June 12, 1934. P. T. WEEKS 1,963,008

RADIO TUBE CONSTRUCTION

Filed April 10, 1934

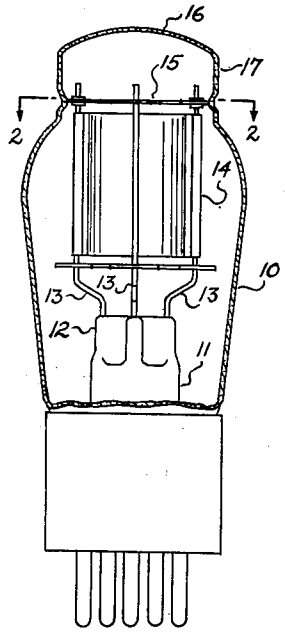


FIG. 1

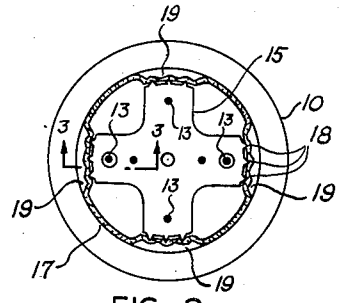


FIG. 2

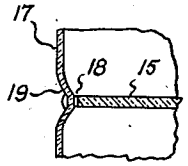


FIG. 3

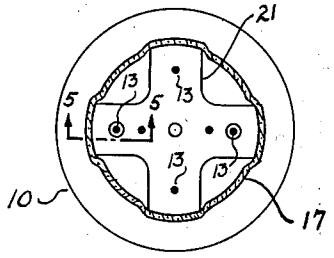


FIG. 4

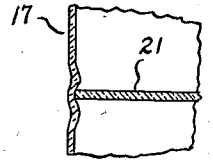


FIG. 5

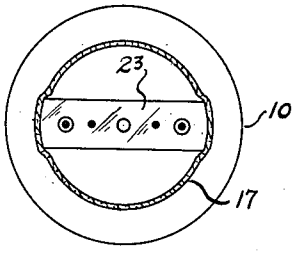


FIG. 6

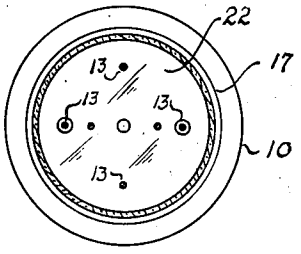


FIG. 7

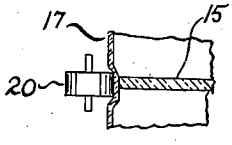


FIG. 8

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RADIO TUBE CONSTRUCTION

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Application April 10, 1934, Serial No. 719,880

19 Claims. (Cl. 250—27.5)

This invention relates to radio tube electrode supports and methods of making the same.

An object of my invention is to devise a support for the electrodes in a radio tube which shall effectively prevent any motion or vibration of the said electrodes.

Another object is to produce such a support which is durable and capable of withstanding considerable amount of abuse.

A still further object is to devise a method for producing such an electrode-supporting structure.

The foregoing and other objects of my invention will be best understood from the following description of exemplifications thereof, reference being had to the accompanying diagrammatic drawing, wherein

Fig. 1 is a vertical view, partly in section, of a radio tube embodying my invention;

Fig. 2 is a cross-section taken along line 2—2 of Fig. 1;

Fig. 3 is an enlarged view of a fragmentary section taken along line 3—3 of Fig. 2;

Fig. 4 is a cross-section similar to that of Fig. 2 showing another embodiment of my invention;

Fig. 5 is an enlarged view of a fragmentary section taken along line 5—5 of Fig. 4;

Figs. 6 and 7 are cross-sectional views similar to Figs. 2 and 4 showing additional modifications of my invention; and

Fig. 8 is a fragmentary section similar to Figs. 3 and 5 illustrating one step in the method of producing my novel electrode support.

