ELECTRON GUN WITH EXPANDED INSULATOR POSTS

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This invention relates to gun structures for electron discharge devices such as cathode ray tubes and traveling wave tubes, and more particularly to an improved gun structure and method of assembling and securing axially aligned and spaced electrodes in such a gun structure.

Electrodes in electron gun assemblies generally must be axially spaced and aligned as well as electrically insulated from each other. A common practice of so supporting these electrodes is embedding tabs on the electrodes into heat-softened glass rods or beads which then cool and harden to permanently secure the parts together. The embedding step is a separate mechanical operation, generally accomplished either by building up the glass insulator stubs on the tabs as by using a glass cane as a welding rod, or by pressing the tabs into a heated glass stub. This step is repeated at three or more peripherally spaced points around the stacked electrodes, each stub being attached one at a time. Not only is this time consuming, but independent heating of one part of the gun structure while the other parts are cool tends to upset alignment of the electrodes or to unduly stress them and the stubs so as to render the gun structure susceptible to damage and breakage.

In accordance with this invention, the mechanical connection of all the insulator posts to the electrodes takes place simultaneously and somewhat automatically. The posts comprise hollow tubes of glass or the like hermetically sealed at opposite ends so as to define a closed chamber within each post. The electrodes are formed with support openings which are axially aligned to receive the posts. When the posts are inserted in the openings and with the electrodes aligned and spaced, the assembly is uniformly heated in an oven. The walls of the posts soften and the increased pressure in the post chambers expands the walls into tight engagement with the electrodes. When the posts cool, the connection becomes permanent.

Another object of this invention is the provision of a gun assembly with insulator spacer-posts so attached to the electrodes as to minimize distortion and stress of the gun parts.

Another object is the provision of a method of fabricating an electron gun assembly without inducing thermal stress in the electrodes or insulators.

Another object is the provision of a technique for securing a plurality of insulator posts to gun electrodes in one heating operation. These and other objects of the invention will become apparent from the following description of a preferred embodiment thereof reference being had to the accompanying drawings in which:

FIGURE 1 is a section of completed electron gun assembly embodying the invention taken on line 1—1 of FIGURE 2;

FIGURE 1A is a section of part of an uncompleted gun assembly showing an insulator post in position prior to the firing operation; and

FIGURE 2 is a transverse section taken on line 2—2 of FIGURE 1.

Referring to the drawings, an embodiment of the invention is shown as a gun assembly comprising a cathode assembly, first and second planar electrodes 11 and 12, respectively, and a third cylindrical electrode 13. Cathode assembly 10 and the three electrodes are supported symmetrically about axis A of the assembly at predetermined axially spaced positions by a plurality of substantially identical tubular insulator posts 15 having inner chambers 15a. Electrodes 11 and 12 have central apertures 16 and 17, respectively, with axes coincident with the gun axis A and similarly the axis of cylindrical electrode 13 is coincident with axis A. Cathode assembly 10 has an outer cylindrical shield 10a and an inner body 10b comprising an emitting surface 19 from which electrons are directed along the axis of the assembly through the electrode apertures. Electrical leads, not shown, are connected to the electrodes to provide appropriate electrostatic fields for shaping and accelerating the electron beam. Typically, electrodes 11 and 12 may be control grids and electrode 13 an accelerator grid in a cathode ray tube.

Cathode assembly 10 is supported on posts 15 by an annular support ring 20 secured as by welding to a groove 21 on outer shield 10a and electrode 13 is similarly supported on the posts by ring 22 permanently secured to the side of the electrode.

The peripheral edge portions of support ring 20, electrodes 11 and 12, and support ring 22 are formed with sets 24, 25, 26, and 27, respectively, of support openings equally radially spaced from axis A. The electrodes are angularly oriented relative to each other so that the support openings in each electrode and support ring are aligned with the other acts of support openings. Each post 15 extends through an aligned series of these support openings and projects above and below (as viewed) support rings 20 and 22.

The posts are substantially identical and preferably made of thin-wall glass or other similar insulator material which softens when heated to a predetermined temperature, preferably as low as possible for guns in cathode ray tubes. The diameter of each expanded post between electrodes in a finished gun assembly is substantially greater than the diameters of the support openings, and the portion of the post which extends through each opening presses tightly against the side of the opening. Accordingly, the opposite side surfaces of each support ring and electrode adjacent the support opening therein are engaged tightly by overlying portions of the post which therefore firmly binds the engaged portions and prevents any axial or other displacement of electrodes relative to each other.

The method of assembling the gun structure will now be described. After rings 20 and 22 have been secured to cathode shield 10a and electrode 13, respectively, and central apertures 16 and 17 have been formed in electrodes 11 and 12, support openings 24, 25, 26 and 27 are formed in these parts preferably on concentric centers. The electrodes are next accurately aligned along axis A as by mounting them on an axially true mandrel which extends through the central openings in the electrodes and cathode shield 10a. To accommodate the different gun opening diameters, an adapter having a center opening equal in size to apertures 16 and 17 may be temporarily secured to each of electrode 13 and shield 10a for receiving a straight cylindrical mandrel. Ceramic spacers or the like are placed between the electrodes to establish proper interelectrode spacing and parallelism and the electrodes are angularly adjusted to align the support openings. Elongated straight tubular insulator posts 15, see FIGURE 1A, having external diameters slightly less than those of the support openings, are then inserted through those openings in the respective electrodes. In guns for
most cathode ray tube applications, commercial glass tubing is satisfactory.

Each post 15 is somewhat longer than the axial spacing between opposite end electrodes to be supported. The open post ends are hermetically sealed by local heating preferably before the posts are inserted into the openings. Chamber 15a in each post is therefore completely sealed.

The assembly is next placed in an oven and is heated rapidly to a predetermined temperature at which the post walls begin to soften. In accordance with the invention, the pressure within post chambers 15a increases substantially with the increase in the temperature and causes the softened elastic post walls to expand sufficiently to tightly grip each electrode at and adjacent to the support openings therein. The temperature of the oven is maintained substantially constant for a predetermined time to insure proper expansion of all posts. Thereafter the oven is cooled and the posts simultaneously harden to rigidly mechanically grip the electrodes. The spacers, mandrel and adapters are removed and the cathode body 10b and electrical leads are connected to complete the assembly. It will be noted that the axis of shield 10a is colinear with the axis of electrodes 11, 12 and 13 and provides an accurate reference as well as support for cathode body 10b.

If desired, the posts may be filled with a suitable material such as low temperature potting compound to increase the strength and rigidity of the gun assembly.

Changes, modifications and improvements may be made to the above described method and embodiment of the invention without departing from the principle and precept thereof. The appended claims therefore describe the invention in terms consistent with the extent to which it has advanced the art.

What is claimed is:

1. An electron gun assembly having an axis comprising a plurality of axially spaced electrodes having central apertures centered on said axis and through which electrons from the cathode assembly pass, said electrodes having a plurality of support openings therein and, a plurality of tubular thermoplastic insulator posts extending generally parallel to said axis for supporting and spacing said electrodes, each post comprising a one-piece structure extending through one support opening in each electrode and being connected to each electrode at said opening, the transverse dimension of each of said posts within said openings being smaller than at all other parts thereof, said post being expanded tightly against adjacent parts of each of said electrodes.

2. The gun assembly according to claim 1 in which said posts are substantially identical and are formed of glass.

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