

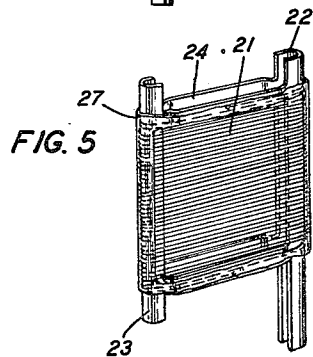
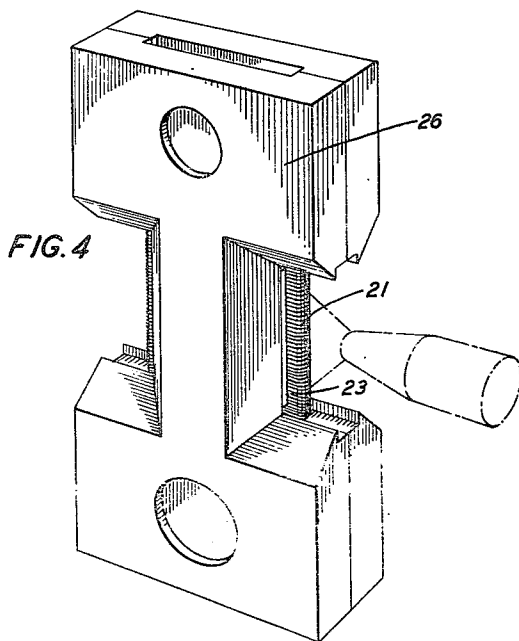
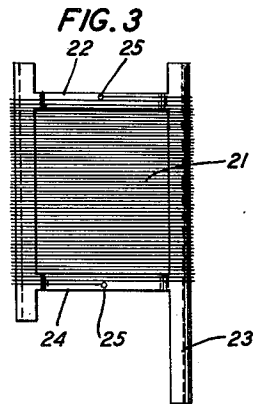
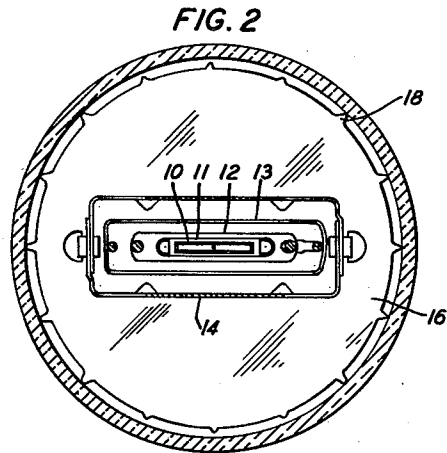
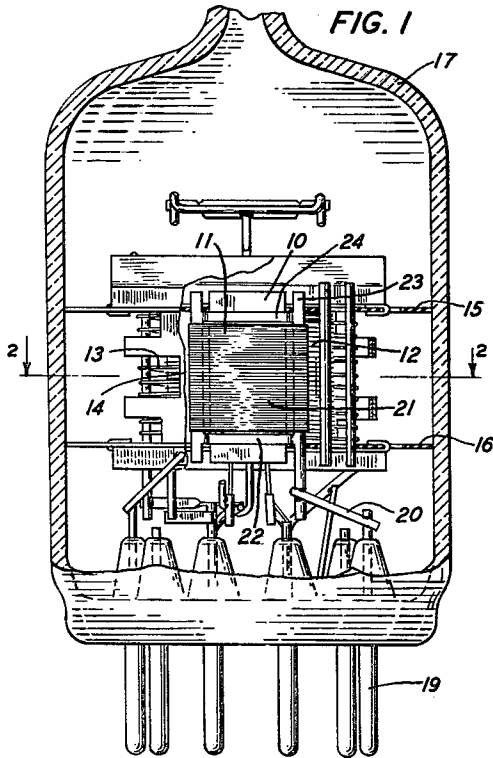
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GRID ASSEMBLY AND METHOD OF FABRICATION

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GRID ASSEMBLY AND METHOD OF FABRICATION

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This invention relates to electron discharge devices and more particularly to a grid assembly and the method of its fabrication for an electron discharge device.

