Jan. 13, 1959 A. R. BOLZ 2,869,015

METHOD OF FABRICATING A GRID ELECTRODE

Filed July 1, 1955

FIG. 1

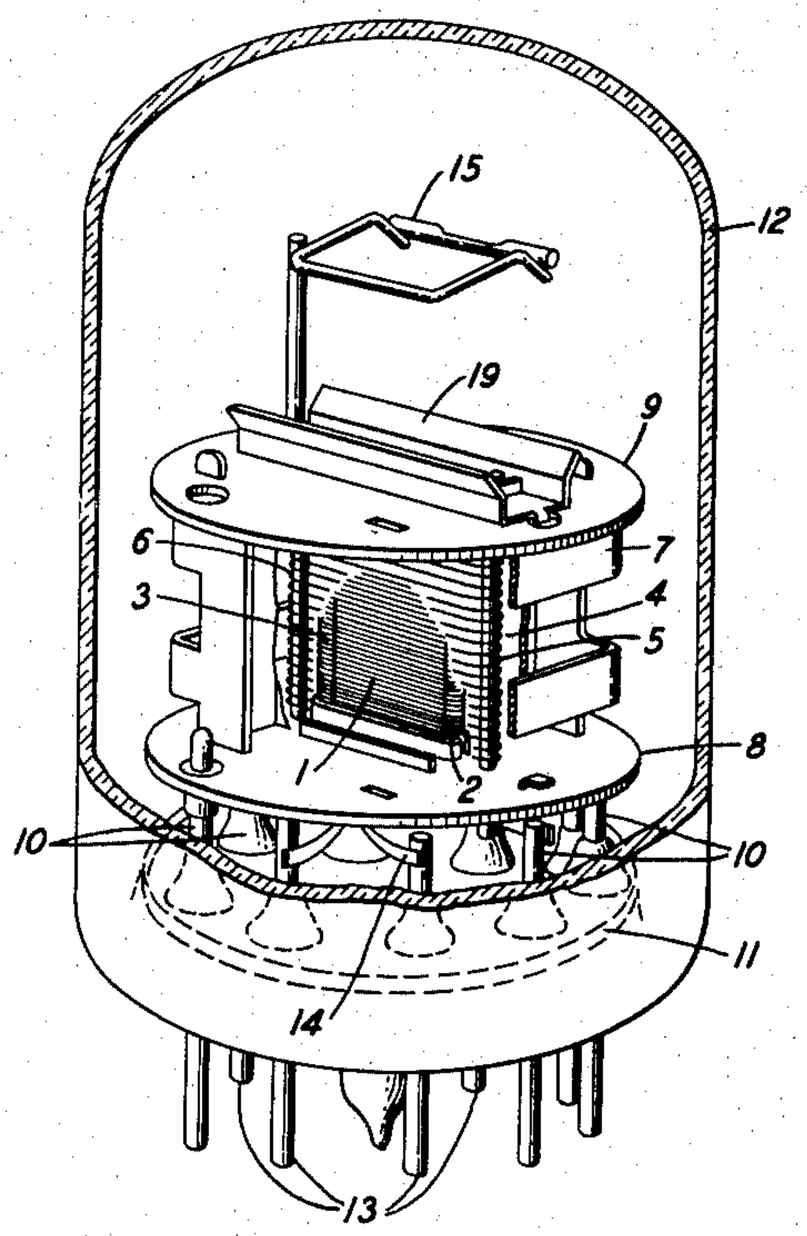


FIG. 2

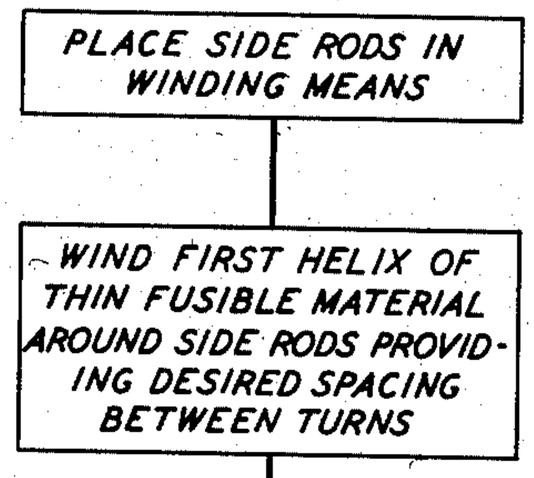


FIG. 3

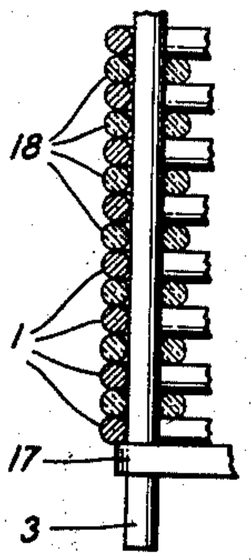
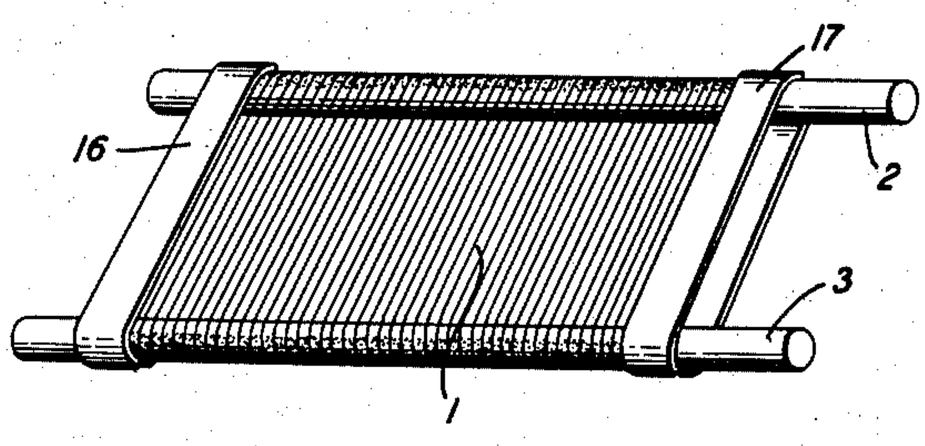


FIG. 4



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METHOD OF FABRICATING A GRID ELECTRODE

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9 Claims. (Cl. 313—350)

The invention relates to space discharge devices and more particularly to a grid assembly and its method of fabricating such devices.

The operating requirements of many present-day types of space discharge devices are such that in these devices there must be an extremely precise mechanical correlation of the elements of the electrode assembly involved. Some desirable characteristics, such as high transconductance and low noise, are directly dependent upon the reliability of the spacing of the control grid wires with respect to each other and with respect to the other electrodes of the assembly.

In discharge devices designed to operate in the higher frequency ranges, for example, in order to secure the desired controlling action upon the electron stream needed for high values of transconductance, it is advantageous that the grid laterals be relatively close together and spaced uniformly along the length of the grid. It is further advantageous that the grid laterals mounted on the grid frame be firmly secured thereto to avoid undesirable effects of electrostatic fields or mechanical vibration upon the grid pitch.

