Feb. 11, 1958 H. E. KREFFT 2,822,646

METHOD OF MANUFACTURE OF A LAMP ENVELOPE

Filed March 30, 1955

Fig. 1.

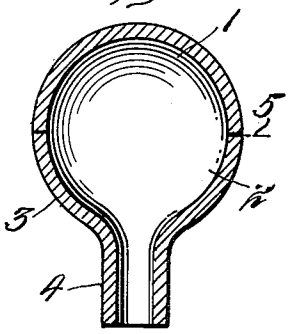


Fig. 2.

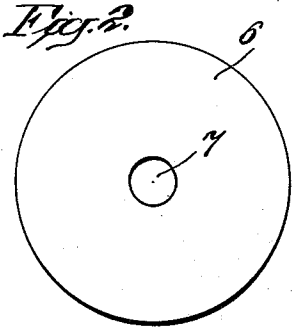


Fig. 3.

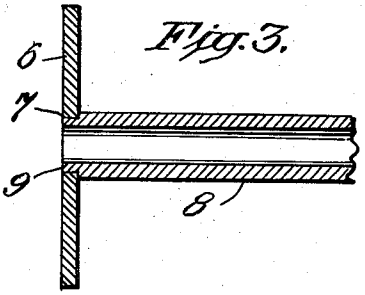


Fig. 4.

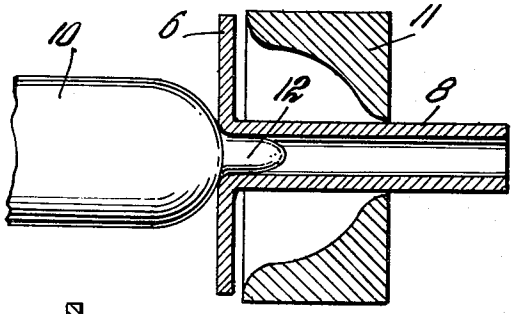


Fig. 5.

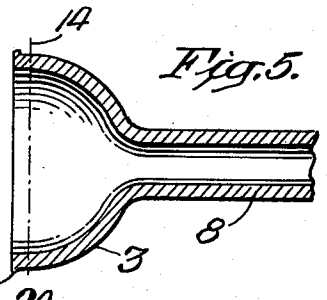


Fig. 6.

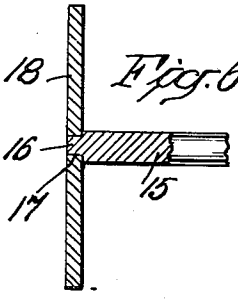


Fig. 7.

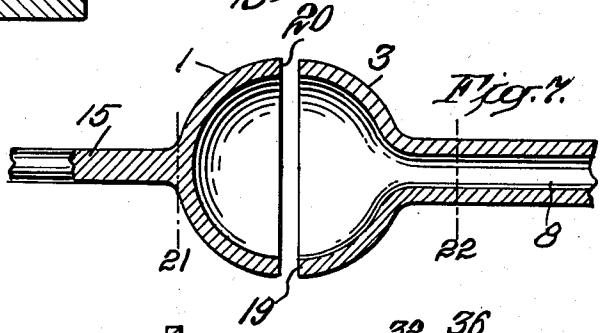


Fig. 8.

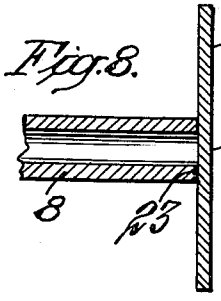


Fig. 9.

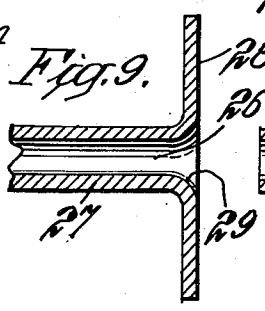
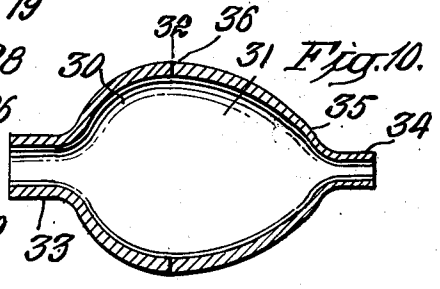


Fig. 10.



