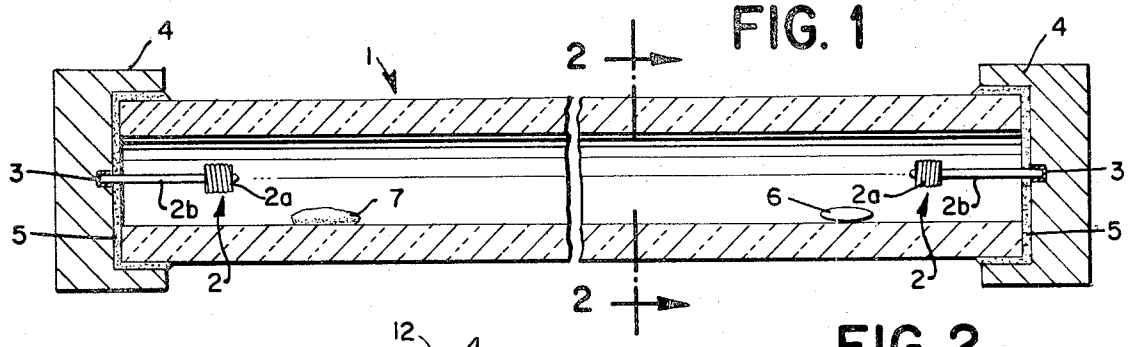


FIG. 2

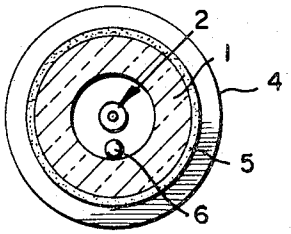


FIG. 3

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FIG. 4

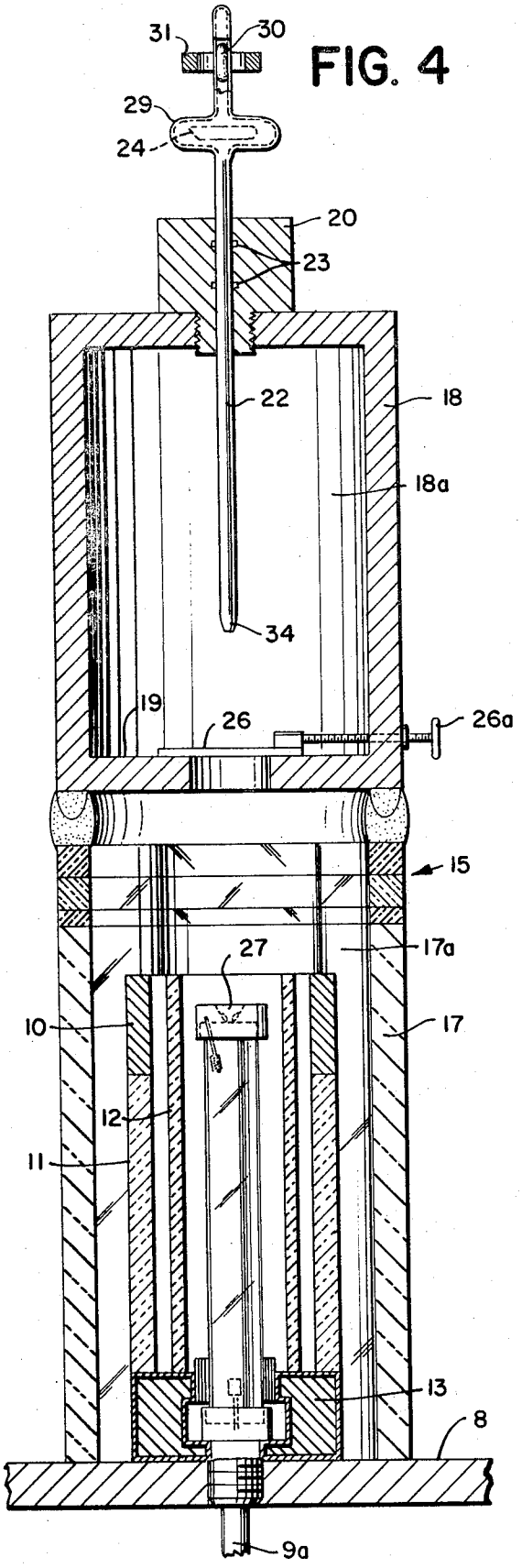


FIG. 5

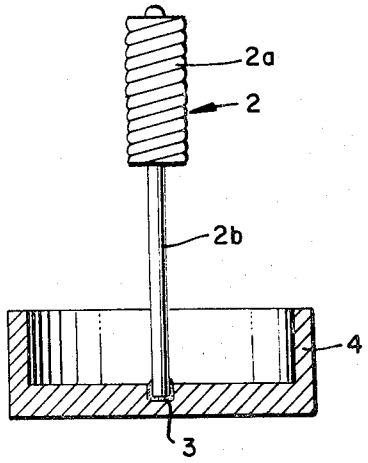
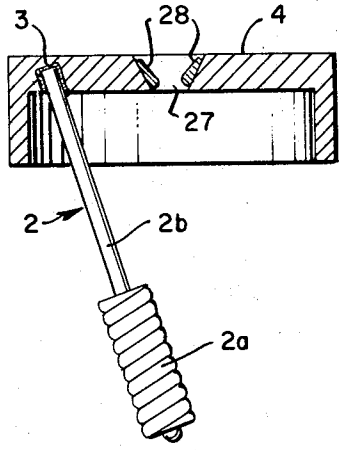


FIG. 6



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METHOD OF MAKING A VAPOR DISCHARGE LAMP

This is a division of application Ser. No. 652,556, filed July 11, 1967, now abandoned.

Because metal vapors and particularly alkali metal vapors are capable of emitting a large percentage of their total spectral output as continuum radiation, they are recognized as a useful source of radiant emission in electric discharge lamps, particularly for applications in the visible and infrared portions of the spectrum. However, in order to achieve high levels of continuum emission, relatively high metal vapor pressures are required. In order to achieve metal vapor pressures of sufficient magnitude, the metal vapor discharge lamps must be operated at a high temperatures. Consequently, the various elements of metal vapor discharge lamps must be made of materials which will not be attacked by alkali metal vapors at high temperatures. For example, the translucent envelope of such a metal vapor discharge lamp might be made of a ceramic material such as polycrystalline alumina or sapphire.

Prior art methods of fabricating electric metal vapor, discharge lamps having ceramic envelopes generally include the joining of a cylindrical translucent ceramic envelope to two formed metal end caps to which suitable electrodes have been attached. One of the end caps is provided with a small hollow tube, known as an exhaust tube, which permits the assembled lamp to be evacuated and the necessary metals and starter gases to be introduced. Because of the high-operating temperatures of the finished lamp, both the end caps and the exhaust tubing must be made of refractory materials. In addition, these materials must have approximately the same coefficient of thermal expansion as the ceramic envelope. Further, the ceramic envelope, the electrodes, the end caps, and the exhaust tubing must be made of materials which are able to withstand the corrosive effect of alkali metal vapors used in the lamp at the requisite high-operating temperatures.

