April 26, 1966 J. G. BURNS 3,247,589

METHOD OF CUTTING GLASS

Filed Feb. 28, 1964

FIG. 1

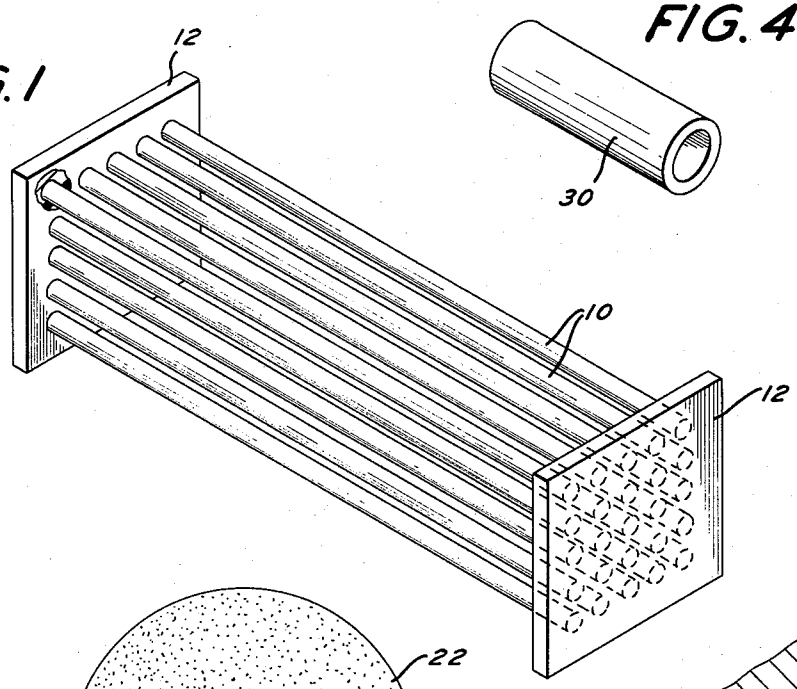
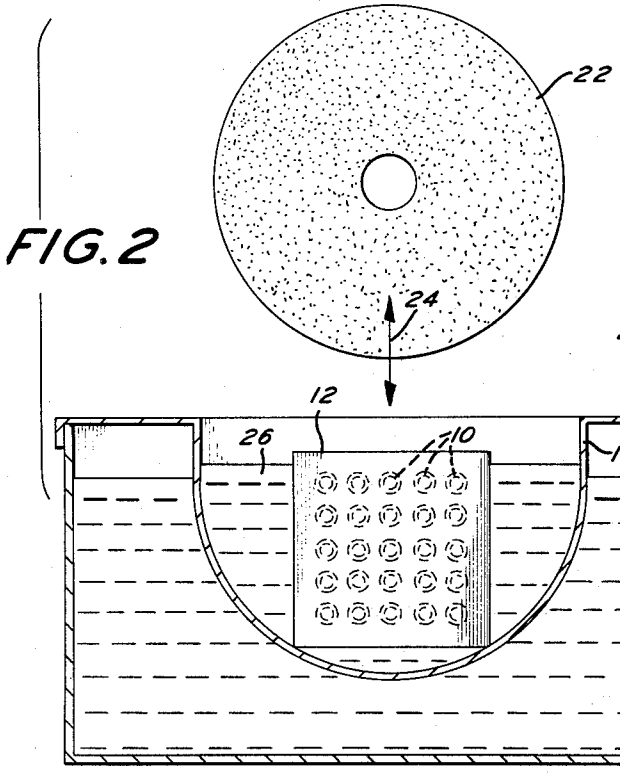


FIG. 4

FIG. 2



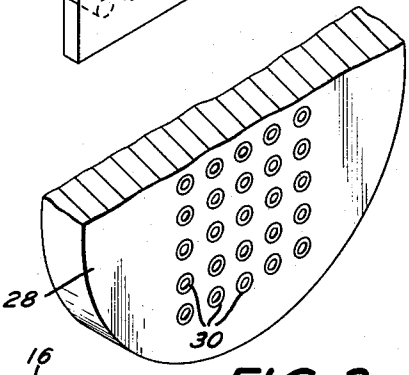


FIG. 3

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METHOD OF CUTTING GLASS

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The present invention relates to a method of cutting glass, and more particularly to a method of cutting a plurality of elongated glass tubes into smaller pieces of uniform length to be used for electrical resistors.