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METHOD OF MANUFACTURE OF A LAMP ENVELOPE

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5 Claims. (Cl. 49—79)

The invention relates to envelopes for electrical discharge or vacuum devices made from clear fused silica, and it particularly refers to the manufacturing method for such envelopes which are often used in the construction of electrical discharge lamps operated under very high pressures, and which are commonly known as compact arc lamps.

In these lamps, the discharge vessel has an essentially spherical shape and it is usually provided with one neck, more often with two coaxial necks accommodating the lead-in conductors of the lamp. This envelope is rather thick-walled as it must withstand operating pressures of 30 to 50 atmospheres at elevated temperatures. In a 1000 watt compact arc lamp, for instance, it is customary to use a discharge vessel which has a diameter of 1½ inches and a wall thickness of .120 to .150 inch, and which operates at a surface temperature of 800 to 1000° C. Clear fused silica is the only known material that will meet this requirement.

In the usual procedure for the manufacture of such lamp envelopes, a piece of heavy walled tubing is transformed into the desired shape by blowing. It requires great skill to produce a heavy walled spherical body in this manner as the tubing is subjected to considerable deformation, which makes it difficult to maintain a uniform wall, also, considering the properties of clear fused silica including a high softening point, a short working range and a tendency towards devitrification, it is difficult to produce envelopes to close dimensional tolerances. Envelopes manufactured in this way are expensive because of high labor cost and the tubing itself is an expensive raw material.

In view of the increasing use of compact arcs, improvements in their manufacture are of great importance. It is, therefore, one object of this invention to provide an improved method by which such envelopes can be produced with a high degree of accuracy and uniformity, and through mechanized means. Another object is to provide means for the manufacture of an envelope section having axial symmetry and any desired shape. A further object is to provide an envelope which is not spherical and possesses different radii of curvature in different parts. A still further object is an envelope having a wall of variable thickness. More objects and advantages of the invention will become apparent from the description hereinafter following and the drawings forming part thereof in which:

Figure 1 is a cross-sectional view of a lamp envelope provided with one neck;

Figure 2 is a top view of an apertured disc;

Figure 3 is a cross-sectional view of the disc of Figure 2 combined with a tube;

Figure 4 illustrates a step in the manufacture of an envelope section;

Figure 5 shows a cross-sectional view of an envelope section provided by the method of Figure 4;

Figure 6 shows a cross-sectional view of component parts utilized in the manufacture of another section for the envelope according to Figure 1;

Figure 7 illustrates a cross-sectional view of an assembly step in the manufacture of an envelope;

Figures 8 and 9 illustrate a modification in the manufacturing method illustrated by Figures 3 and 4;

Figure 10 is a cross-sectional view of a lamp envelope provided with a non-spherical vessel and two coaxial necks.

According to the invention, the manufacture of a lamp envelope comprises the steps of sealing one end of an elongated thick-walled tubular or cylindrical part of clear fused silica into an opening provided in the center of a plane disc consisting of the same vitreous material and having a circular shape and comparable wall thickness, but of larger diameter than said part, said part being vertically positioned, with respect to said disc, heating said disc to a high working temperature and subsequently molding it over a mandrel having the size and shape of the internal surface of a section of the envelope by means of a molding tool, thus forming a molded section of the envelope, cutting and/or grinding the rim of said section in a plane perpendicular to the axis of said part and producing a flat annular edge for engagement with the edge of another such section having a similar shape, sealing the edges of said sections together to form a complete envelope.

The invention is based on the fact that in the manufacture of clear fused silica, as a first step, a solid cylindrical slug of considerable diameter is formed from small particles which are fused together under a high temperature. This slug is subsequently pierced axially and transformed into tubing by a drawing process. In accordance with the invention, this last step is eliminated, and instead, a pair of plane discs of circular shape cut from the original solid or pierced slug and having a suitable thickness is used as raw material from which a pair of sections is formed by molding, which pair is subsequently sealed together and constitutes the desired body for the envelope. In order to carry out this procedure and obtain an envelope provided with one neck or two co-axial necks arranged on opposite ends of the envelope body, each disc is provided, prior to the molding process, with an axial tube or rod as will be explained in more detail with reference to the drawings.