In the prior art method of manufacturing these types of lamp, the end and electrode assemblies are first hermetically sealed at both ends of the translucent ceramic tube and the sealed lamp assembly is connected to an exhaust system by means of the above-mentioned exhaust tube. Impurities and residual gases are then evacuated from the lamp through the exhaust tube and the required metals and starter gases are introduced. The exhaust tube is then cold welded or pinched off at a point along its length so as to finally hermetically seal the lamp and detach it from the exhaust system.

One problem occurring in metal vapor discharge lamps constructed according to the methods of the prior art is that during the operation of the lamp alkali metal vapors tend to condense in the cavity of the tip of the exhaust tubing remaining in the lamp envelope because of the large temperature difference which exists between the end cap of the lamp and this extreme tip of the pinched off exhaust tube.

A second problem of the prior art methods of manufacture arises from the difficulty of removing all traces of the metallic emission material of the electrodes from the exhaust tube prior to the pinching off operation. Any traces of metal or metal condensate will destroy the required cleanliness and surface structure of the inner wall of the exhaust tube and thus prevent a proper cold weld.

A third problem of the prior art methods of manufacture is the general difficulty of pinching off of cold welding the refractory material of the exhaust tubing without causing mechanical damage. For example, refractory metals such as columbium and tantalum have a fibrous structure which demands great care, control instrumentation and equipment in order to successfully achieve a pinch off.