Electronic discharge device requirements encountered in the very high and ultra-high frequency ranges impose conditions which can only be satisfied by extremely precise mechanical correlation of the elements of the electrode assembly involved. High transconductance and low noise at these frequencies are fundamentally dependent upon the spacing between the cathode and the control grid. Transconductance also depends upon the diameter of the control grid wires and the spacing thereof. In order to attain the high transconductance, it is necessary to reduce the diameter of the control grid lateral wire to a point where the wire is not self-supporting when wound in grid form. Therefore, the fine fragile wire must be wound on a support frame which maintains the collateral relation of grid and cathode constant at very close spacing, for example of the order of 2.5 mils. In addition, the grid lateral must be relatively close together and uniformly spaced along the length of the grid to secure the desired controlling action upon the electron stream from the cathode. It is highly desirable further, that the grid lateral should be mounted on the grid frame with as much tension as is practical in order that the effects of electrostatic fields or mechanical vibration will not disturb the grid pitch and result in excessive microphonics.

Heretofore, grids have been secured to their supporting members in many ways, the more common of which include a fused metal joint, produced by brazing or welding, or mechanically secured joint wherein the supporting member is notched, the grid lateral laid in the notch and the supporting member swaged to close the walls of the notch over the mounted lateral. When the grid assemblies are constructed employing grid spacings on the order of 2.5 mils, lateral diameters down to 0.00014 inch and lateral pitches in the range of 500 to 1000 turns per inch, it has not been feasible to employ the notching and swaging processes to secure the laterals to their support members. A welded joint has been found difficult to produce at these magnitudes while employing known methods and further a high number of rejects occurred due to the faulty joints formed between some of the lateral turns in the frame, these defects apparently resulting from the insufficient contact of the welding electrode with each of the very closely spaced wires extending around the support. Therefore, when these magnitudes were

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involved, it was found necessary to secure the laterals by brazing. The brazing process has generally been accomplished at about 1000° C. or higher, lower brazing temperatures being possible in some applications where low temperature brazes could be employed.

It is often necessary in the manufacture of vacuum tubes to employ dissimilar metals in the fabrication of the electrode structures. For example, due to the cost and difficulty involved in fabricating supporting frames of tungsten sheet material for these small grid laterals, it has been found desirable to employ some other highly refractory metal such as molybdenum. Further, tungsten has been found to be the most convenient material from which to draw very small grid laterals. Hence a very satisfactory grid results by mounting tungsten grid laterals upon a molybdenum frame. The thermal expansion of molybdenum and tungsten are approximately 5.5×10^{-6} per degree centigrade and 4.44×10^{-6} per degree centigrade respectively, therefore there is an expansion differential tending to stretch the tungsten laterals and distort the molybdenum frame during the brazing process. Since the frame is usually strong, the laterals are likely to be stretched beyond their elastic limit in those grids where the wire is wrapped around the frame. This results in loose laterals or reduced tension in the laterals even though they remain taut.

The stretching of the lateral wires can be reduced or prevented by decreasing the stress produced in them by the differential expansion. This can be accomplished by reducing the brazing temperature. However, low temperature brazes are often not applicable to particular materials employed in grid manufacture.

Therefore, the object of this invention is to reduce thermal stresses to which an electrode is subjected during its fabrication.

This object is realized in accordance with features of this invention by constructing grid assemblies by conventional methods and securing the grid laterals to their support members with a low temperature bonding material. This material is applied over the mounted grid laterals in the form of a powder or fluid suspension and fired at a relatively low temperature to form a glazed bond between the laterals and supports.

The assembly and method of manufacture will be more completely understood from the following detailed description when read in conjunction with the accompanying drawings in which:

Fig. 1 is an elevational view partly in sections of

a representative multielement discharge device embodying features of this invention;

Fig. 2 is a cross-section plan view of the device of Fig. 1 taken on the line 2—2;

Fig. 3 illustrates an elevational view of a grid assembly after the winding is applied prior to the final processing;

Fig. 4 is a perspective of a grid assembly mounted in a mask and arranged to be coated with the bonding material; and

Fig. 5 is a perspective of the grid in final form with the binder material fired and the assembly prepared for insertion in the unitary electrode assembly of Fig. 1.

Referring now to the drawings, Fig. 1 discloses an electronic discharge device, in which this invention might be employed, enlarged about four times the size of an actual tube. An electrode assembly comprising a cathode 10, a surrounding control grid 11, a screen grid 12, a suppressor grid 13 and an anode 14 all supported upon a pair of transverse mica end spacers 15 and 16, is mounted in the sealed envelope 17 and supported therein by the peripheral projections 18 on the end spacers 15 and 16 which frictionally engage the inner surface of the wall of the envelope 17 and by the straps 20 welded to the stem pins 19. Electrical connection from the exterior of the envelope to the electrodes is made by the pins 19, which extend through the base of the envelope and are sealed therein, and the straps 20 extending from the pins to the various electrodes.

