Nov. 16, 1965 W. V. CUSHING 3,218,113

METHOD FOR FABRICATING DISCHARGE DEVICE

Filed Oct. 18, 1962

FIG. 1.

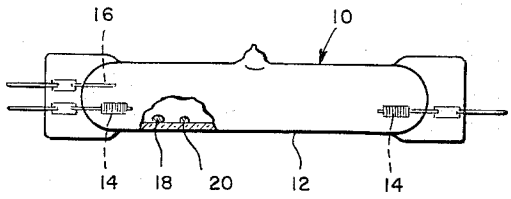
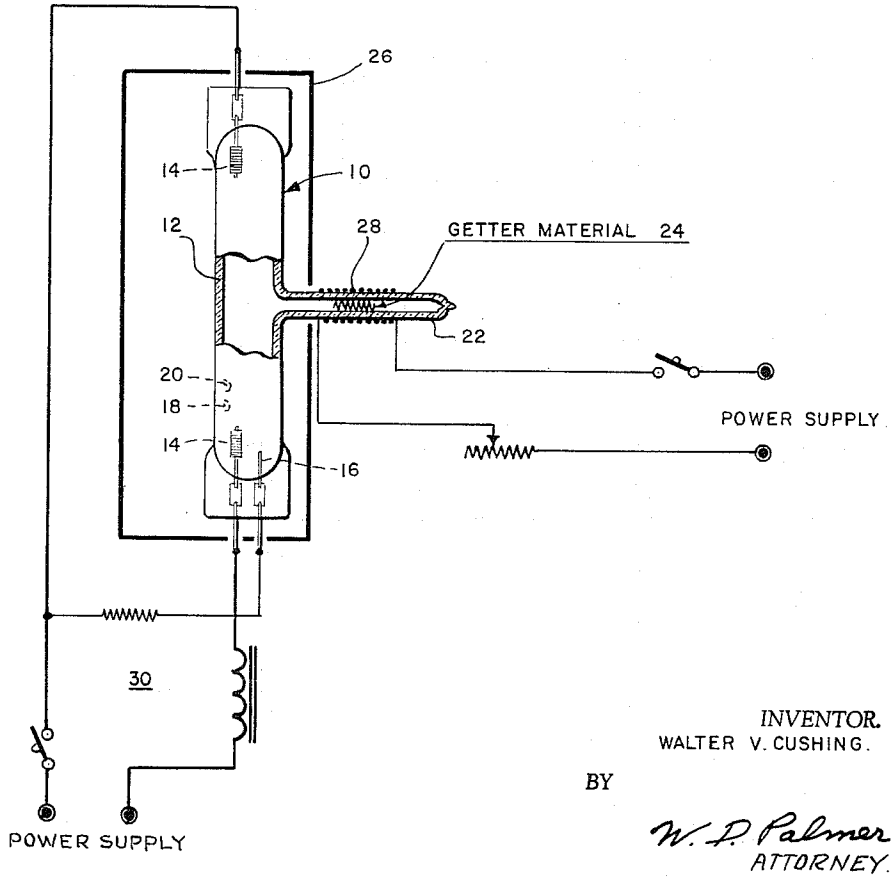



FIG. 2.




INVENTOR.
WALTER V. CUSHING.

BY

W. P. Palmer
ATTORNEY.

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# 3,218,113 METHOD FOR FABRICATING DISCHARGE DEVICE

Walter V. Cushing, Verona, N.J., assignor to Westinghouse Electric Corporation, Pittsburgh, Pa., a corporation of Pennsylvania

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This invention relates to discharge devices and, more particularly, to an improved method for fabricating a vapor-discharge device in order to getter substantially all impurities which can be present in the fabricated discharge device.

In copending U.S. application, Serial No. 188,368, filed April 18, 1962, and owned by the present assignee, is disclosed a vapor-discharge device which incorporates a filling of mercury and other additive material such as thallium iodide, sodium iodide, or mixtures thereof. Such lamps operate with very good efficiency and the additive discharge-supporting material can be so selected as to provide the lamps, when operated, with very good color rendition. Difficulties have been encountered in fabricating these lamps, since they appear to be very sensitive to the presence of impurities. These impurities normally result in excessively large starting voltages, so that the lamps will not start satisfactorily on a conventional ballast.