The present invention relates to electric discharge lamps of the type wherein the source of radiant emission comprises a combination of metal vapors and inert starter gases. More particularly, this invention relates to metal vapor electric discharge lamps having translucent ceramic envelopes such as, for example, polycrystalline alumina or sapphire envelopes, which are fabricated without the use of the exhaust tubing required by conventional lamps. The invention further relates to a method of making metal vapor discharge lamps in

which the evacuation of impurities and residual gases and the introduction of the necessary metals and starter gases are accomplished without the use of special exhaust tubing.

It is therefore an object of this invention to provide an improved metal vapor discharge lamp and method of manufacture which obviate the problems of the prior art devices and methods.

More particularly it is an object of this invention to provide an improved metal vapor discharge lamp having no vestigial exhaust tubing tip.

It is also an object of this invention to provide an improved method of manufacturing metal vapor discharge lamps which does not require the use of exhaust tubing.

It is a further object of this invention to provide a method of manufacturing metal vapor discharge lamps wherein the evacuation of impurities and residual gases from the lamp and the introduction of the required metals and starter gases into the lamp are integral with the sealing of the end caps to the translucent ceramic envelope.

According to the above and other objects, this invention provides a metal vapor discharge lamp comprising a translucent ceramic envelope having an end cap and electrode assembly sealed at either end thereof and containing suitable metal emission materials and inert starter gases. As hereinafter described the ends of the lamp do not have the usual exhaust tubes.

The method of manufacturing the discharge lamp of the present invention includes disposing the translucent ceramic tube and a first end cap assembly within an evacuated gastight chamber, heating the ceramic tube and end cap so as to first drive off impurities and residual gases and then bond the tube and one end cap in a gastight seal, inserting a charge of metal into the ceramic tube to provide a source of radiant emission in operation, positioning a second end cap at the open end of the tube, heating the ceramic tube and second end cap so as to again drive off impurities and residual gases, introducing a starter gas into the ceramic tube, further heating the ceramic tube and second end cap so as to bond the tube and end cap in a gastight seal, and removing the assembled lamp from the gastight chamber.

Other objects and advantages of the present invention will be more clearly understood from the following description and accompanying drawings which set forth the principle of the invention and, by way of example, the preferred mode which has been contemplated of applying that principle.

FIG. 1 is a sectional view of the metal vapor discharge lamp of the present invention;

FIG. 2 is a cross-sectional view taken along the line 2—2 of the lamp shown in FIG. 1;

FIG. 3 is a sectional view of a portion of the apparatus used in the method of manufacture of the metal vapor discharge lamps of the present invention showing a lamp mounted therein;

FIG. 4 is a sectional view of a modified form of the apparatus used in the method of manufacturing discharge lamps according to the present invention, also showing a lamp mounted therein;

FIG. 5 is a detailed sectional view of an end car and electrode assembly for the discharge lamp of the present invention, and

FIG. 6 is a detailed sectional view of a modified form of an end cap and electrode assembly for the discharge lamp of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. 1 and 2 show a metal vapor discharge lamp including a transparent or translucent envelope, 1, which may, for example, be in the form of a tube, as shown. Envelope 1 may be made of any material which is transparent or translucent over a substantial portion of the spectrum of the lamp's emitted light and which is able to withstand the effects of the alkali metal vapors at the high-operating temperatures encountered.

For example, translucent envelope 1 may be made of a ceramic material such as polycrystalline alumina or sapphire.

An end cap 4 is secured to each end of the translucent envelope 1. End caps 4 may be made of any refractory material having approximately the same coefficient of thermal expansion as the material of translucent envelope 1 and which is able to withstand attack by alkali metal vapors at high temperatures. For example, end caps 4 may be made of refractory metal such as columbium or tantalum.

Secured to each end cap 4 is an electrode 2 which may be made, for example, of tungsten. As shown in greater detail in FIG. 5, electrode 2 may comprise a coil 2*a* or coils of tungsten wound on a tungsten rod 2*b*. If desired a suitable electron emission material such as, for example, Thorium oxide suspended in N-propanol may be applied to the inner surface of coil 2*a*. The rod 2*b* of electrode 2 is joined to end cap 4 in any suitable manner such as, for example, by brazing with titanium brazing material 3.