In the construction of space discharge devices, such as radio tubes, it has been found that it is desirable to have some definite support for the upper end of the electrode assembly within the tube in order to prevent excessive vibration and movement of the electrode assembly. This electrode assembly consists of a plurality of electrodes together with their supporting structure such as, for example, standards connected thereto. Radio tubes are commonly constructed with an insulating spacer at the upper end of the electrode assembly which is employed largely for fixing the position of the electrodes with respect to each other. It has been attempted to secure a definite support for the upper end of the electrode assembly by making the glass envelope of the radio tube with a cylindrical portion, and making the insulating spacer large enough so that it touches the inside walls of said cylindrical portion.

In this type of construction various problems exist, particularly with respect to obtaining the proper close fit between the insulating spacer and the glass envelope. This fit must be loose enough to permit the easy insertion of the electrode assembly into the glass envelope and not to interfere with the "pull-down" of the electrode assembly after the sealing-in operation. If the fit is too loose, the electrode assembly is not properly supported, and there results the possibility of mechanical rattle and damage to the electrode assembly when the tube is subjected to severe vibration. Also there is an appreciable variation in diameter between glass envelopes, and the two difficulties mentioned above are commonly encountered as a result. As a partial remedy the insulating spacer has been provided around its outer edges with pointed projections having some degree of flexibility which will tend to cause these projections to accommodate themselves to smaller diameter envelopes by bending of these projections. However, since the spacer is made of insulating material which is brittle, these projections are very likely to be broken off when the tube is subjected to vibration.

I have found that all of the difficulties enumerated above can be entirely overcome by softening the glass envelope around the edges of the insulating spaced by the application of heat thereto and shrinking the glass wall of the envelope into intimate contact with the edge of said insulating spacer, as will be described below. This prevents any transverse motion of the spacer relative to the glass walls while the vertical movement of the spacer is largely prevented by said spacer being secured to the electrode assembly.

In the drawing is shown a radio tube having a glass envelope 10 with the usual stem 11 having a press 12 in which are sealed a plurality of electrode-supporting wires or standards 13. In some types of radio tube construction, some of the supporting standards for the electrode structure are anchored to the stem by means other than being sealed in the press. The supporting standards 13 support an electrode assembly 14. The standards 13 project above the electrode assembly 14, and are engaged at their upper ends by an insulating spacer 15, usually constructed of mica. The glass envelope 10 is provided with an upper dome portion 16 having cylindical sides 17. The insulating spacer 15 may be X-shaped, as shown more clearly in Fig. 2, and may be provided with a number of projections 18 along its outer edges. The size of the insulating spacer 15 is ordinarily large enough so that the projec-

tions 18 come into intimate contact with the cylindrical walls 17 of the glass envelope 10. In order to effectively prevent any possibility of relative movement between the insulating spacer 15 and the cylindrical walls 17, I shrink the portions 19 of the cylindical walls 17 so that these portions are firmly pressed onto the projections 18.

The shrinking described above may be accomplished as follows. The electrode assembly 14 mounted on the stem 11 is first inserted into the glass envelope 10 far enough so that the insulating spacer 15 slides up into the dome-shaped portion 16 of the glass envelope 10. The ends of the projections 18 come into contact with the cylindrical wall portions 17, and slide along the inner surface thereof. The stem 11 is then fused to the glass envelope 10, and at the end of this fusing operation and while the glass at the portion where the fusing takes place is still soft, the stem 11 together with the electrode assembly 14 is pulled down relative to the glass envelope 10. This operation is known as "pull-down". During the pull-down, of course the ends of the projections 18 slide along the inner surfaces of the cylindrical wall portions 17. When the above operations have been completed, heat is applied to the portions 19 of the cylindrical walls 17 as, for example, by directing a gas flame against each of these portions. When the glass becomes sufficiently softened, the surface tension of the glass itself causes these portions to shrink in against the projections 18. In order to insure a sufficient amount of intimate contact between the projections 18 and the portions 19, I may exert mechanical pressure against the outside of these portions 19, as, for example, by such a roller 20 as shown in Fig. 8. Instead of a roller, of course other means for exerting such mechanical pressure, such as fingers and the like, may be used.