In order to getter the impurities present in such additive lamps, and thus reduce the starting voltage, the lamps can be operated or seasoned for a very extended period, during which seasoning the components comprising the lamp apparently react with the impurities to convert them to a harmless status. Such prolonged seasoning, which may be as long as 100 hours, is not practical from a commercial standpoint because of the space and cost factors involved.

It is the general object of this invention to provide an economical method for gettering unwanted impurities from a substantially fabricated discharge device, in order that the starting voltage for the fabricated discharge device will be within commercially acceptable limits.

It is another object to provide a method for completing the fabrication of a partially fabricated arc tube, in order to getter substantially all unwanted impurities which can be present in the fabricated arc tube.

It is a further object to provide a method for gettering impurities from a partially fabricated discharge device and to remove such gettered impurities, as well as the gettering material, from the discharge device, in order to improve the performance of the fabricated discharge device.

The aforesaid objects of the invention, and other objects which will become apparent as the description proceeds, are achieved by positioning in an elongated arm, a material which will getter the impurities desired to be removed. The elongated arm is in communication with the interior of the discharge device envelope and the device and arm are hermetically sealed. A discharge is initiated in the device and is maintained for a predetermined period of time. Simultaneously, the elongated arm is heated in order to prevent condensation of the discharge-sustaining material in the elongated arm, and also to heat the getter material to a temperature sufficient to getter any unwanted impurities present in the discharge device. Thereafter, the elongated arm is tipped off at a point which is close to the envelope of the discharge device, in order to remove the getter material from communication with the discharge device.

For a better understanding of the present invention,



reference should be had to the accompanying drawings wherein:

FIGURE 1 is an elevational view, partly in section, showing the completed arc tube for a high-pressure, vapor-discharge device fabricated in accordance with the present method; and

FIG. 2 is a schematic plan view illustrating an arc tube being fabricated in accordance with the present method.

With specific reference to the form of the invention illustrated in the drawings, in FIG. 1 is shown an arc tube for a high-pressure, vapor-discharge device. The arc tube **10** comprises an envelope **12**, such as quartz, having operating electrodes **14** sealed through either end thereof, and a starting electrode **16** sealed through the envelope and positioned proximate to one of the operating electrodes. The arc tube **10** contains a small charge of inert, ionizable starting gas, a predetermined quantity of mercury **18**, and a predetermined quantity of additive, discharge-sustaining material **20**. As a specific example, for an arc tube desired to be operated with the power input of 400 watts, the arc tube encloses a volume 22.5 cc., a discharge-sustaining filling comprising 66 mg. of mercury, 50 mg. of thallium iodide, sodium iodide, or mixtures thereof, and argon starting gas at a pressure of 20 mm. In actual use, the arc tube **10** is supported within and sealed within an outer envelope, as is generally disclosed in U.S. Patent No. 2,748,303, dated May 29, 1956. For best operation, the spacing between the arc tube **10** and the outer envelope is evacuated.

The general construction of the arc tube is subject to considerable modification. As an example, the envelope **12** can be fabricated of light-transmitting, high-temperature material other than quartz, such as polycrystalline alumina. In addition, filling materials other than mercury and the indicated additive iodide can be utilized. For example, the present invention can be used to fabricate a zinc- or cadmium-discharge device. Preferably the electrodes **14** incorporate a small amount of thorium for purposes of electron emission, although other known electron-emissive materials can be substituted for the thorium.

