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Szilagyi

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[54] **ARC TUBE FORMING PROCESS**

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[52] **U.S. Cl.** **65/109;** 65/110

[51] **Int. Cl.** **C03b 23/00;** C03b 23/08

[58] **Field of Search** 65/108, 109, 110

[56] **References Cited**

FOREIGN PATENTS OR APPLICATIONS

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[57] **ABSTRACT**

A quartz arc tube forming process providing a one-piece construction having better uniformity, strength and precision than the prior three-piece construction. The vitreous tubing is heated to plasticity and necked down by cone-sections to a short neck at two places close together. The upstanding double-cone portion between the two necks is then heated and stretched in order to reduce it to the same diameter as the two necks without excessive wall thickening. This procedure is repeated on the tubing at intervals corresponding to the arc tube length and the tubing is severed at the stretched portions to release the formed units.

6 Claims, 8 Drawing Figures

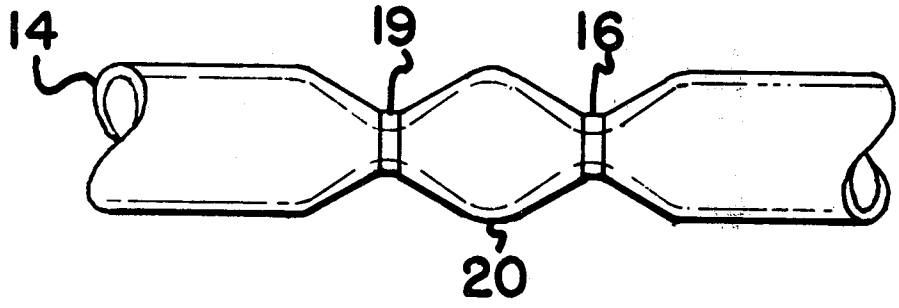


Fig. 1

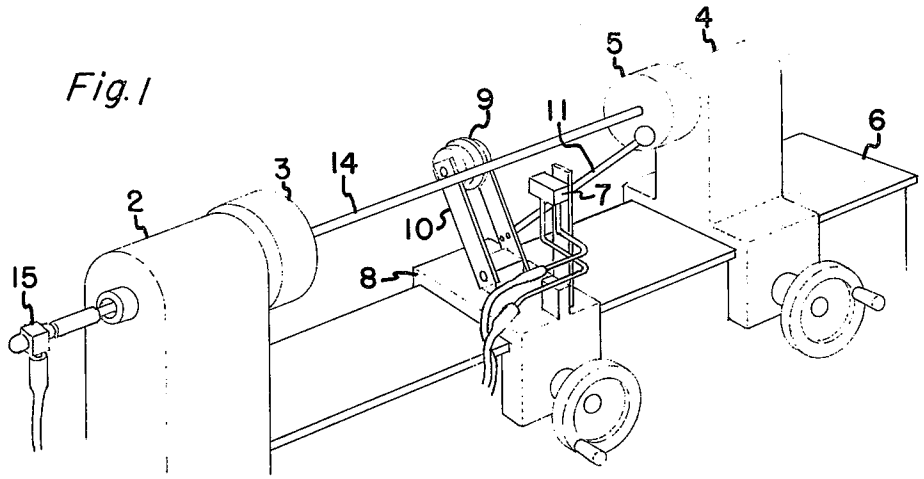


Fig. 2

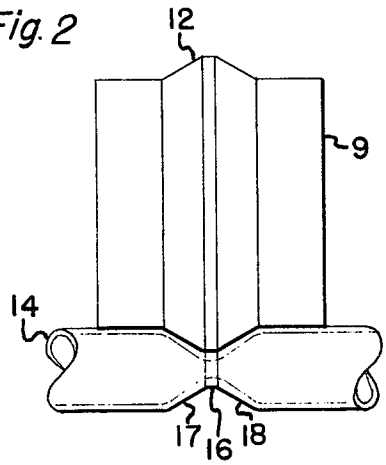


Fig. 5

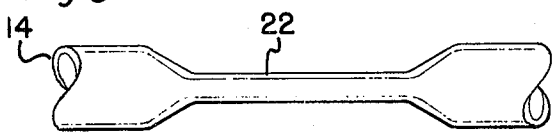


Fig. 6

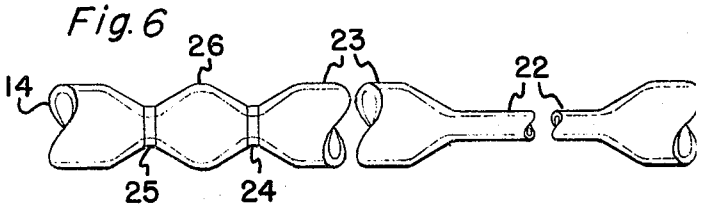


Fig. 3

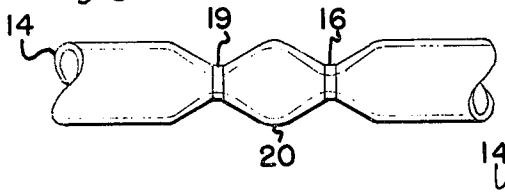


Fig. 7

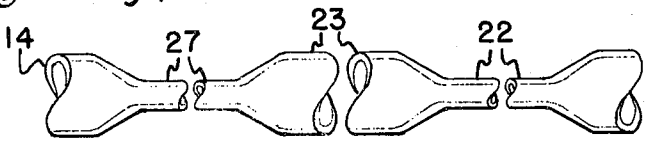


Fig. 4

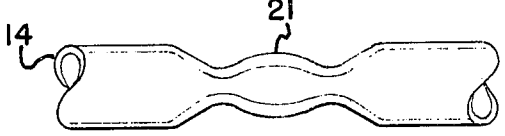
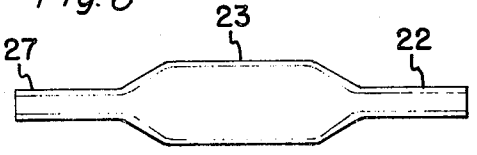


Fig. 8



ARC TUBE FORMING PROCESS

The invention relates to a process for forming vitreous envelopes or bulbs from tubing and is particularly useful in making so-called one piece quartz arc tubes with preformed end chambers.

BACKGROUND OF THE INVENTION

High pressure metal vapor arc lamps such as mercury or metal halide lamps generally comprise an inner arc tube made of quartz which is enclosed within a vitreous outer envelope or jacket provided with a screw base at one end. The arc tube has electrodes sealed into its ends and contains an ionizable medium comprising an inert starting gas and mercury in the case of mercury vapor lamps, or mercury and one or more metal halides in the case of metal halide lamps.