The above-recited conditions have presented some rather difficult mechanical problems in the prior art of grid fabrication. Such well-known methods of spacing and securing grid wires to a frame as notching and swaging or using welded metal joints have not proved entirely satisfactory due to the difficulty in obtaining small spacings in the former and in utilizing high melting point metals in the latter. Further, it was a difficult and time-consuming task with such methods to obtain an exact and uniform spacing of the grid laterals.

It is an object of this invention to provide an improved method of fabricating grid assemblies for space discharge devices wherein the turns of a grid wire may be accurately and relatively easily spaced and secured on a grid frame.

It is a further object of this invention to enable utilization of the means for initially spacing the grid wire turns subsequently for securing the turns to the grid frame in a desired spaced relation to each other.

It is a still further object of this invention to realize an improved method of grid fabrication applicable to refractory metals such as molybdenum and tungsten.

These and other objects are realized in a specific illustrative embodiment of this invention in which the side rods of the grid frame structure are wound with a helix of a thin fusible material in continuously contacting relation therewith to provide the requisite number of turns per lineal inch of the supporting rods. The grid wire then is wound about the rods in alternate or interposed relation with the fusible material, the spaces between adjacent convolutions of the latter serving to locate the successive turns of the grid wire and determining the desired number of turns per lineal unit. The entire assembly then is heat treated to fuse the fusible helix material sufficiently to bond the turns of the grid wire securely in the desired position.