End caps 4 are preferably secured to the ends of translucent tube 1 by a quantity of material of frit composition 5. The frit composition 5 may be for example, one or more glasses such as silicon dioxide suspended in a suitable suspending agent or vehicle such as, for example, butyl acetate. The frit composition 5 is applied to the inner surfaces of end cap 4 which is then placed in position at one end of translucent tube 1. Heat is then applied to drive off impurities and residual gases such as, for example, water vapor and/or traces of this frit-suspending agent. Further heating causes the glass frit to fuse and flow so as to form a hermetic seal between translucent tube 1 and end cap 4 as will be explained below in greater detail.

The assembled metal vapor discharge lamp of FIGS. 1 and 2 contains a charge of metal which serves as a source of metal vapor for the lamp in operation. For example, the lamp of FIGS. 1 and 2 contains a quantity of sodium 7 which provides the principal source of radiant emission and a quantity of mercury 7 which acts as a buffer. In addition, the lamp of FIGS. 1 and 2 may contain a suitable starter gas such as xenon, for example. Although mercury and sodium are typical metals and xenon is a typical starter gas for use in the present metal vapor discharge lamp, it will be recognized by those skilled in the art that other metals and starter gases might be employed.

FIG. 3 illustrates apparatus which may be employed to carry out the method of manufacturing metal vapor discharge lamps of the present invention. A bell jar base plate 8 together with a suitable bell jar 20 form a gastight chamber in which the fabrication of the discharge lamp is carried out. In the apparatus of FIG. 3 base plate 8 also acts as a "heat sink" during the fabrication of the lamp. Base plate 8 is therefore made of a suitable material having high-thermal conductivity such as, for example, aluminum. Heat is carried away from plate 8 by means of a suitable coolant such as, for example, water circulating through cooling coils 9 which are disposed beneath base plate 8 in a heat conductive relationship.

Secured to base plate 8, for example, by screw 13*b* or any other fastener, and projecting upward therefrom is a receptacle 13 for receiving and holding one end of the metal vapor discharge lamp during the fabrication process. Receptacle 13 is made of a material of high-thermal conductivity such as, for example, brass, and is in thermal communication with base plate 8 with the result that receptacle 9 acts as a "heat sink" which draws heat away from the lower end of the lamp during the fabrication process. Base plate 8 and receptacle 13 each have a central passageway 9*a* and 13*a*, formed by a bore or tube, connecting the interior of the gastight bell jar chamber to a suitable exhaust system, not shown, through which the bell jar can be evacuated.

Located within the bell jar enclosure is a heat source for supplying the necessary heat to carry out the various steps of the fabrication process as will be explained below in greater detail. In the preferred form of the apparatus shown in FIG. 3, the heat source comprises a cylindrical metal susceptor 10, preferably made of molybdenum or tungsten. Cylindrical susceptor 10 is positioned coaxially with the lamp being fabricated and surrounds the upper end cap of the lamp when the lower end of the lamp is in position in receptacle 13. As will be appreciated by those skilled in the art, metal susceptor 10 is capable of being heated by eddy currents induced in the susceptor by a suitable induction coil, not shown, which may be located outside the bell jar. The heat thus generated is transmitted by radiation from susceptor 10 to end cap 4 and ceramic envelope 1 of the lamp to be fabricated. Susceptor 10 may be supported in position by any suitable means such as, for example, cylindrical ceramic support member 11 which rests on the upper surface of receptacle 13 as shown in FIG. 3. In addition, there may optionally be provided a tube of polycrystalline alumina 12 concentrically surrounding the lamp to be fabricated and serving as an evaporation protecting shield.

