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ARC DISCHARGE ENVELOPE AND METHOD OF MAKING SAME WITH THREE BUTTED GLASSY TUBES

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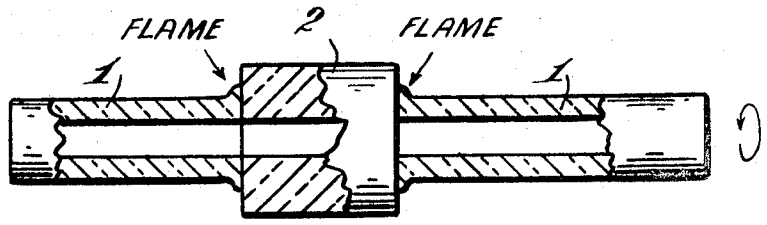


Fig. 1

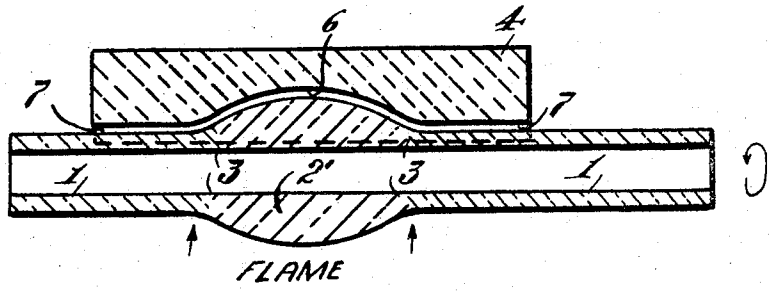


Fig. 2

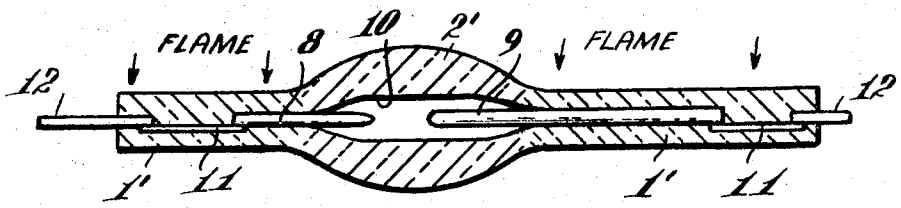


Fig. 3

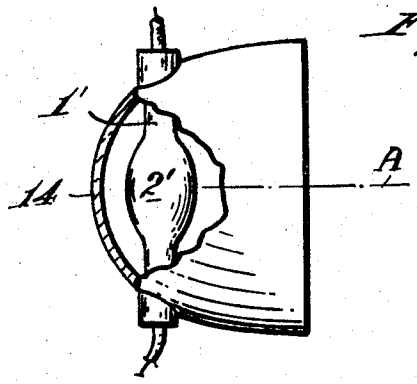


Fig. 4

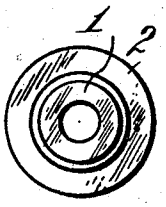


Fig. 5

INVENTORS
Wayne Evans
Rudolph Marcucci
Paul Gates
BY Roberts, Cushman & Grover
ATT'YS

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ARC DISCHARGE ENVELOPE AND METHOD OF MAKING SAME WITH THREE BUTTED GLASSY TUBES

Wayne Evans, West Peabody, Rudolph Marcucci, Beverly, and Paul Gates, Danvers, Mass., assignors to Sylvania Electric Products Inc., a corporation of Delaware

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U.S. Cl. 313—220 5 Claims

ABSTRACT OF THE DISCLOSURE

An envelope for a short arc discharge lamp is made by butting two small outer diameter quartz end tubes against a larger outside diameter tube of the same inside diameter, fusing the three tubes in alignment, and hot molding the larger tube during rotation with a paddle mold so that its outside contour is curved outwardly continuously from the outer surface of the end tubes. The envelope thus formed has a substantially constant inner diameter, smooth and free of ripples giving the molded intermediate tube precisely reproducible optical properties.