The common economical way to make arc tubes uses so-called full press seals wherein the entire end segment of a piece of quartz tubing is collapsed and sealed off. This is done by pinching the ends of the quartz tube while in a heat-softened condition between a pair of opposed jaws to press the quartz about a foliated inlead supporting an electrode on its inner end. The quartz which is viscous at the instant of pinching assumes a generally rounded shape in the transition zone from the main body to the press seal which may be referred to as the end chamber. The shape or blow-out of the end chambers varies with the type of quartz, the wall thickness, the heat concentration and the nitrogen pressure build-up within the arc tube at pressing. Also there is a seam line where the pinched walls come together whose depth and shape may vary appreciably from tube to tube.

In the conventional high pressure mercury vapor lamp which operates with its mercury filling all vaporized, the specific shape of the end chamber does not appreciably affect performance of electrical characteristics and there has been little concern over it. However in the new metal halide lamps containing a quantity of mercury which is substantially all vaporized in operation and a metal halide in excess of the quantity vaporized, the specific shape of the end chamber governs the location of the cold spot where the excess collects and thereby critically affects lamp performance and color. Lamps containing a limited quantity of mercury and an excess of sodium iodide, and this includes the great majority of all metal halide lamps sold commercially, are particularly sensitive to end chamber variations in shape or dimensions. Such variations affect the end chamber temperature and hence the color of the lamp which is determined by the balance between the mercury vapor pressure and the vapor pressures of the various metal halides.

One expedient which provides a partial solution to the problem is to use a small-neck arc tube. The pinches or press seals then are smaller and narrower and the dimensional variations along with temperature variations in operation are reduced about proportionately. However small-neck arc tubes up to the present have generally been made in a so-called three-piece construction wherein a larger diameter quartz tube which forms the central body portion is necked down at the ends to which smaller diameter pieces of tubing are joined. This is a relatively laborious and expensive process. Also considerable variation in quartz wall thickness occurs at the join between the neck portion and the body portion and this introduces dimensional and temperature variations in the finished arc tube.