In practicing the present invention, the arc tube is first fabricated in generally conventional fashion, with the electrodes **14** operatively disposed proximate to the ends of the arc tube, and an elongated arm **22**, as shown in FIG. 2, is affixed to and in communication with the interior portion of the arc tube **10**. A getter material **24**, which is selected so that it will react with and getter all impurities which might be present in the fabricated arc tube, is then placed into an intermediate section of the elongated arm **22**. As a specific example, the getter material **24** which is utilized in zirconium, or titanium, or mixtures thereof in total amount of sixteen mg., formed as a coil which contacts the interior surfaces of the elongated arm **22** to prevent slipping out of place during the processing. The coil of getter material **24** will also permit the discharge-supporting material to be loaded into the envelope **12**. The partially fabricated arc tube is then exhausted and filled with the desired discharge-supporting material, which includes the starting gas. A suitable filling process is generally disclosed in U.S. Patent No. 2,764,857, dated October 2, 1956. The elongated arm is then tipped off at a point which is remote from the arc tube **10**, in order to hermetically seal the arc tube, the elongated arm **22** and the getter material **24** which is contained in the elongated arm **22**.

The partially fabricated, sealed arc tube **10** is placed into an enclosure **26**, in order to simulate service operating conditions and protect the operator from ultra-violet

radiations, and an additional heater element 28 is placed about the intermediate portion of the elongated arm 22 which contains the getter material 24. A discharge is then initiated in the arc tube 10 by connecting the operating electrodes 14 across a conventional starting and operating circuit 30. Simultaneously, the heater coil 28 is energized in order to prevent condensation of the discharge-sustaining mercury and additive iodide in the elongated arm 22, and also to heat the getter material 24 to a predetermined temperature, in order to cause the material 24 to getter substantially all unwanted impurities which are present in the arc tube. As a specific example, the arc tube 10 is operated at its designed power input of 400 watts and the heating coil is energized to heat the zirconium or titanium getter strip 24 to a temperature of approximately 600° C. This operation is continued for a period of approximately twenty minutes. After operation of the device in the aforestated manner, in order to getter substantially all unwanted impurities, the device is cooled so that the pressure therein is less than atmospheric and the elongated arm 22 tipped off at a point close to the envelope 12 by means of a conventional gas-sealing fire. Thereafter the arc tube is incorporated into an outer envelope in accordance with conventional practices. A suitable arc tube mount structure within an outer envelope is generally shown in the aforementioned U.S. Patent No. 2,748,303.

As an alternative embodiment, the elongated arm 22 can be tipped off close to the envelope while the device is still operating by utilizing a pressure tip-off device such as disclosed in U.S. Patent No. 2,983,078, dated May 9, 1961, or by other known, so-called, pressure-tip-off devices.

In the practices of the prior art, getter materials such as zirconium have been energized inside a discharge device envelope and allowed to remain in the envelope after they have served their gettering purpose. It has been found that the presence of zirconium or other suitable getter material in a discharge device which contains a metallic iodide additive will result in rapid blackening of the envelope, thereby impairing the performance of the device. Thus in order to utilize the beneficial effects of a getter such as zirconium or titanium, it is necessary to operate the device and drive the impurities which are present into contact with the heated getter, which must thereafter be removed from the discharge device envelope without introducing any additional impurities into the envelope. This is readily accomplished by the present invention.

Devices processed in accordance with the present invention have been seasoned for a period of only twenty minutes, and thereafter have been operated for extended periods without developing any blackening of the arc tube. If the present method of gettering were not used, the seasoning period required would be so excessive as to render the devices commercially impractical. Also, if the getter were permitted to remain in the device during service operation, the arc tube would quickly blacken.

While the preferred getter materials are zirconium, titanium, or mixtures thereof, other getter materials can be substituted therefor, and such other getter materials are generally known in the art. Also the amount of getter material which is used is not critical and can be varied considerably, as can the temperature to which the getter material is heated.

It will be recognized that the objects of the invention have been achieved by providing a method for gettering unwanted impurities from a substantially fabricated discharge device so that the operating characteristics of the device are improved.

While best embodiments of the invention have been illustrated and described in detail, it is to be particularly understood that the invention is not limited thereto or thereby.