A recently developed projection light source comprises a relatively small glassy (e.g. quartz) envelope with electrodes spaced as little as a quarter of an inch apart. For this reason the projector light is sometimes called a short arc lamp. The electrodes are sealed in a cavity about a half-inch long and under a quarter of an inch in diameter. The cavity is filled with inert gas such as argon or xenon and vaporizable metals such as mercury, iodine, sodium and tellurium under high pressure. Such a lamp may draw 300 watts of power, with operating power densities in the order of 5000 watts/cm.^{3}, a pressure of several atmospheres, and an envelope temperature of 1000° C. due to an intense arc discharge which fills the cavity. Under these operating conditions it is easily understood that great thermal and mechanical stress is placed on the wall of the cavity. For this reason the cavity wall must be made much thicker than the envelope ends in which the electrical connections to the electrodes are sealed. Moreover the cavity wall must be externally contoured to merge with the sealed ends and to match the optical contour of the reflector in which the lamp is customarily mounted.

It has been proposed to start with a length of uniform quartz tube and thicken the mid portion of the tube by softening the middle of the tube, applying axial pressure and gathering molten quartz at the middle to a greater thickness than the ends. An envelope so prepared, however, has irregular wall thickness, uneven external contours, reduced cavity thickness and optically undesirable irregularities on the inner and outer surfaces of the cavity wall.

It is the object of the present invention to provide an envelope of the type described and a method of making an envelope which has a thicker mid portion wall, with good optical and mechanical properties, and which lacks the irregularities and defects of prior envelopes.

According to the invention an envelope for an arc discharge device comprises two glassy end tubes, an intermediates glassy tube of like inside diameter and greater outside diameter than said end tubes, the bores of said three tubes being axially aligned, said tubes being joined by a fused zone at each end of the intermediate tube, the outside of said intermediate tube comprising a surface of revolution continuously curved outwardly between said fused zones, and the inside diameter of said tubes being substantially constant.

Further according to the invention a method of forming an arc discharge envelope comprises butting two glassy tubes against each end of an intermediate glassy tube of like inside diameter and greater outside diameter than said two tubes with the three tubes in axial alignment, fusing the three tubes together in said alignment, and hot molding the intermediate tube so as to form a convex outer surface of revolution continuous from the outer surface of each said two tubes to the greatest outside diameter of said intermediate tube, thereby to form a continuous tubular envelope with a smooth mid portion of substantially greater wall thickness.

For the purpose of illustration a typical embodiment of the invention is shown in the accompanying drawing in which:

FIGS. 1 to 3 are sectional views showing stages in the fabrication of a lamp envelope, FIG. 1 being shown partly in elevation;

FIG. 4 is an elevation of the lamp mounted in a reflector; and

FIG. 5 is an end view of the stage of FIG. 1.

As shown in FIGS. 1 and 5 fabrication of a short arc lamp envelope is begun with two end lengths **1** of fused quartz tube butted to a shorter intermediate length **2** of of fused quartz tube of the same inner diameter and a substantially greater outer diameter and hence wall thickness. For example, the end tubes **1** may be 2 mm. ID and 5 mm. OD, the intermediate tube **2** being 2 mm. ID and 10 mm. OD. The butted ends of the tubes are softened in flame and fused to each other at zones **3** indicated in FIG. 2 by a discontinuity in the cross-hatching. In fusing the three tubes they are held in axial alignment so that their bores or inside diameters are continuous.