According to the present invention, the metal vapor discharge lamps are fabricated in the following manner. First, an end cap and electrode assembly such as that shown in FIG. 5 is prepared for assembly by spreading a glass frit composition 5 on the inner surfaces of the end cap 4. The translucent ceramic tube is then placed in position in receptacle 13 as shown in FIG. 3. If desired, one or more asbestos shims 14 may be inserted so as to hold translucent tube 1 in position in receptacle 13. The end cap and electrode assembly which has been prepared with the glass frit composition is then placed in position at the upper end of translucent tube 1. Susceptor 10, support member 11, and evaporation shield 12 are arranged as shown in FIG. 3. The bell jar is then lowered over the entire assembly and sealed to base plate 8 so as to form a gastight chamber which is then evacuated by means of a suitable exhaust system through the passage 13*a* in receptacle 13. An induction heater coil is placed over the bell jar and positioned concentrically with susceptor 10 which, in turn, surrounds the components to be sealed. Alternating current is then applied to the induction coil thus heating susceptor 10. As the power applied to the induction coil is gradually increased, the temperature of susceptor 10 gradually increases thus causing increasing amounts of heat to be applied to the components of the lamp to be fabricated. Because the heating process is carried out in a vacuum, impurities and residual gases trapped in the lamp components are driven off at intermediate temperatures of about 600° C. to 1,200° C. The temperature is gradually further increased to approximately 1,600° C. at which temperature the glass frit fuses and flows to form a hermetic seal between metal end cap 4 and translucent ceramic tube 1. The sealed components are then allowed to cool gradually to room temperature. If desired, a quantity of inert gas may be introduced into the chamber through passage 13*a* or another passage shown) to speed up the cooling process. For example, argon gas at 100 mm. pressure might be introduced into the chamber for this purpose.

When the sealed components have reached room temperature, the bell jar is removed and the partially assembled lamp is inverted so that the metal end cap 4 rests in receptacle 13 and the open end of translucent ceramic tube 1 faces upward. At this point a suitable charge of metal may be introduced into the open end of translucent ceramic tube 1 to provide a source of metal vapor for the lamp in operation. For example, in the preferred form of the invention, small quantities of sodium 6 and mercury 7 are introduced into the partially assembled lamp. It will be appreciated by those skilled in the art that the handling of the sodium metal 6 should preferably be carried out in an inert protective atmosphere to prevent the undesired reaction of the sodium with oxygen and water vapor present in an air atmosphere.

The second end cap and electrode assembly is prepared with the glass frit composition and placed in position over the open end of translucent ceramic tube 1. The bell jar and induction coil are then replaced, the chamber is evacuated, and power is applied to the induction coil so as to heat susceptor 10. Once again the temperature of the components to be sealed is gradually increased to a temperature sufficient to drive off impurities and residual gases, but not sufficient to

cause the glass frit to fuse and flow. As explained above, a temperature of about 600° C. to 1,200° C. is sufficient to drive off impurities and residual gases such as, for example, water vapor and/or traces of the frit suspending agent.

After the impurities and residual gases have been driven off, a starter gas may be introduced into the chamber and thus into the partially assembled lamp through the as yet unsealed joint between the end cap **4** and the translucent ceramic tube **1**. For example, a quantity of inert gas such as argon or xenon at a pressure of approximately 30 mm. of mercury may be introduced for this purpose. Increased power is then applied to the induction coil so as to heat the lamp components to a temperature sufficient to cause the glass frit to fuse and flow and form a hermetic seal between the metal end cap **4** and the translucent tube **1**. As described above, the glass frit employed in this illustrative example fuses and flows at approximately 1,600° C. After the hermetic seal has been affected, the assembled lamp is allowed to cool to room temperature. Inert gas may be used to speed the cooling process as explained above.

During the heating and sealing of the second end cap **4** to the translucent ceramic tube **1**, the first end cap **4** and hermetic seal are maintained at a reduced temperature by means of the "heat sink" formed by receptacle **13**, base plate **8**, and cooling coils **9**. In this manner the first hermetic seal is kept intact during the formation of the second seal. The heat sink also helps to keep the sodium and mercury particles **6** and **7** respectively from being vaporized by the heat of the sealing process.

Proper control of the heating and cooling cycles is important in order to obtain consistently good seals. Generally, the heating cycle should be sufficiently slow to avoid cracking the components, to permit impurities and residual gas to be completely exhausted, and to permit the glass frit to fully flow to form a hermetic seal. The maximum temperature reached should not be so high as to crack the components, and likewise, the cooling cycle should be sufficiently slow to avoid cracking. The precise relationship between time and temperature depends upon the particular materials used, and different optimum time temperature relationships can probably be established for each different combination of materials. For purposes of illustration, satisfactory results have been obtained for the combination of a polycrystalline alumina tube, columbium end cap, and Corning No. 1731 glass frit composition by heating the components to be sealed from room temperature to approximately 1,600° C. at an approximately uniform rate over a period of approximately four minutes and then cooling in an atmosphere of 100 mm. of argon for approximately 5 minutes. It will be recognized, however, that the present invention is not limited to any particular heating and cooling cycle, but that it embraces any heating and cooling cycle which does not crack or otherwise damage the components and which allows the frit composition binders, impurities, and residual gases to be driven off before the frit is caused to fuse, flow and form a good, gastight hermetic seal.