Instead of causing the glass to shrink against the projections 18 in the manner described, I may first exhaust the glass envelope 10, and after the said envelope has been sufficiently exhausted, soften the portions 19 by the application of heat thereto. Under these conditions the atmospheric pressure on the outside of the glass envelope 10 being considerably greater than that within said envelope, presses strongly against the softened portions of the cylindrical wall 17, and forces these portions 19 firmly against the projections 18.

Instead of using such an insulating spacer having projections 18, as shown at Fig. 2, an insulating spacer 21 from which the projections 18 have been eliminated can be used, as for example shown in Fig. 4. The shrinking of the glass wall against the edges of the insulating spacer 21 takes up any clearance between the edges of this insulating spacer and the inner surfaces of the cylindrical portion 17, and thus rigidly supports the entire electrode assembly. Instead of softening limited portions of the cylindrical wall 17, as described in Fig. 2, a ring adjacent the edges of the insulating spacer 21 around the entire circumference of the cylindrical walls 17 may be softened. This is done, for example, by directing a gas flame against this portion of the cylindrical wall 17 and rotating the glass envelope 10 so that a ring around the entire circumference of the cylindrical wall portion 17 is softened. Under these conditions the entire softened ring shrinks in toward the insulating spacer 21, and may assume the configuration as shown in Figs. 4 and 5. As will be seen from these figures, the glass actually forms a pocket for each of the arms of the insulating spacer 21, and prevents any motion whatsoever of this insulating spacer. Here again, in order to insure an intimate contact between the glass of the cylindrical wall 17 and the edge of the insulating spacer 21, a roller, such as 20 in Fig. 8, or other means for applying a mechanical pressure against the softened portion of the cylindrical wall 17, may be used. Of course the shape of the insulating spacer may take a wide variety of forms. For example, instead of the X-shaped spacer as shown in Figs. 2 and 4, an insulating disk 22, as shown in Fig. 7, may be used. In this figure the shrinking of the glass wall against the edge of the insulating spacer 21 is shown as occurring around the entire circumference of the insulating disk 22. The method whereby this shrinking may be accomplished may be the one described for Figs. 4 and 5. Of course it is to be understood that softening and shrinking at individual restricted portions of the cylindrical wall 17 may be accomplished as described with respect to Fig. 2.

In the construction of the type which I have described, the size of the insulating spacer may also be greatly decreased. In some instances merely such an insulating strip 23 as shown in Fig. 6 may be used as the insulating spacer. In Fig. 6 the relationship between the insulating spacer and the glass walls is very similar to that shown for Fig. 4, and the manner in which the intimate contact between the glass wall and the insulating spacer is secured may be that described for Fig. 4. Of course any other convenient method, such as that described for Fig. 2, may be likewise used. In constructing tubes as described above, it appears that when the softened glass is shrunk in against the edge of the insulating spacer, a certain amount of bonding or sealing action occurs between the insulation of the spacer and the glass. This may be an actual fusing of the glass around the edge of the insulating spacer or else merely a very intimate mechanical contact between them. In using the word "sealed" in the specification and claims, I intend that this term shall cover the intimate bonding action between the glass and the insulation whether or not any actual fusing of the two surfaces occurs.

I have found that in constructing tubes in the manner described above, the entire tube structure may be subjected to very severe lateral vibration, and even with insulating spacers having the slender projections 18, these projections are not damaged in the slightest by such vibration, whereas with similar tubes of the ordinary construction, the projections 18 are soon crushed.