Figure 1 shows a lamp envelope which is composed of a substantially semi-spherical section **1** and another section **2** which consists of a substantially spherical portion **3** and a neck portion **4**. Both sections are sealed together at their equator **5** and thus form a spherical lamp envelope having one neck. The procedure for fabricating one of these sections, **2**, is illustrated by Figures 2, 3, 4, and 5 which show a plane disc **6** provided with a central bore **7**, and a tube **8**, of which one end has a plug portion **9** having the same diameter as the bore **7** so that both parts, **6** and **8**, can be assembled to form a tubulated disc as shown in Figure 3. The disc **6** is obtained from a pierced slug of clear fused silica by cutting with a wheel and the bore **7** is produced by internal grinding of an opening already existing in the disc. The diameter and the thickness of the disc are suitably chosen in accordance with the desired size and wall thickness of the section which, in a later step, is molded from this disc, as will be explained later in connection with a practical example. The tube **8** consists of the same vitreous material, and its diameter and wall thickness are the same as desired for the neck of the finished lamp envelope, also, its diameter is suitably chosen somewhat larger than the bore **7** so that a plug **9** fitting this bore can be ground in the tube wall. As a first step in the manufacture of the lamp envelope, a tubulated disc is made by sealing the plug **9** into the bore **7** by means of gas-oxygen

fires which are locally applied to the central part of this assembly. This procedure is conveniently carried out on a lathe or a rotating sealing head where the tube is held by a chuck while the disc rests squarely on the plug 9. The next step in the formation of section 2 is illustrated by Figure 4 where 10 indicates a mandrel having the precise size and shape of the internal surface of the section, and over which the heated and softened disc portion 6 is molded by a tool 11 which may be a paddle or the cavity of a mold having the precise shape and size of the external surface of the spherical portion 3 of the section. Both the mandrel and the mold are mounted coaxially with the tube 8 which is suitably held by a rotating chuck, and both parts of this molding tool cooperate for performing the molding operation and may be retracted from the range of the fires while the disc is heated to a high temperature as required for molding clear fused silica. The molding operation is carried out more safely if the mandrel 10 is provided with a coaxial reamer pin 12 which fits into the bore of the tube 8, and thus serves as a guide which supports the tube end during the molding operation and maintains a bore of desired diameter. For the mandrel and the mold cavity, a refractory nickel-chromium alloy which will stand operating temperatures of 800 to 950° C. has been found to be suitable, and preferably, the molding operation is carried out while these parts are in this temperature range. After the molding operation, the envelope section shown in Figure 5 is obtained which possesses a tubular portion formed by the tube 8, a spherical portion 3 produced by the molding of the disc 6, and a rim portion 13 which is subsequently removed by cutting off the section in a plane indicated by the line 14, thus producing a plane edge of annular cross section.

The procedure for molding section 1 of the envelope from a plane disc of clear fused silica is similar; in this case, however, a rod 15 having a plug 16 is sealed into the central bore 17 of a disc 18, as illustrated by Figure 6. This disc may have the same diameter and wall thickness as the disc 6 from which the other section is formed as approximately the same amount of material is required for both sections. The rod 15 only serves as a means of support for molding the disc 18 and for assembling the complete envelope and therefore, may have any diameter providing sufficient strength to serve this purpose. After the molding of this disc, excess material forming a rim portion as shown in Figure 5 for the other section is removed by means of a cutting wheel, and a plane edge of annular cross-section identical with the edge on the other section is produced.

A step in the manufacture of the envelope of Figure 1 is illustrated by Figure 7 where both sections are shown in precise axial alignment, but separated from each other prior to the process of sealing together the edges 19 and 20. This step is conveniently carried out on a glass lathe which is commonly provided with two coaxial synchronized chucks of which each supports one section by means of the tube 8 or the rod 15, respectively. The edges 19 and 20 are heated by gas-oxygen fires to the required working temperature, and in order to obtain a clean junction between the two sections, the ground surfaces of their edges are first fire polished while holding them apart from each other, and thereafter they are brought into contact with each other and the sealing operation is performed in the usual way by repeated pushing together and pulling apart of the softened material. In order to correct any deformation of the envelope wall, which may be caused by this operation, air at a slight pressure may be introduced through the tube 8 while the sealing operation is carried out. As a last step, the tube 8 and the rod 15 are cut off at the points indicated by the lines 21 and 22, and the flat part left on the apex of section 1 is finally smoothed out and glazed by heat application.