FIG. **4** shows a modified form of apparatus for carrying out the present method of manufacturing metal vapor discharge tubes. The apparatus of FIG. **4** permits the introduction of a highly pure charge of metal into the lamp envelope. The apparatus of FIG. **4** includes an evacuable housing with lower and upper sections **17** and **18** separated by a wall **19** forming chambers **17***a* and **18***a*. A vacuum gate valve **26** is located on the upper surface of wall **26** and is operable by a control handle **26***a* which extends outside of the housing through a suitable vacuum seal. The portion of the housing **18** forming upper chamber **18***a* is preferably made of a material such as columbium or stainless steel which are resistant to attack by alkali metal vapors. An O-ring seal block **20** is secured, as by threaded engagement, to the top of of upper housing section **18**. A pair of O-rings **23** form a gastight circumferential seal around a piece of tubing **22** which extends through O-ring seal block **20** into upper chamber **18***a*. The tube **22** is slidable up and down within the O-rings. A T-portion **29** of tube **22** holds a capsule **24** containing the quantity of predistilled metal to be introduced into the lamp during the fabrication process, Tube **22** extends above T-portion **29** so as to permit a steel slug **30** to be raised by a magnetic coil **31** as shown. When released by magnetic coil **31**, steel slug **30** impacts and breaks capsule **24** causing the charge of metal to flow down through tube **22** into the waiting lamp envelope as will be explained below in greater detail. Tube **22** may be made of glass or quartz or other material depending on the type of metal charge to be handled.

The lower housing portion **17** includes a quartz cylinder which rests on base plate **8** and forms a gastight seal therewith. The quartz cylinder is joined to upper housing portion **18** by a graded quartz to "Kovar" seal **15**. Gate valve **26** controls the opening in wall **19** between upper chamber **18***a* and lower chamber **17***a*.

Using the apparatus of FIG. **4**, the method of manufacturing metal vapor discharge lamps is as follows. First, an end cap and electrode assembly of the type shown in FIG. **5** is prepared with a suitable glass frit composition. The translucent ceramic tube **1** is placed in position in receptacle **13**, the fritted end cap **4** is placed in position on the upper end of tube **1** and the bell jar assembly **17–18** **18** is placed in position with valve **26** closed. Lower chamber **17** is evacuated, and the lamp components to be sealed are gradually heated by susceptor **10** to drive off impurities and residual gases and finally to cause the frit to fuse, flow, and form a gastight seal between end cap **4** and tube **1**. The lamp is then cooled to room temperature and inverted so that the sealed end rests in receptacle **13**. A glass frit composition is then applied to the inner surfaces of the modified form of end cap and electrode assembly shown in FIG. **6**. In the modified assembly of FIG. **6**, tungsten electrode **2** is brazed at an angle to columbium or tantalum end cap **4** with titanium braze **3**. An opening **27** is formed at or near the center of end cap **4**. Glass frit composition **28** is applied around the edges of opening **27** as shown.

After the inner surfaces of end cap **4** of FIG. **6** have been prepared with the glass frit composition **5**, the end cap and electrode assembly is placed in position on the upper, open end of translucent ceramic tube **1**. The bell jar assembly of FIG. **4** is then placed in position with gate **26** open so that both lower chamber **17** and upper chamber **18** may be evacuated. Heat is then applied by means of susceptor **10** in order to drive off impurities and residual gases. This step is preferably carried out prior to the introduction of the charge of metal in order to avoid possible reaction between the metal and the impurities.

The tip **34** of tube **22** is then moved downward to a position immediately above the opening **27** in end cap **4**, and steel slug **30** is raised and then released by magnetic coil **31** so as to break capsule **24** and allow the charge of metal to flow down through tubing **19** into the lamp via opening **27**. If desired, external heat may be applied to tube **22** to induce the charge of metal to flow down into the lamp.