The control grid 11 of this tube is made up of very fine grid laterals 21, wound on a sheet metal frame 22 having side members 23 and cross straps 24 maintaining the side members rigid with respect to each other. This grid is formed by mounting two half sections of the frame 22 together in a winding machine, securing the end of a fine wire which is to form the grid laterals 21 to one of the cross straps 24 by a drop 25 of some binder such as amyl acetate solution, then winding the wire on the frame and securing the other end of the winding to the frame by a drop 25 of the binder. Next the side members 23 of the frame and the grid wires which are wound on them in electrical contact therewith are coated with a finely divided glazing material which may be in a powder form or more conveniently suspended in a liquid binder. This material can be applied for example by spraying or brushing, a very convenient arrangement for its application being shown in Fig. 4 where the grid assembly is mounted in a spraying mask 26 with the side members 23 exposed. The glazing material may then be applied by spraying it suspended in a liquid binder (as represented by the nozzle drawn in phantom in Fig. 4), over the mounted laterals and the frame side members. The assembly is then fired at the glazing temperature of the powder for a sufficient time to evaporate the binder and form a glaze which adheres to both the side members 23 and the laterals 21. Then the grid is cooled and removed from the oven.

Fig. 5 represents the completed control grid after firing showing the grid laterals 21 secured to the frame side members 23 by a thin layer of glaze 27 (greatly exaggerated in thickness for purposes of clarity). It is to be noted that the frame cross straps 24 are also glazed, this being done to provide an insulating coating and thereby insure against the short-circuiting of one of the adjacent electrodes and the control grid.

While it is not intended to limit this invention to any particular glazed bond or method of its application, several very satisfactory glazes formed from powdered glass have been used in constructing electrode assemblies in accordance with this invention. For example, a potash-barium-borosilicate glass produces a very satisfactory glazed bond when ground to a sufficient fineness to pass through a 325 mesh and suspended in a binder solution comprising 91.4 per cent Cellosolve acetate and 8.6 per cent polymethyl methacrylate. In applying this solution to a molybdenum frame having a .3 mil tungsten wire wound thereon, a layer of less than 1 mil thickness fired at 700° C. for fifteen minutes in a hydrogen atmosphere produces an excellent bond between the wires and the frames while providing a joint having excellent electrical conductivity. Another glaze which has been used with good results at even lower firing temperatures consists of a high-lead glass ground to pass a 325 mesh and suspended in the same binder solution set forth above. This glaze bond is then fired at 550 degrees in a vacuum for about fifteen minutes.

To recapitulate, this invention comprises an electronic discharge device assembly and its method of manufacture whereby the maximum temperature to which the structure must be subjected during fabrication is reduced materially, thereby eliminating strains in the elements of the assembly which occur due to thermal expansion. It has been found that excellent electrical and mechanical joints can be produced between metallic members which are in contact with each other at temperatures in the range of 550° C. to 700° C. by employing a bonding material which may be applied in a finely divided form over the members and fired at its glazing temperature so it adheres to the metal surfaces. It is to be noted that the glaze is an insulating material and serves several functions, as such, first and most important in the present application, it provides a bond for an electrically conductive joint, and second it serves as an insulating coating over the ineffective portions of the electrode.

What is claimed is:

1. An electrode comprising a conductive support, a plurality of fine wire laterals mounted on said support in conductive relationship therewith, and a glaze bonding said laterals to said support.

2. An electrode comprising a conductive support, a plurality of laterals mounted on said support in conductive relationship therewith, and a glaze bonding said laterals to said support.

3. An electrode comprising a plurality of side rods, a plurality of laterals mounted on said side rods in conductive relationship therewith, and a glaze bonding said laterals to said side rods.

4. An electrode comprising a metallic frame having a pair of parallel side members and a pair of cross straps extending between said members, a plurality of fine wire laterals mounted on said side members in conductive relationship therewith, and a glaze bonding said laterals to said side members, said glaze also covering said cross-straps.

5. An electrode comprising a metallic frame having a pair of parallel side members and a pair of cross straps extending between said members, a plurality of laterals mounted on said side members in conductive relationship therewith, and a glaze bonding said laterals to said side members.

6. The method of manufacturing wire elec-

trodes which comprises mounting lateral wires on a conductive support, masking the effective surface of said electrodes, spraying a suspension of finely divided glass on the junctions between said laterals and said support, and firing said coated portions at a temperature sufficient to form a glaze which bonds said support to said laterals.

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