The three tube assembly is then mounted on a horizontal lathe and rotated slowly while a cross fire torch applies flame across at least the entire length of the intermediate tube **2**. As shown in FIG. 2 a paddle **4** of refractory material is then pressed against the rotating intermediate tube **2** and adjacent portions of the end tubes **1** beyond the fusion zones **3**. The paddle has an open concavity **6** forming a partial surface of revolution merging with straight tubular portions **7**. The paddle rounds the flat ends of the intermediate tube and forms a bulbous surface of revolution which is continuous from the linear outer surfaces of the end tubes **1** to the center portion of the formed intermediate tube **2'** which has the greatest outside diameter and wall thickness. Optionally, axial pressure may be applied to the assembly to bow the wall of the intermediate tube outwardly and compensate for any tendency of the wall to bow inwardly while being molded by the paddle. Occasional bursts of air or nitrogen into the bore may aid in forming the bore wtih a smooth, straight surface, devoid of ripples. By the method described an envelope, shown in FIG. 2, is formed with smooth continuous exterior and interior surfaces around the bore of the intermediate tube which forms the discharge cavity of the finished lamp.

The lamp is completed by filling the lamp and sealing in each end tube **1'** a sub-assembly comprising tungsten electrodes **8** and **9** respectively connected through molybdenum ribbons **11** to lead in wires **12**. The unconnected ends of the electrodes **8** and **9** extend into the cavity **10** in which an intense discharge occurs during operation. The cavity is filled, for example, with 3 mg. of indium iodide (InI_3) and argon at a pressure of 600 mm. of mercury, which may rise to six to nine mm. in operation. Other fills may be used.

As appears in FIG. 4 the finished lamp may be mounted in a reflector **14** curved about an axis A. For projecting motion pictures it is required that the film be evenly

illuminated, and it is therefore very important that the lens-like wall of the intermediate tube 2' be free of wrinkles and optical discontinuities which would cause spotty transmission of light from the arc to the reflector.

A lamp according to the present invention has continuous inner and outer surfaces around the cavity, and is free of wrinkles and like discontinuities, yet can be produced economically and with reproducible optical uniformity by the present method.

While one desirable embodiment of the invention has herein been disclosed by way of example, it is to be understood that the invention is broadly inclusive of any and all modifications falling within the terms of the appended claims.

We claim:

1. The method of forming an arc discharge envelope which comprises

butting two glassy tubes against each end of an intermediate glassy tube of like inside diameter and greater outside diameter than said two tubes with the three tubes in axial alignment,

fusing the three tubes together in said alignment, and

hot molding the outside only of the intermediate tube so as to form a convex outer surface of revolution continuous from the outer surface of each said two tubes to the greatest outside diameter of said intermediate tube,

thereby to form a continuous, tubular envelope with continuous inner and outer walls having a smooth mid portion of substantially greater wall thickness.

2. The method according to claim 1 wherein the intermediate tube is formed with a substantially constant inside diameter.

3. The method according to claim 1 wherein said intermediate tube is molded by rotating the three fused tubes on their common axis with the intermediate tube and adjacent portions of said two tubes in contact with a mold.

4. An envelope for an arc discharge device comprising,

two glassy end tubes,

an intermediate glassy tube of like inside diameter and greater outside diameter than said end tubes,

the bores of said three tubes being axially aligned,

said tubes being joined by a fused zone at each end of the intermediate tube,

the outside of said intermediate tube comprising a surface of revolution continuously curved outwardly between said fused zones, and the inside diameter of said tubes being substantially constant.

5. An arc discharge device comprising a generally tubular envelope including

two glassy end tubes,

an intermediate glassy tube of like inside diameter and greater outside diameter than said end tubes,

the bores of said three tubes being axially aligned,

said tubes being joined by a fused zone at each end of the intermediate tube,

the outside of said intermediate tube comprising a surface of revolution continuously curved outwardly between said fused zones, and the inside diameter of said tubes being substantially constant inside said curved surface,

first and second electrodes disposed axially of the envelope and having outer ends sealed in said end tubes and spaced inner ends terminating inside said intermediate tube,

and conductor means terminating outside said envelope and extending through respective end tubes to, and electrically connected with, respective electrodes.

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JAMES W. LAWRENCE, Primary Examiner

RAYMOND F. HOSSFELD, Assistant Examiner

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