In United States Letters Patent No. 2,958,899, to S. J. Stein et al., issued November 8, 1960 and entitled "Apparatus for Deposition of Solids From Vapors" there is described a method of making electrical resistors wherein a continuous length of glass tubing is coated on its outer surface with a resistance material. The coated glass tubing is then cut into short lengths which constitute the active body portion of the resistors. Terminals are attached to the body portion, and they are enclosed in an insulating casing to complete the resistor. Generally, the coated, continuous length glass tube is first cut into sticks which are approximately two feet in length. The sticks are tested electrically to determine whether the resistance material coating is of the desired resistance value. The satisfactory sticks are then cut into the short resistor bodies of one-half to two inches in length depending on the size resistor being made.

There are a number of problems with regard to cutting the sticks into the shorter pieces so as to provide good resistor bodies. The sticks must be cut so that the ends of the bodies are square, i.e., perpendicular to the longitudinal axis of the glass tube. Also, the ends of the glass bodies must not be chipped or the glass tube and resistance coating cracked. The bodies must be of uniform length to obtain resistors having the same resistance value. In addition, the resistance coating must not be damaged or contaminated, which could change the electrical characteristics of the coating. For mass production of resistors, it is desirable to be able to cut a plurality of the sticks at one time so as to reduce the cost of the cutting operation.

It is an object of the present invention to provide a novel method of cutting an elongated glass tube into short pieces.

It is another object of the present invention to provide a method of simultaneously cutting a plurality of elongated glass tubes into short pieces.

It is still another object of the present invention to provide a method of simultaneously cutting a plurality of elongated glass tubes into short pieces with the ends of the short pieces being perpendicular to the longitudinal axes thereof.

It is a further object of the present invention to provide a method of simultaneously cutting a plurality of elongated glass tubes into short pieces without chipping or breaking the short pieces.

It is a still further object of the present invention to provide a method of simultaneously cutting into short pieces a plurality of elongated glass tubes which are coated with a resistance material without damaging or contaminating the coating.

Other objects will appear hereinafter.

The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others thereof, which will be exemplified in the method hereinafter disclosed, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following

detailed description taken in connection with the accompanying drawing in which:

FIGURE 1 is a perspective view illustrating the first step of the method of the present invention wherein a plurality of glass tubes are secured together in a bundle.

FIGURE 2 is a schematic view of an apparatus for carrying out further steps of the method of the present invention.

FIGURE 3 is a perspective view of a plurality of cut glass pieces ready for the final step of the method of the present invention.

FIGURE 4 is a perspective view of a short glass body cut from the elongated glass tube.

In general, the method of the present invention comprises arranging in closely spaced, parallel arrangement a plurality of elongated glass tubes which are coated on their outer surface with a resistance material. The arrangement or bundle of the elongated glass tubes is then placed in a container which is filled with distilled water to completely cover the glass tubes. The water is then frozen so as to encase the glass tubes in a block of ice. A saw is then passed through the block of ice and the glass tubes along planes uniformly spaced along and perpendicular to the longitudinal axes of the glass tubes. This divides the block of ice into wafer like sections each of which contains a plurality of the short glass pieces. The wafers are then heated to melt the ice, and the individual glass pieces are removed from the water and dried.

By completely encasing the glass tubes in ice, each of the tubes is supported around its entire surface as the saw passes therethrough so as to obtain a clean cut without chipping or breaking the glass. Also, by using water as the encasing material, the water can be easily removed at a relatively low temperature and without leaving any contaminates on the resistance material coating so that there is no adverse effects on the electrical characteristics of the resistance material. Since the glass tubes are cut completely therethrough, it is possible to provide the short glass pieces with end surfaces which are perpendicular to the longitudinal axes thereof. In addition, the method of the present invention permits the simultaneous cutting of a plurality of glass tubes to obtain glass pieces of uniform length.

Referring initially to FIGURE 1 of the drawing, the method of the present invention in detail comprises first arranging a plurality of the coated glass tubes **10** in closely spaced parallel relation. As shown, the glass tubes **10** are arranged in parallel rows with a plurality of tubes in each row. This can be easily achieved by means of a suitable mechanical jig. A separate block **12** of a plastic material is cast around each end of the bundle of the glass tubes **12** with the blocks extending across and closing the ends of the tubes. Thus, the blocks **12** secure the glass tubes **10** together as a bundle, and seal the ends of the glass tubes. It has been found necessary to seal the ends of the glass tubes to prevent water from entering the tubes since any water within the tubes upon freezing may cause a cracking of the tubes.

Referring to FIGURE 2, there is shown a schematic illustration of an apparatus for carrying out the next step of the method of the present invention, i.e., encasing the glass tubes in a block of ice, and cutting through the ice and the tubes. The apparatus comprises a rectangular container **14** of a length greater than the length of the glass tubes **10**, a width greater than the width of the bundle of the glass tubes, and a depth greater than the height of the bundle of the glass tubes. The container **14** is open at its top, and a metal cover **16** extends across the open top of the container and is seated on the top edges thereof. The cover **16** has a U-shaped trough **18**

extending into the container **14**. The trough **18** is of a size larger than the volume of the bundle of the glass tubes. The container **14** is filled with a cooling medium **20** to a depth so that the wall of the trough **18** is in contact with the cooling medium. Although any cooling material may be used, a mixture of Dry Ice in a good heat conducting liquid, such as butyl Cellosolve or acetone, produces good results.