Aside from the mechanical strength and the protection of the parts within the tube from breakage, my novel construction also results in the elimination of noises which heretofore have been very troublesome, especially in tubes connected in very sensitive circuits. This elimination of noise is probably the result of the prevention not only of vibrations of large amplitude, such as cause breakage of the parts, but also vibrations of smaller amplitude which give rise to the undesirable noises which I have mentioned. When the glass wall of the tube has been softened and pressed against the edge of the insulating spacer, it is very hot and in intimate contact with the edge of the insulating spacer. When this heated wall portion is allowed to cool, it contracts and exerts considerable pressure

upon the insulating spacer. Thus the spacer in the final form of the tube is under considerable compression from the glass walls. In some instances there is even a slight buckling of the insulating spacer, indicating the degree of this compression. Due to the fact that the insulating spacer is under this strong compression, no appreciable relative movement can occur between the glass and the electrode assembly, even though the insulating spacer in itself may have considerable elasticity. The resulting structure is one in which the electrode assembly, the insulating spacer, and the glass tube are effectively one continuous mechanical piece. Thus, any vibration which tends to be set up in the electrode assembly itself is strongly damped by the glass wall of the envelope to which it is rigidly united. Merely inserting an electrode assembly and an insulating spacer into a glass tube and depending upon the elasticity of the insulating spacer to bring it into contact with the tube walls, does not produce a sufficiently rigid mechanical union between the glass walls and the electrode assembly to eliminate the undesirable noises which have heretofore existed in these tubes. Thus my novel arrangement not only effectively prevents any mechanical failure of the parts within the tube, but also effectively eliminates undesirable noises in the set in which the tube may be connected.

Of course it is to be understood that this invention is not limited to the particular details of these modifications or processes described above as many equivalents will suggest themselves to those skilled in the art. For example, instead of using mica as the insulating spacer, a rigid insulator, such as a ceramic, may be substituted for the mica. The top supporting element instead of being an insulating plate could be any other kind of element to which the glass wall could be tied, and which would thus rigidly support the electrode assembly. Also instead of the envelope 10 being entirely of glass, but a portion of that envelope may be of glass. Thus when I use the term "glass envelope" in the specification and claims, I intend that it shall cover an envelope even if partially of glass. Various other changes in my invention will readily suggest themselves. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. A space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, a plurality of electrode-supporting standards anchored to said stem, electrodes supported by said standards, and an insulating plate fastened to said standards at a point removed from said stem, said insulating plate contacting at its edge with the inner wall of said envelope and being sealed to said wall at at least one point on said edge.

2. A space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, and an insulating plate fastened to said electrode assembly at a point removed from said stem, said insulating plate contacting at its edge with the inner wall of said envelope and being sealed to said wall at at least one point on said edge.

3. A space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, and an insulating plate fastened to said electrode assembly at a point removed from said stem, said insulating plate having projections along its edge, said insulating projections contacting with the inner wall of said envelope and being sealed to said wall.

4. A space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, a circular insulating disk fastened to said electrode assembly at a point removed from said stem, said insulating disk contacting at its edge with the inner wall of said envelope and being sealed to said wall at at least one point on said edge.

5. In a space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, and an insulating plate fastened to said electrode assembly at a point removed from said stem, the steps in the method of making said tube which comprise inserting said stem and electrode assembly within said envelope, fusing said stem to said envelope, softening the glass of said envelope adjacent the edge of said insulating plate in the plane of said plate by the application of heat, and causing said softened glass to shrink in against the edge of said insulating plate.

6. In a space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, and an insulating plate fastened to said electrode assembly at a point removed from said stem, the steps in the method of making said tube which comprise inserting said stem and electrode assembly within said envelope, softening the glass of said envelope adjacent the edge of said insulating plate by the application of heat, exerting mechanical pressure by means of a pressure member against the outside of said softened glass, and pressing said softened glass in against the edge of said insulating plate.

7. In a space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, and an insulating plate fastened to said electrode assembly at a point removed from said stem, the steps in the method of making said tube which comprise inserting said stem and electrode assembly within said envelope, softening the glass of said envelope adjacent the edge of said insulating plate by the application of heat, exerting mechanical pressure by means of a roller against the outside of said softened glass, and pressing said softened glass in against the edge of said insulating plate.