The object of the invention is to provide a new and improved method of making small neck tubular vitreous envelopes suitable for press sealing or pinching into arc tubes or other form of electric lamps.

SUMMARY OF THE INVENTION

The vitreous arc tube forming process of my invention provides a small neck tubular vitreous envelope in a one-piece construction having greater strength and uniformity and better dimensional constancy then the prior three-piece construction.

In accordance with my process, vitreous tubing is necked down at two places to provide twin short small necks with an upstanding portion of vitreous tubing between them. The upstanding portion is then heated to plasticity and stretched while shrinking down to approximately the same diameter as the twin necks in order to provide a long neck without excessive wall thickness. The foregoing steps are repeated to form another long neck portion at another place in the tubing. The tubing is then severed at the two long neck portions resulting in a formed unit or envelope having narrow necks at both ends.

The process may be carried out while the vitreous tubing is revolving in a glass lathe. Preferably the tubing is necked down by cone sections in the transition zones or shoulders between the full diameter of the tubing and the reduced diameter of the short cylindrical neck portions. The terms conical and cyclindrical are intended in a descriptive sense and not as exact geometrical definitions. The necks are relatively short by comparison with the conical sections or shoulders so that excessive build-up of wall thickness is avoided. The upstanding portion between the twin necks is shaped as a double cone. When heated, it tends to shrink into a prolate spheroid but the stretching elongates it into a long neck which merges into the original short twin necks at each end.

DESCRIPTION OF DRAWINGS

In the drawings wherein like symbols denote corresponding parts throughout the several views:

FIG. 1 illustrates pictorially a glass blowing lathe provided with burner and forming roller suitable for the practice of the invention.

FIGS. 2 to 8 illustrate successive stages in processing a piece of quartz tubing into a one piece small neck arc tube.

DETAILED DESCRIPTION

The processing of quartz tubing into arc tube envelopes by my process may be done using conventional glass working apparatus. By way of example there is shown in FIG. 1 a glass blowing lathe 1 comprising a head stock 2 including chuck 3 and a tail stock 4 including chuck 5. The tail stock 4 is movable on the bedplate 6 and the lathe includes conventional drive means for rotating the head and tail chucks synchronously. An oxyhydrogen surface mix block burner 7 is provided for directing a broad flame on the quartz tubing and is mounted in front of the tubing on a carriage 8 which is slidable on the bedplate 6. A shaping roller 9 made of graphite or heat resistant ceramic is mounted for free turning on an arm 10 pivotally attached to the carriage 8. The roller 9 is located behind the quartz tubing and

can be brought into engagement with the tubing by pressing down on the lever **11** to cause arm **10** to swing forward. The roller **9** is provided with an annular surface ridge or embossment **12** corresponding in cross section to the necking down desired to be achieved in the quartz tubing.

In practicing my process, a long piece of quartz tubing **14** is inserting through the head stock and extends into the tail stock. A rotating coupling **15** of conventional construction is attached to one end of the quartz tubing, suitably to the left end beyond the head stock, and the opposite end is stoppered (not shown). A blow tube is attached to the rotating coupling to permit the glass blower to pressurize the tube to assist in forming the heat-softened quartz.

The sequence of steps in forming a quartz arc tube by my process is illustrated in FIGS. **2** to **8.** The burner **7** heats a short region of quartz tubing to the softening point and the roller **9** is pressed into engagement to produce the first necking down at **16.** While rolling is a convenient way of forming a neck, it may be done in other ways, for instance by molding. The portion of quartz tubing **14** to the right of the first necking is eventually cut off and wasted. Therefore the first necking **16** is made as close to the tail stock as conveniently possible. The neck is made relatively short so that as the rolling or molding proceeds, the quartz is stretched as it is formed into the conical shoulders **17, 18** and does not thicken up excessively at or near the narrow neck or throat **16.**

In the next step, a second necking **19** is produced to the left and close by the first as indicated in FIG. **3,** and this may conveniently be done by shifting the carriage **8** appropriately to the left before engaging the quartz tubing. When the forming roller **9** engages the quartz tubing to form necking **19,** the quartz has already cooled sufficiently to be rigid in the region of necking **16** and this is necessary to avoid distortion.

