Feb. 11, 1947. C. E. BUCHWALD ET AL 2,415,412

METHOD OF FORMING VACUUM TUBES

Filed July 31, 1943

FIG. 1

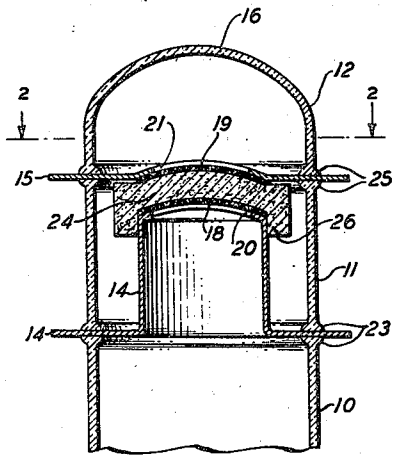


FIG. 4

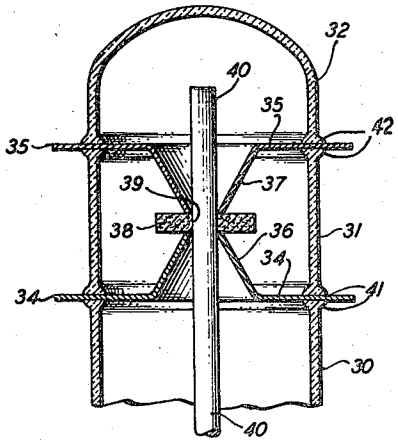


FIG. 2

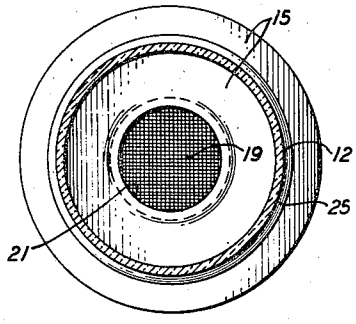
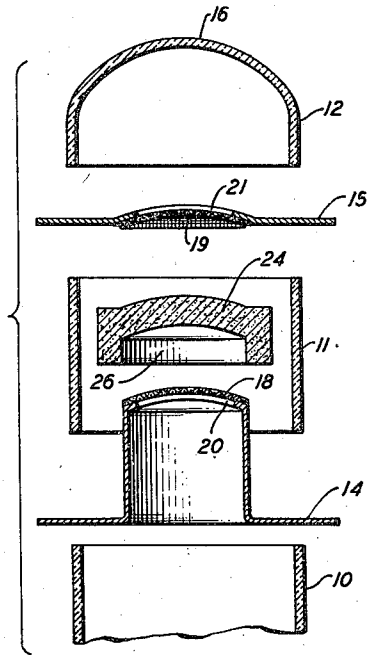


FIG. 3



INVENTORS C. E. BUCHWALD
S. K. SHULL

BY E. R. Moulton

ATTORNEY

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METHOD OF FORMING VACUUM TUBES

Charles E. Buchwald and Sherman K. Shull, New York, N. Y., assignors to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York

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12 Claims. (Cl. 49—81)

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This invention relates to a method of making vacuum tubes, and more particularly to the securing of metallic members in glass bulb structures.

In certain types of vacuum tubes resilient metallic members are supported by the outer glass bulb structure. In certain instances mesh grids constitute parts of the resilient metallic members and in each instance it is important that there exist an accurate predetermined spacing between the numbers.

An object of the invention is to provide a simple and highly efficient method of forming structures with accurately spaced portions therein.

With this and other objects in view, the invention comprises a method of forming a bulb structure comprising sealing a metallic member between bulb portions, spacing the metallic member from another metallic member by a soluble spacer, sealing a cover portion over the last mentioned metallic member and adjacent bulb portion to complete the bulb structure, and dissolving the spacer.

Other objects and advantages will be apparent from the following detailed description when considered in conjunction with the accompanying drawing, wherein

Fig. 1 is a vertical view of one species of the invention, showing the completed structure excepting the removal of the spacer;

Fig. 2 is a horizontal sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is an exploded view illustrating the various parts to be assembled by the method, and

Fig. 4 is a fragmentary vertical sectional view of another species of the invention.