After the charge metal has been introduced into the lamp, tube **22** is withdrawn upward, gate **26** is closed, and an inert starter gas may be introduced into lower chamber **17**. Further heat is then applied to cause frit **28** to fuse and flow to seal opening **27** in end cap **4**. Frit **5** fuses and flows to form a hermetic seal between end cap **4** and translucent ceramic tube **1**. As described above in connection with FIG. **3**. the "heat sink" formed by receptacle **13** and base plate **8** serves also to prevent the metal charge from evaporating during the sealing of the second end cap to the upper end of ceramic tube **1**. After the seal has been formed, the assembled lamp is gradually cooled to room temperature with the optional aid of an inert gas at approximately 100 mm. of pressure.

Although the present invention has been illustrated by reference to a preferred embodiment, it will be apparent to those skilled in the art that certain modifications may be made without departing from the principles of the invention. For example, the principles of the present invention embrace a method of manufacturing metal vapor discharge lamps

wherein the heat required for sealing the metal end caps to the translucent ceramic tube is generated by including eddy currents in the end caps themselves, no separate susceptor being required.

Further, the principles of the present invention embrace a method of manufacturing metal vapor discharge tubes wherein both end caps are simultaneously sealed to the ends of the translucent ceramic tube.

It will be apparent to those skilled in the art that other modifications and adaptations of the present invention may be made without departing from the spirit and scope of the invention as set forth with particularity in the appended claims.

What is claimed is:

1. The method of making a metal vapor discharge lamp comprising the steps of

disposing a translucent tubular envelope within an evacuated gastight chamber;

securing a first end cap and electrode assembly to one end of said envelope to form a gastight seal;

inserting a charge of metal into said envelope through an opening in a second end cap and electrode assembly to provide a source of metal vapor for the operation of said lamp;

introducing a starter gas into said envelope; thereafter heating to secure said second end cap and electrode assembly to the other end of said envelope and to form said seal opening and thereby form a gastight seal; and

removing the assembled lamp from said gastight chamber.

2. The method of claim 1, further comprising the step of heating the envelope to outgas it.

3. The method of claim 2, wherein said outgassing step is carried out prior to securing the first end cap to the envelope.

4. The method of claims 2, wherein the outgassing step is also carried out prior to securing the second end cap to the envelope.

5. The method of claim 1, wherein the end caps and electrode assemblies are sealed to the envelope by providing frit between the end caps and the ends of the envelopes and further comprising the step of heating the frit to cause it to flow to form the seal.

6. The method of claim 1, wherein the first end cap is sealed to the envelope by providing frit between the first end cap and one end of the envelope and the heating of the envelope and the first end cap is carried out to a first temperature to drive off impurities and outgas the envelope, and then the heating of the envelope and first end cap is carried out to a second and higher temperature to cause the frit to flow and form a gastight seal.

7. The method of claim 6, wherein the second end cap is sealed to the envelope by providing frit between the second end cap and the other end of the envelope and the heating is carried out to a first temperature to drive off impurities and outgas the envelope, and then the heating of the envelope and the second end cap is carried out to a second and higher temperature to cause the frit to flow and form a gastight seal.

8. The of claim 6, wherein said first temperature is in the range between about 600° C. and 1200° C.

9. The method of claim 1, further comprising the step of holding the first end cap and electrode assembly in heat-conductive relationship with a heat sink while the second end cap is being secured to the envelope.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,628,846 Dated December 21, 1971

Inventor(s) SALVATORE CORTORILLO

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 1, line 36, change "lamp" to -- lamps --

Col. 1, line 36, after "end" insert -- cap --

Col. 2, line 60, delete "car" and insert -- cap --

Col. 4, line 51, after "passage" insert --(not --

Col. 5, line 17, after "been" delete "affected" and insert -- effected --

Col. 6, line 24, delete "18" (second occurrence)

Col. 6, line 57, insert "of" before "metal"

Col. 7, line 26, delete "form said"

Col. 7, line 27, insert -- said -- before "opening"

Col. 8, line 2, delete "claims" and insert -- claim --

Col. 8, line 25, insert "method" after "The"

Page 1 of the Patent, the filing date of the application should be March 10, 1970, not March 1, 1970.

Signed and sealed this 29th day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
☆ U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.