I claim as my invention:

1. The method of gettering unwanted impurities from a hermetically sealed substantially fabricated discharge device having a light-transmitting envelope, electrodes operatively disposed within said envelope, a discharge-sustaining filling contained within said envelope, an elongated arm opening into said envelope and tipped off at a point remote from said envelope, and a predetermined amount of selected getter material positioned in an intermediate portion of said elongated arm, which method comprises:

(a) initiating a discharge between said electrodes and maintaining such initiated discharge for a predetermined period of time, while simultaneously heating said elongated arm to prevent condensation of said discharge-sustaining material therein and to heat said getter material to a temperature sufficient to getter any unwanted impurities present in said discharge device; and

(b) tipping off said elongated arm at a point close to said envelope while maintaining the hermetic sealing of said envelope to remove said getter material from communication with said envelope.

2. The method of gettering unwanted impurities from a substantially fabricated discharge device having a hermetically sealed light-transmitting envelope, electrodes operatively disposed within said envelope, a discharge-sustaining filling contained within said envelope, an elongated arm opening into said envelope and tipped off at a point remote from said envelope, and a predetermined amount of selected getter material positioned in an intermediate portion of said elongated arm, which method comprises:

(a) initiating a discharge between said electrodes and maintaining such initiated discharge for a predetermined period of time, while simultaneously heating said elongated arm to prevent condensation of said said discharge-sustaining material therein and to heat said getter material to a temperature sufficient to getter any unwanted impurities present in said discharge device;

(b) cooling said envelope to reduce the vapor pressure therein to less than atmospheric; and

(c) tipping off said elongated arm at a point close to said envelope while maintaining the hermetic sealing of said envelope to seal said getter material from communication with said envelope.

3. The method of completing the fabrication of a partially fabricated arc tube having an elongated arm extending therefrom and opening into such arc tube, in order to getter substantially all unwanted impurities which can be present in the fabricated arc tube, which method comprises:

(a) placing into an intermediate section of said elongated arm, a predetermined amount of material which is a getter for the unwanted impurities which can be present in said arc tube when fabricated;

(b) exhausting said arc tube and said elongated arm and introducing into said arc tube the discharge-supporting material required for proper operation of said arc tube;

(c) tipping off said elongated arm at a point remote from said arc tube to hermetically seal said arc tube and said elongated arm and said getter material contained in said elongated arm;

(d) initiating a discharge in said arc tube and maintaining such initiated discharge for a predetermined period of time, while simultaneously heating said elongated arm to prevent condensation of discharge-sustaining material therein and to heat said getter material to a temperature sufficient to getter any unwanted impurities present in said arc tube; and

(e) tipping off said elongated arm at a point close to said arc tube which maintaining the hermetic sealing

of said arc tube to seal said getter material from communication with said arc tube.

4. The method of completing the fabrication of a partially fabricated arc tube having an elongated arm extending therefrom and opening into such arc tube, in order to getter substantially all unwanted impurities which can be present in the fabricated arc tube, which method comprises:

(a) placing into an intermediate section of said elongated arm, a predetermined amount of material which is a getter for the unwanted impurities which can be present in said arc tube when fabricated;

(b) exhausting said arc tube and said elongated arm and introducing into said arc tube the discharge-supporting material required for proper operation of said arc tube;

(c) tipping off said elongated arm at a point remote from said arc tube to hermetically seal said arc tube and said elongated arm and said getter material contained in said elongated arm;

(d) initiating a discharge in said arc tube and maintaining such initiated discharge for a predetermined period of time, while simultaneously heating said elongated arm to prevent condensation of discharge-sustaining material therein and to heat said getter material to a temperature sufficient to getter any unwanted impurities present in said arc tube;

(e) cooling said arc tube to reduce the vapor pressure therein to less than atmospheric; and

(f) tipping off said elongated arm at a point close to said arc tube while maintaining the hermetic sealing of said arc tube to seal said getter material from communication with said arc tube.