Referring now the drawing, through the aid of which the method may be more clearly understood, attention is directed to Figs. 1 to 3 inclusive. The structure shown in Fig. 1 is formed of three glass bulb portions 10, 11 and 12 and two metallic members 14 and 15. The bulb portions are in the present instance formed of glass, the first two being tubular while the portion 12, although tubular in cross-sectional contour, is closed at its upper end, as at 16, to form with its companion portions a complete bulb structure. The metallic members 14 and 15 are in the present instance formed of copper and are quite thin. The thickness of these members is purposely exaggerated in the drawing to more clearly illustrate the various portions of their structure. Mesh grids 18 and 19 are secured to their respective members 14 and 15, by suitable means such as welding at their edges,

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and thus extend over openings 20 and 21 in the centers of their members. The grids 18 and 19 are formed of metallic mesh or finely woven wires of a suitable metal, they being normally of a finer structure than shown in the drawing. The grids are, therefore, delicate in structure, and to obtain the maximum efficiency of the vacuum tube of which they will be a part, through the functions of the grids, it is important that their contours be maintained, which as illustrated, are convexed, and that the members supporting them be assembled with the bulb portions so that the grids will be accurately spaced from each other.

In actual practice there may be various steps and assisting structures for accomplishing these and other steps of the method, but it is not believed necessary to show machines or other structures through the aid of which such steps may be accomplished. Concentrating upon the present invention, the portion 10 may be supported by suitable means and, if desired, rotated relative to heating means such as flames from gas burners. The member 14 with its mesh grid 18 is centrally placed upon the top of the portion 10 over which the portion 11 is lowered. The portions 10 and 11, through the application of heat by suitable means (not shown) at the juncture of the member 14 with the portions 10 and 11, may be fused to the member, as at 23, short of the peripheral edge of the member.

The next step includes the placing of a spacer 24 in the form of a cup-shaped pellet made to conform to both the grids 18 and 19 and the adjacent end of the member 14. The spacer is formed of a material, such as sodium aluminate, soluble in hot water, having a melting point of approximately one thousand six hundred degrees (1,600°) centigrade. The member 15 is then disposed in place, resting upon the upper end of the portion 11, the grid 19 conforming to and resting upon the spacer 24. At this time the portion 12 is positioned upon the member 15 and, through the application of heat at the juncture of the member 15 with the portions 11 and 12, the portions are fused to the member as at 25 (Fig. 1).

It will be apparent that the spacer 24 is of a sufficient size and contour to extend beyond the edges of the openings 20 and 21 in their respective members, so that the weight of the spacer is carried by the member 14 and, through the solid structure of the spacer, the member 15 is held against displacement during the fusing of the portions 11 and 12. Furthermore, the an-

nular downwardly projecting portion 26 of the spacer conforms to the cylindrical portion of the member 14 and serves to locate the central portion thereof over the grid 18. In this manner the accurate spacing of the screen grids is assured, the spacer serving not only to maintain the desired contour of the grids but to control the resilient members 14 and 15 during the steps of the method in assembling the members and parts of this structure. The spacer also holds the member 15 properly spaced from the member 14 during the last fusing step and eliminates displacement thereof.

There remains an additional step, that is, the removal of the spacer 24. This is accomplished through the application of a liquid, such as water of a temperature sufficient to dissolve the spacer, the liquid serving also to wash the material of which the spacer is formed from the bulb structure thus completed. The application of the hot water or liquid for dissolving the spacer may be applied to the structure through the open lower end, that is, through the portion 10, in any suitable manner. If desired, the member 14 may be provided with one or more apertures to facilitate in the draining of the water and soluble material from the completed structure. This material may also pass through the grids 18 and 19.

The species shown in Fig. 4 illustrates a similar method, the only difference between this species and that shown in Figs. 1 to 3 inclusive lying in the structure of the metallic members and the spacer for supporting them through the assembling steps. In this embodiment bulb portions 30, 31 and 32, identical in structure with the portions 10, 11 and 12, are provided, metallic members 34 and 35 being of the contours shown, having conical central portions 36 and 37 which are to be accurately spaced from each other through the aid of a spacer 38. The spacer 38 is in this instance annular in general contour, having a central opening 39 for receiving a locating rod 40. The same method steps may be taken in completing this structure, that is, the fusing of the portions 30 and 31 with the member 34 therebetween to form a connection 41 similar to the connection 23 (Fig. 1). The spacer 38 may then be located upon the central portion 36 of the member 34, its location being maintained through the aid of the locating rod 40 extending through the central aperture of the spacer. At this time the upper member 35 may be disposed in place and after the portion 32 is lowered to rest upon the periphery of the member 35, the portions 31 and 32 may be fused at their juncture with the member to form a connection 42 similar to the connection 25. During these method steps of assembling the portions and members, the accurate spacing of the members is maintained by the spacer 38 assisted by the rod 40. The rod may then be removed from the spacer, and through the application of a heated liquid, such as water, the spacer which is formed of the same material as the spacer 24, may be dissolved and the liquid together with the dissolved material of the spacer may be removed from the completed bulb structure. Apertures in the base of the member 34 may be provided to facilitate in the removal of the liquid and dissolved material of the spacer.