In accordance with a feature of this invention, a thread of thin fusible material is wound upon the support rods of a grid frame to enable the turns of a grid wire to be easily and properly located thereon in a desired spaced relation to one another.

It is a further feature of this invention that the thread of thin fusible material subsequently be heat treated to bond the turns of grid wire to the frame in the desired spaced relation.

A complete understanding of this invention, together with the above-noted and other features thereof, may be gained from consideration of the following detailed description and the accompanying drawing, in which:

Fig. 1 is an elevational view of an illustrative discharge device incorporating a grid assembly fabricated in accordance with this invention, a portion of the envelope and the internal structure of the device being broken away to show the grid assembly;

Fig. 2 is a chart showing the steps constituting a method of fabricating a grid in accordance with one specific embodiment of this invention;

Fig. 3 is a partial elevational view of one side rod of the grid assembly after the fusible material and grid are wound prior to the final processing; and

Fig. 4 is a perspective view of the grid in final form with the fusible material fired and the assembly prepared for insertion in the unitary electrode assembly in Fig. 1.

Referring now to the drawings, Fig. 1 discloses an electronic discharge device of the type in which the invention advantageously may be utilized. Such device may comprise an electrode assembly including a control grid **1** wound about a pair of side rods **2** and **3**, a screen grid **4** surrounding the control grid **1** and wound about a pair of side rods **5** and **6**, and an anode **7**. The entire electrode assembly is supported between a pair of transverse mica end spacers **8** and **9**, the lowermost one of which is held in position by a number of support members **10** which are fixed to the inner base member **11** of the envelope **12**. Electrical connection from the exterior of the envelope to the electrodes is made by the pins **13**, which extend through the base of the envelope and are sealed therein, and the straps **14** extending from the pins to the various electrodes. The discharge device further may include a getter **15** and an end shield **19** as shown in Fig. 1.

The control grid **1** of the discharge device shown in Fig. 1 is made up of a plurality of turns of a fine grid wire wound on a frame which advantageously may comprise the pair of side rods **2** and **3**. These side rods advantageously are rigidly maintained in proper spaced relation with respect to each other by a pair of cross straps **16** and **17** located near the ends of the side rods as best seen in Fig. 4

In accordance with one embodiment of this invention, the grid is fabricated in the manner shown by the chart of Fig. 2. The side rods of the grid frame first are placed in a winding machine, such as is known in the art, and a helix of thin fusible material **18**, which advantageously may be glass thread, is wound upon the side rods to provide the requisite number of turns per lineal inch of side rod. In accordance with a further aspect of this invention, the glass thread thus utilized has a coefficient of expansion matching that of the grid materials used. For example, in the specific illustrative embodiment shown in Figs. 3 and 4 of the drawing, wherein the grid is of tungsten and the frame side rods of molybdenum, a glass having properties similar to that commerically known as Corning No. 7052 advantageously may be employed. This is a borosilicate glass which is composed of the following approximate parts: silica 68.0, alumina 8.1, sodium oxide 1.9, barium oxide 2.4, lithium oxide 8.5, and boron oxide 15.2, and has a co-

efficient of expansion substantially equal to 4.7×10^{-6} centimeters per centimeter length per degree centigrade.

In accordance with one specific embodiment of this invention, a pair of cross straps 16 and 17, which advantageously may be comprised of molybdenum, is then fastened to the ends of the side rods providing a rigid and unitary grid frame structure. A helix of fine grid wire then is wound about the side rods of the grid frame, the spaces between adjacent convolutions of the glass thread serving properly to locate the successive turns of the grid wire and to determine the desired number of turns per lineal inch of side rod.

The entire grid assembly then is heat processed, such as by placing the assembly in an electrically heated oven for a sufficient time to cause the thread of fusible material to fuse and permanently bind the turns of the grid wire to the grid frame at the desired spacing.

This arrangement provides an efficient assembly wherein the helical grid winding is relatively easily spaced and secured to the grid frame. The spacing between adjacent turns of the grid wire is controlled in a simple manner through the choice of a thread of fusible material of proper diameter. Furthermore, the heat treatment incidental to the fusing process is not seriously detrimental to the tension stress of the fine grid wire or the frame structure since these components advantageously are highly refractory metals, thus resulting in very little loss in the residual tension.