8. In a space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, and an insulating plate fastened to said electrode assembly at a point removed from said stem, the steps in the method of making said tube which comprise inserting said stem and electrode assembly within said envelope, fusing said stem to said envelope, exhausting said envelope, softening the glass of said envelope adjacent the edge of said insulating plate by the application of heat, and causing said softened glass to shrink in against the edge of said insulating plate.

9. In a space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, and an insulating plate

fastened to said electrode assembly at a point removed from said stem, the steps in the method of making said tube which comprise inserting said stem and electrode assembly within said envelope, directing a flame against the glass of said envelope adjacent the edge of said insulating plate, causing relative rotation between said glass envelope and flame to soften a ring of glass around the edge of said insulating plate, and causing said softened glass to shrink in against the edge of said insulating plate.

10. In a space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, and an insulating plate fastened to said electrode assembly at a point removed from said stem, the steps in the method of making said tube which comprise inserting said stem and electrode assembly within said envelope, softening a ring of glass around the edge of said insulating plate, and causing said softened glass to shrink in against the edge of said insulating plate.

11. In a space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, and an insulating plate fastened to said electrode assembly at a point removed from said stem, the steps in the method of making said tube which comprise inserting said stem and electrode assembly within said envelope, softening the glass of said envelope adjacent the edge of said insulating plate by the application of heat, and sealing said softened glass to said insulating plate.

12. In a space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, a plurality of electrode-supporting standards anchored to said stem, an electrode assembly anchored to said stem, an insulating plate fastened to said electrode assembly at a point removed from said stem, the steps in the method of making said tube which comprise inserting said stem and electrode assembly within said envelope, heating the glass of said envelope adjacent the edge of said insulating plate, bringing said heated glass portion into contact with the edge of said insulating plate, and cooling said heated glass portion whereby it is caused to contact and exert considerable compression upon said insulating plate.

13. A space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, an insulating plate fastened to said electrode assembly at a point removed from said stem, said insulating plate being sealed to the inner wall of said envelope.

14. A space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, an insulating member fastened to said electrode assembly at a point removed from said stem, said insulating member being sealed to the inner wall of said envelope.

15. A space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, a plate fastened to said electrode assembly at a point removed from said stem, said plate being sealed to the inner wall of said envelope.

16. A space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, a plate fastened to said electrode assembly at a point removed from said stem, said plates being maintained in fixed relationship to said glass wall, the wall of said glass envelope being molded to the edge of said plate at at least one point in the plane of said plate.

17. In a space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, a plate fastened to said electrode assembly at a point removed from said stem, the steps in the method of making said tube which comprise inserting said stem and electrode assembly within said envelope, and molding the glass wall of said envelope to the edge of said plate at at least one point in the plane of said plate.

18. In a space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, and a plate fastened to said electrode assembly at a point removed from said stem, the steps in the method of making said tube which comprise inserting said stem and electrode assembly within said envelope, softening the glass of said envelope adjacent the edge of said plate in the plane of said plate by the application of heat, and causing said softened glass to shrink in against the edge of said plate.

19. In a space discharge device comprising a sealed glass envelope containing a stem at one end of said envelope, an electrode assembly anchored to said stem, and a plate fastened to said electrode assembly at a point removed from said stem, the steps in the method of making said tube which comprise inserting said stem and electrode assembly within said envelope, softening the glass of said envelope adjacent the edge of said plate in the plane of said plate, and causing said softened glass to shrink in against the edge of said plate.

PAUL T. WEEKS.

CERTIFICATE OF CORRECTION.

Patent No. 1,963,008. June 12, 1934.

PAUL T. WEEKS.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, line 83, for "spaced" read spacer; and line 105, for "cylindical" read cylindrical; page 2, line 6, for "cylindical" read cylindrical; page 4, lines 38 and 39, claim 12, strike out the words "a plurality of electrode-supporting standards anchored to said stem,"; and lines 49-50, for "contact" read contract; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 24th day of July, A. D. 1934.

Bryan M. Battey

(Seal) Acting Commissioner of Patents.