As already explained, the size of the discs, and the diameter and wall thickness of the tube are properly chosen in accordance with the desired dimensions of the envelope, and with the quantity of material required by the molding operation. For example, in the manufacture of a spherical envelope having an outside diameter of 1⅝ inches, a wall thickness of .140 inch, and a neck of ½ inch outside diameter, the following materials were used: two discs having a diameter of 2⅛ inches and a thickness of ⅛ inch; a tube having an outside diameter of ½ inch, a wall thickness of .110 inch, and a length of 2½ inches; a rod having a diameter of ¼ inch and a length of 2½ inches.

For the manufacture of a tubulated disc from which one of the sections is molded, a different procedure may be followed. According to this modification which is illustrated by Figures 8 and 9, a tube 8 provided with a squarely cut and fire polished end 23 is sealed onto the center of a solid disc 24 which is produced from a solid slug of clear fused silica by cutting with a wheel. Preferably, the central part of the surface of this disc facing the tube end 23 is also fire polished prior to the sealing operation as in this way a clear junction of high mechanical strength is more safely obtained. Subsequently, the center of the disc is pierced by means of a piercing fire which is directed against its outer surface 25 while an elevated air pressure is applied through the tube 8. In this way, a tubulated disc having a central opening 26, a tube portion 27 and a plane flange 28, as illustrated by Figure 9, is produced which body is very similar to the one shown in Figure 4. While carrying out this operation, the opening 26 is conveniently shaped by a reamer through which an opening having the diameter of the tube bore and a round shoulder 29 are formed.

Obviously, a lamp envelope having two co-axial necks can be manufactured in accordance with the invention and by the procedures described, if two tubulated sections, as illustrated by Figure 5, are utilized in the composition of the envelope. The invention, however, is not restricted to spherical sections having a constant radius of curvature or a uniform wall thickness as any other sections of different shape having axial symmetry may be molded by the process described in connection with Figure 4, the only requirement being that their annular edges have equal or nearly equal diameters and wall thicknesses. In order to facilitate the sealing operation between such pairs of sections, the walls near the edges may be wedge shaped so that this operation may be started between relatively narrow edges and the desired wall thickness of the envelope near its equator subsequently built up by working the softened material as described with reference to Figure 7. One example of a non-spherical lamp envelope which has two necks and a variable wall thickness is shown in Figure 10. It consists of an egg-shaped discharge vessel composed of two sections 30 and 31 which are sealed together in a plane indicated by the line 32 and which are provided with necks 33 and 34 respectively of different diameters. The wall thickness of section 31 which is cup shaped is small near the neck 34, and considerably larger near the junction with the other section, as indicated by reference numbers 35 and 36 in Figure 10. Section 30 is spherical and also has a wall of variable thickness matching that of the other section near the junction. Owing to the different shapes and sizes, these sections are molded from tubulated discs which have different diameters and thicknesses, and to which tubes of different diameters and wall thicknesses are sealed, as required by the envelope necks.

What is claimed is:

1. The method of manufacturing a vitreous container comprising bonding an end of an elongated vitreous member to a vitreous plate member substantially centrally thereof, simultaneously heating at least said plate member and shaping said plate member into a cup-like member with the elongated member extending in a direction

opposite the opening of the cup-like member, said cup-like member and elongated member comprising an envelope section, reproducing said section to provide a complementary section, contacting the rims of a pair of said cup-like members and bonding the said rims to each other.

2. The method of manufacturing a vitreous container according to claim 1, wherein said container is formed of fused silica.

3. The method of manufacturing a vitreous container according to claim 1, comprising forming an aperture through one of said plate members substantially centrally thereof and bonding an end of a tubular member to the walls of said aperture, and bonding a vitreous rod to another plate member substantially centrally thereof.

4. The method of manufacturing a vitreous container according to claim 3, comprising removing said rod from said cup-like member.

5. The method of manufacturing a lamp envelope comprising forming an aperture through a fused silica disc

substantially centrally thereof, fusing an end of a fused silica tube to the walls of said aperture, fusing an end of a fused silica rod to another fused silica disc, heating and shaping said discs into cup-like members with the rod and the tube extending in a direction opposite the openings of their respective cup-like members, fusing the rims of both cup-like members together and subsequently removing said rod.

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