Fig. 3 shows a partial view of the grid assembly comprising the side rod 3, the turns of the grid wire 1, and the turns of the fusible thread 18 prior to heating of the grid assembly to fuse the thread 18. In accordance with an aspect of the invention the diameters of the grid wire and the fusible thread advantageously are of the same diameter, as, for example, .001 inch each, thus enabling a grid of 500 turns per inch to be wound around the side rods in the region between the cross straps. It can now be seen that due to the advantages obtained by this highly efficient method of construction grids having very close spacings may be constructed with sufficient precision to satisfy the electrical characteristics required in present-day discharge devices.

Fig. 4 shows the completed grid assembly after the heat treatment has caused the grid laterals 1 to be fused to the side rods 2 and 3 in the desired spaced relation. The grid assembly as shown is in condition to be inserted in the discharge device in the manner shown by the unitary assembly of Fig. 1.

While this invention has been disclosed in a particular embodiment and method of operation, it will be understood by those skilled in the art that various modifications may be made in the materials, shape of grid frame, winding method and processing to achieve the results of the invention.

What is claimed is:

1. The method of fabricating a grid assembly of the type including a frame having a pair of side support members which comprises the steps of winding a helix of fusible material about each of said support members, said helix defining a plurality of spaces between adjacent ones of the turns of said thin fusible material, winding a helix of grid wire upon said support members, said grid wire being positioned in said spaces, and heating the grid assembly to cause the fusible material to fuse and bond the grid wire to said support members.

2. The method of fabricating an electrode assembly for space discharge devices comprising winding a plurality of turns of a fusible material around a frame, winding a grid wire upon said frame, said grid wire being positioned between adjacent ones of said turns, and heating said electrode assembly to cause said fusible material to secure said grid wire to said frame.

3. The method of spacing a grid wire on a frame in an electrode assembly comprising the steps of winding a helix of a fusible material on said frame to provide a desired number of turns per lineal unit of said frame, and winding a helix of grid wire on said frame in the spaces between adjacent convolutions of the fusible material to space properly successive turns of said grid wire.

4. The method of spacing a grid wire on a frame in an electrode assembly in accordance with claim 3 further comprising the step of heating the frame for a sufficient time to cause the fusible material to bond the grid wire to the frame in the desired spaced relation.

5. A composite electron discharge grid assembly comprising a support member, a thin wire of fusible material wound about said support in continuously contacting relation therewith defining positioning means on said support, and a helix of grid wire wound about said support in successively interposed relation with adjacent turns of said thin fusible material, each turn of the helix contacting adjacent turns of the fusible material.

6. A composite electron discharge grid assembly in accordance with claim 5, wherein said helix of thin, fusible material has a coefficient of thermal expansion substantially equal to that of said support member and grid wire.

7. A composite electron discharge grid assembly comprising a pair of side supports, a helix of thin, fusible material wound about each of said supports in continuously contacting relation therewith, adjacent turns of said thin, fusible material defining positioning means on said supports, means for spacing said supports apart from each other, and a helix of grid wire wound about said supports, said grid wire being interposed between adjacent turns of said thin fusible material.

8. The method of fabricating a grid assembly for space discharge devices which comprises the steps of winding a helix of a fusible material around each of a pair of support members, securing a plurality of cross straps to said pair of support members to form a rigid frame assembly, winding a helix of grid wire around said frame assembly, said grind wire being positioned by the adjacent turns of said fusible material, and heating the frame assembly to fuse said fusible material and secure the grid wire to the support members in the desired spaced relation.

9. The method of manufacturing an electrode structure which comprises the steps of winding a thread of fusible material about a pair of support members, the adjacent turns of said thread defining a plurality of spaces therebetween, connecting a pair of strap members to said support members to form an integral frame assembly, winding a plurality of turns of grid wire around said frame assembly, said grid wire being positioned in the spaces defined by the turns of said thread, and heating the frame assembly to cause said thread to fuse and bond the grid wire to said support members.

References Cited in the file of this patent

UNITED STATES PATENTS

1,340,575	Stoekle	May 18, 1920
1,957,223	Murphy	May 1, 1930
2,224,214	Brown	Dec. 10, 1940
2,501,002	Parker	Mar. 21, 1950
2,790,926	Morton	Apr. 30, 1957