5. The method of completing the fabrication of a partially fabricated arc tube having an elongated arm extending therefrom and opening into such arc tube, in order to getter substantially all unwanted impurities which can be present in the fabricated arc tube, which method comprises:

(a) placing into an intermediate section of said elongated arm, a predetermined amount of material which is a getter for the unwanted impurities which can be present in said arc tube when fabricated;

(b) exhausting said arc tube and said elongated arm and introducing into said arc tube a predetermined amount of inert ionizable starting gas, mercury, and additive material comprising metallic halide;

(c) tipping off said elongated arm at a point remote from said arc tube to hermetically seal said arc tube and said elongated arm and said getter material contained in said elongated arm;

(d) initiating a discharge in said arc tube and maintaining such initiated discharge for a predetermined period of time, while simultaneously heating said elongated arm to prevent condensation of mercury and metallic iodide therein and to heat said getter material to a temperature sufficient to getter any unwanted impurities present in said arc tube; and

(e) tipping off said elongated arm at a point close to said arc tube while maintaining the hermetic sealing of said arc tube to seal said getter material from communication with said arc tube.

6. The method of completing the fabrication of a partially fabricated arc tube having an elongated arm extending therefrom and opening into such arc tube, in order to getter substantially all unwanted impurities which can be present in the fabricated arc tube, which method comprises:

(a) placing into an intermediate section of said elongated arm, a predetermined amount of at least one getter material of the group consisting of zirconium and titanium;

(b) exhausting said arc tube and said elongated arm and introducing into said arc tube a predetermined amount of inert ionizable starting gas, mercury, and metallic iodide;

(c) tipping off said elongated arm at a point remote from said arc tube to hermetically seal said arc tube and said elongated arm and said getter material contained in said elongated arm;

(d) initiating a discharge in said arc tube and maintaining such initiated discharge for a predetermined period of time, while simultaneously heating said elongated arm to prevent condensation of mercury and metallic iodide therein and to heat said getter material to a temperature sufficient to getter any unwanted impurities present in said arc tube; and

(e) tipping off said elongated arm at a point close to said arc tube to seal said getter material from communication with said arc tube.

7. The method as specified in claim 6, wherein said metallic iodide is at least one material of the group consisting of thallium iodide and sodium iodide.

8. The method of first activating a getter material which is in communication with the volume enclosed by the envelope of a partially fabricated discharge device, and thereafter removing said getter material from communication with said discharge device without introducing any additional impurities into said discharge device, which method comprises:

(a) affixing an elongated arm to said envelope and in communication with the atmosphere enclosed by said envelope, and placing into an intermediate portion of said elongated arm, a predetermined amount of selected getter material;

(b) exhausting said elongated arm and said envelope and introducing into the volume enclosed by said envelope a predetermined amount of selected discharge-sustaining substance;

(c) hermetically sealing said elongated arm at a point remote from said envelope to hermetically seal said envelope, while maintaining said getter material in communication with the volume enclosed by said envelope;

(d) initiating a discharge in the volume enclosed by said envelope and maintaining such discharge for a predetermined period of time, while simultaneously heating said arm to prevent condensation of discharge-sustaining material in said elongated arm and to heat said getter material to a temperature sufficient to getter any unwanted impurities present in said device; and

(e) hermetically sealing said elongated arm at a point close to said envelope to seal said getter material from communication with the volume by said envelope.

9. The method of first activating a getter material which is in communication with the volume enclosed by the envelope of a partially fabricated discharge device, and thereafter removing said getter material from communication with said discharged device without introducing any additional impurities into said discharge device, which method comprises:

(a) affixing an elongated arm to said envelope and in communication with the atmosphere enclosed by said envelope, and placing into an intermediate portion of said elongated arm, a predetermined amount of selected getter material;

(b) exhausting said elongated arm and said envelope and introducing into the volume enclosed by said envelope a predetermined amount of selected discharge-sustaining substance;

(c) hermetically sealing said elongated arm at a point remote from said envelope to hermetically seal said envelope, while maintaining said getter material in communication with the volume enclosed by said envelope;

(d) initiating a discharge in the volume enclosed by said envelope and maintaining such discharge for a predetermined period of time, while simultaneously heating said elongated arm to prevent condensation of discharge-sustaining material in said elongated arm and to heat said getter material to a temperature sufficient to getter any unwanted impurities present in said device;

(e) cooling said envelope to reduce the vapor pressure therein to less than atmospheric; and

(f) hermetically sealing said elongated arm at a point close to said envelope to seal said getter material from communication with said envelope.



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FRANK E. BAILEY, *Primary Examiner.*