The two adjacent short necks **16, 19** where the diameter is at a minimum, have an upstanding double cone portion **20** in between. The third step in my process consists in shrinking the double cone portion to the same diameter as the two adjacent neck portions **16, 19** while at the same time avoiding excessive wall thickening. This is accomplished by playing an oxyhydrogen flame on the double cone portion **20** and for this purpose I prefer to use a single jet large orifice burner. The softening of the quartz is extended barely into the neck region **16, 19.** The double cone portion now begins to collapse into a prolate spheroid. It may be desirable at this time to pressurize the tube slightly in order to control the rate of collapse and the operator may do this by blowing into the blow tube. As the double cone collapses into a prolate spheroid, the tubing is stretched by moving the tail stock to the right so that portion **20** passes through a prolate spheroid **21** as illustrated in FIG. **4** to a straight walled elongated neck portion **22** as illustrated in FIG. **5,** having about double the length of the original tubing. Substantial uniformity of wall thickness within the stretched long neck portion **22** is achieved by controlling the rate of stretching.

The wall thickness in the long neck may readily be made equal to, less or greater than the original wall thickness of the quartz tubing. The main control factors are the separation of the twin necks **16, 19** which determines the length of the double cone **20,** and the extent of stretch into long neck portion **22.** By increasing the separation and/or stretching less, the wall thickness may readily be made several times the original wall thickness of the quartz tubing. This permits making thick neck tubes for sealing heavier current foils when desired.

With the formation of the long neck **22,** one side of an arc tube envelope **23** has been formed. A similar neck is next formed on the opposite end by passing through the intermediate stages of forming two short necks **24, 25** as indicated in FIG. **6,** and then collapsing and stretching the double cone portion **26** into a long neck **27** as indicated in FIG. **7.** Thereafter the long necks **22** and **27** are severed at the midpoints and a completed arc tube **23** is released as indicated in FIG. **8.**

It is a matter of convenience whether a single bulb or several are formed in the quartz tubing **14** before the individual envelopes are severed. If the individual envelopes are severed as they are formed, less shifting of the carriage **8** is required but rechucking of the quartz tube in the head stock and tail stock is required for every bulb. Alternately, a whole series of bulbs may be formed in the tubing and thereafter the individual arc tube envelopes may conveniently be released by severing the tubing at the long necks **22, 27** etc. in any manner convenient. In yet another mode of operation, the quartz tube **14** may be shifted to the right through the tail stock as each arc tube envelope is completed and the necks snapped off at the point of emergence to the right of the tail stock.

The foregoing description of a specific technique followed in processing quartz tubing into arc tube envelopes or bulbs is intended by way of illustrative example of my method only. It will be apparent that the method lends itself readily to automation but that in so doing, minor changes in the steps or in the sequence of steps may be desirable.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A process for forming small neck envelopes from vitreous tubing comprising the steps of:

heat-softening and necking down the vitreous tubing at two places to provide twin small necks which are short relative to their shoulders with an upstanding portion of vitreous tubing between them;

allowing the quartz to cool sufficiently to be rigid at least in the shoulders remote from said upstanding portion;

then heat-softening and stretching the upstanding portion while shrinking it down to approximately the same diameter as the twin necks in order to provide a long neck without excessive wall thickness, said stretching resulting from mechanical application of tension to the tubing and said shrinking resulting from application of heat without use of a die;

repeating the foregoing steps to form in a similar way another long neck portion without excessive wall thickness at another place in the tubing;

and then severing the tubing at the two long neck portions in order to release a formed unit having narrow necks at both ends.

2. The process of claim **1** wherein the vitreous tubing is necked down into twin small necks by heating to plasticity at the selected places and rolling down.

3. The process of claim 1 wherein the vitreous tubing is necked down into twin small necks by heating to plasticity and molding at the selected places.

4. The process of claim 1 wherein the vitreous tubing is necked down by cone sections to produce twin small cylindrical necks at the two selected places with an upstanding double cone portion between them which is then heated to plasticity, and stretched as it is shrunk down into a long neck portion.

5. The process of claim 1 wherein the vitreous tubing is necked down by cone sections to produce twin small cylindrical necks at the two selected places with an upstanding double cone portion between them, and the double cone portion is then heated to plasticity and stretched as it shrinks through a prolate spheroid into a long neck portion.

6. The process of claim 5 wherein the length and extent of stretch of the double cone portion are chosen to result in substantially constant wall thickness in the neck portions.

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