In each instance, that is in each structure, the members which are metallic are accurately spaced from each other and maintained in desired relative positions by a solid spacing member during the last assembling or fusing steps, and

at the completion of the article the spacer is in a position where it cannot be removed in its original state. However, through the application of hot water to the spacer in each instance, it will dissolve and thus be removed with the hot water. The method steps have been described as being spaced in time, but if desired all bulb portions and metallic members, with the aid of the spacers, may be assembled simultaneously. Furthermore, the metallic members may be secured at spaced positions in a complete glass casing or bulb while being separated by one of the spacers.

Although specific improvements of the invention have been shown and described, it will be understood that they are but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined by the appended claims.

What is claimed is:

1. The method of forming a bulb from tubular bulb portions and metallic members comprising joining the bulb portions and securing the metallic members therein, spacing the metallic members with a soluble solid member interposed therebetween, and dissolving the spacing member.

2. The method of forming a bulb comprising securing metallic members at spaced positions in a glass casing, spacing the metallic members with a soluble solid member during the securing of certain of the metallic members in the casing, and dissolving the spacing member.

3. The method of forming a bulb comprising securing metallic members at spaced positions in a glass casing, spacing the metallic members with a soluble solid member conforming to the metallic members during the securing of certain of the metallic members in the casing, and dissolving the spacing member.

4. The method of forming a bulb from tubular bulb portions and metallic members comprising joining the bulb portions and securing the metallic members therein, spacing the metallic members with a soluble solid member extending over one member and formed to conform to both members to accurately space them apart, and dissolving the spacing member.

5. The method of forming a bulb comprising securing metallic members at spaced positions in a glass casing, spacing the metallic members with a spacer soluble in a hot liquid, and applying a hot liquid to the spacer to dissolve it.

6. The method of forming a bulb comprising securing metallic members at spaced positions in a glass casing, spacing the metallic members with a spacer soluble in hot water, and applying hot water to the spacer to dissolve it.

7. The method of forming a bulb from tubular bulb portions and metallic members comprising joining the bulb portions and securing the metallic members therein, spacing the metallic member with a spacer soluble in a hot liquid, and applying a hot liquid to the spacer to dissolve it.

8. The method of forming a bulb from tubular bulb portions and metallic members comprising joining the bulb portions and securing the metallic members therein, spacing the metallic members with a spacer soluble in hot water, and applying hot water to the spacer to dissolve it.

9. The method of forming a bulb comprising securing metallic members at spaced positions in a glass casing, spacing the metallic members with a spacer formed of sodium aluminate, and applying hot water to the spacer to dissolve it.

10. The method of forming bulbs comprising fusing a pair of bulb members together and simultaneously therewith securing a metallic member therein at the fused juncture of the portions, disposing a soluble spacer on the metallic member and therewith space a second metallic member therefrom, disposing the second metallic member on the spacer, fusing another bulb portion with the one adjacent the second metallic member and securing the second metallic member therein, and dissolving the spacing member.

11. The method of forming bulbs comprising fusing a pair of bulb members together and simultaneously therewith securing a metallic member therein at the fused juncture of the portions, disposing a spacer soluble in a hot liquid on the metallic member and therewith space a second metallic member therefrom, disposing the second metallic member on the spacer, fusing another bulb portion with the one adjacent the second metallic member and securing the second metallic member therein, and applying a hot liquid to the spacer to dissolve it.

12. The method of forming bulbs comprising fusing a pair of bulb members together and simultaneously therewith securing a metallic member therein at the fused juncture of the portions, disposing a spacer soluble in hot water on the metallic member and therewith space a second metallic member therefrom, disposing the second metallic member on the spacer, fusing another bulb portion with the one adjacent the second metallic member and securing the second metallic member therein, and applying hot water to the spacer to dissolve it.

CHARLES E. BUCHWALD.
SHERMAN K. SHULL.