Mounted above the trough **18** is a flat, circular abrasive saw **22**. The saw **22** is positioned in a plane which is perpendicular to the length axis of the trough **18**, and is mounted on suitable mechanical means, not shown, for rotating the saw and moving it into and out of the trough as indicated by the arrow **24**. Either the container **14** or the saw **22** is mounted for movement along the length axis of the trough **18** so as to permit the saw to be positioned at various points along the trough.

To carry out the method of the present invention, the bundle of the glass tubes **10** are seated in the trough **18** as shown in FIGURE 2. The plastic blocks **12** at the ends of the bundle space the tubes **10** from the wall of the trough **18**. The trough **18** is then filled with water **26**, preferably distilled water, to a level so that all of the tubes **10** are immersed in the water. The water **26** is then cooled by the cooling medium **20** until the water is completely frozen into a block of ice. To ensure that each of the glass tubes **10** is completely supported by the ice, it is necessary that the block of ice be free of any air bubbles or voids. It has been found that by freezing the water from the bottom of the trough **18** upwardly, as is achieved by the apparatus shown in FIGURE 2, the block of ice is free of air bubbles or voids. Thus, when the water is completely frozen, each of the glass tubes **10** is completely encased in and supported by the block of ice.

When the water **26** is completely frozen, the saw **22** or container **14** is moved to place the saw over the junction of the glass tubes **10** and one of the plastic blocks **12**. The saw **22** is then rotated and moved downwardly into the trough **18** so as to cut through the block of ice and the glass tubes **10**. The saw **22** is then raised out of the trough **18**, and either the saw or the container **14** is moved to place the saw over the glass tubes at a point spaced from the first cut equal to the desired length of the glass pieces. The saw **22** is then moved back into the trough **18** to again cut through the block of ice and the glass tubes **10**. This cutting operation is continued until the other ends of the glass tubes are reached.

The above described cutting operation divides the block of ice into a plurality of wafers **28** each containing a plurality of the short glass pieces **30**, see FIGURE 3. The ice wafers **28** are then removed from the trough **18**, or the cover **16** is removed from the container **14**, and the ice is permitted to melt. The ice can be melted either at room temperature or at a slightly elevated temperature. When the ice is completely melted, the short glass pieces **30** are removed from the water and permitted to dry. The glass pieces can be dried either at room temperature or at a slightly elevated temperature. FIGURE 4 shows one of the final glass pieces **30** which is coated with the resistance material.

Thus, there is provided by the present invention a

method of cutting an elongated glass tube into a plurality of short pieces of any desired length without chipping or breaking the glass pieces and with the glass pieces having squared ends. Also, the method of the present invention permits the cutting of a plurality of glass tubes at one time. In addition, using the method of the present invention there is no adverse affect to the electrical characteristics of a resistance material coated on the glass tubes because of any contamination of the resistance material.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

I claim:

1. A method of cutting a plurality of elongated glass tubes into shorter pieces comprising the steps of arranging the glass tubes in closely spaced parallel relation, then encasing the glass tubes in a body of ice which individually surrounds and supports each glass tube, and then cutting through the body of ice and the glass tubes at spaced intervals along the length of the tubes.

2. The method in accordance with claim **1** including the steps of melting the ice after the cutting step, removing the glass pieces from the water after the ice is melted, and then drying the glass pieces.

3. A method of cutting a plurality of elongated glass tubes into shorter pieces comprising the steps of securing the glass tubes together in closely spaced parallel relation, placing the glass tubes in a container which is open at its top, filling the container with water until the glass tubes are completely immersed in the water, then cooling the water until the tubes are completely encased in a body of ice, and then cutting through the body of ice and the glass tubes at spaced intervals along the length of the glass tubes.

4. The method in accordance with claim **3** including sealing the ends of the glass tubes before immersing the tubes in the water to prevent the water from entering the tubes.

5. The method in accordance with claim **4** in which the ends of the glass tubes are sealed and the glass tubes are secured together by forming a separate block of a plastic material around the adjacent ends of the glass tubes.

6. The method in accordance with claim **3** in which the water is cooled from the bottom of the container upwardly.

7. The method in accordance with claim **3** including the steps of melting the ice after the cutting step, removing the glass pieces from the water after the ice is melted, and then drying the glass pieces.

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