April 25, 1967 HIROSHI HISADA 3,315,330

ELECTRON TUBES

Filed Feb. 19, 1963

Fig. 1

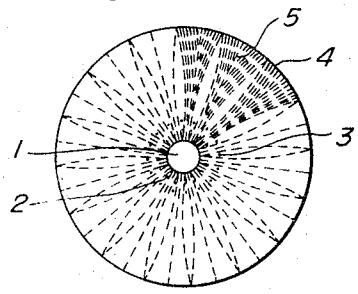



Fig. 2

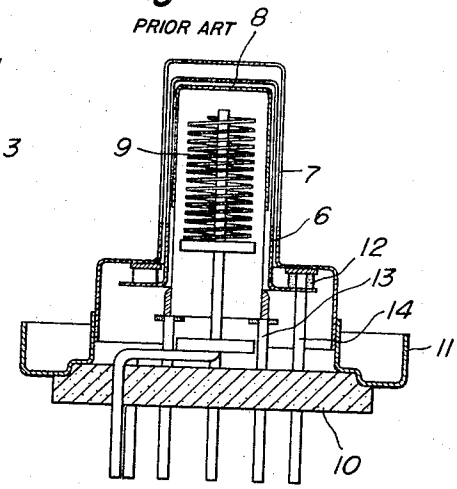



Fig. 3A

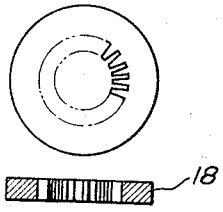



Fig. 3C

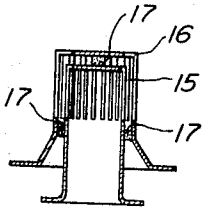



Fig. 3B

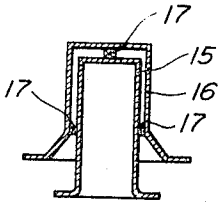
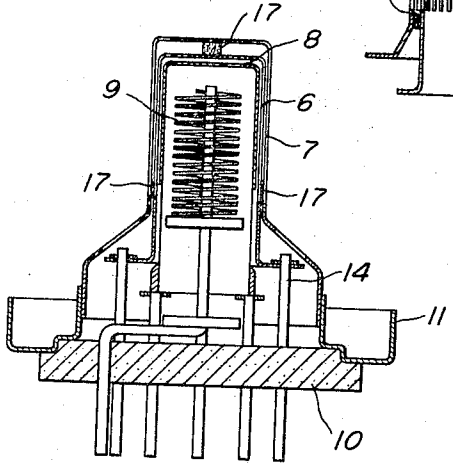



Fig. 4




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United States Patent Office 3,315,330 Patented Apr. 25, 1967



3,315,330

# ELECTRON TUBES

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Filed Feb. 19, 1963, Ser. No. 259,520
Claims priority, application Japan, Apr. 7, 1962, 37/14,091
5 Claims. (Cl. 29—25.16)

This invention relates to electron tubes, and more particularly to grid structures for tetrodes having coaxial cylindrical electrode systems, such tetrodes being hereinafter referred to as cylindrical tetrodes.

A cylindrical tetrode comprises a first or control grid and a second or screen grid. In order to fabricate these two grids into an extremely accurate structure having precisely aligned slits, it has been a common practice to assemble two cylindrical metal blanks in accurate coaxial relation by aid of electrical insulating block or blocks fixed to both the cylindrical blanks, and to provide necessary radially aligned slits in both blanks by a single electrical discharge machining. In the grid structure thus fabricated, the insulating blocks holding the two grids in the accurate relative positions are existent in the relatively narrow space between the two grids, still after the electrode system has been completed in a cylindrical tetrode. This necessarily provides relatively large interelectrode capacitance which is not desirable. In addition, during operation of the tube, usual spattering would cause conductive films to deposit on the insulating blocks, resulting in degradation of insulation.

The primary object of the present invention is to provide a cylindrical tetrode having a grid structure of the kind specified in which any insulating block is not existent therein for holding the control and screen grids in accurate relative positions, that would increase interelectrode capacitance and result in degradation of insulation.

Another object of the present invention is to provide a method for fabricating a grid structure of the kind specified in which adhesive elements are employed for temporarily holding the control and screen grids in accurate relative positions during fabrication, which adhesive elements can completely be removed after the whole electrode system has been perfectly assembled, by heating or chemical treatment.

There are other objects and particularities of the present invention which will be made obvious from the following detailed descriptions with reference to the accompanying drawings, in which:

FIG. 1 shows diagrammatically flying paths of electrons in a tetrode having coaxial cylindrical electrode system;

FIG. 2 is a longitudinal sectional view of a known electrode system of cylindrical tetrode;

FIGS. 3(A), 3(B) and 3(C) are views for explaining steps of fabricating a grid structure according to the present invention; and

FIG. 4 is a view similar to FIG. 2 of an electrode system of cylindrical tetrode embodying the present invention.

Referring to FIG. 1, a typical cylindrical tetrode comprises a cylindrical cathode **1**, a plurality of control grid wires **2** disposed in a coaxial cylinder, screen grid wires **3** similarly disposed in a coaxial cylinder, and a cylindrical anode **4** coaxially surrounding the grids. In order that the electron beams **5** emitted from the cathode **1** may reach the anode **4** in the most efficient manner, it is a common practice to have the screen grid wires **3** hidden behind the control grid wires **2** having negative potential, as seen from the central cathode **1**, whereby electrons are prevented from being captured by the screen grid **3** having relatively high positive potential. Such wire alignment of the two grids **2** and **3** must be extremely accurate.



Accordingly, in the prior art cylindrical tetrode as shown in FIG. 2, two concentric cylindrical rigid blanks of grids are assembled together with an annular space of strictly uniform radial distance therebetween, the assemblage being held rigid by aid of insulating blocks to which both blanks are fixedly secured, and then the two blanks are subjected to electrical discharge machining operation for forming radially aligned slits in both blanks, each aligned pair being formed by a single discharge.

Thus in FIG. 2, a control grid **6** and a screen grid **7**, with insulating blocks **12** interposed between and fixedly secured to lateral flanges of respective grids, have a plurality of radially aligned pairs of longitudinal slits formed therein by electrical discharge machining, such slits being in circumferentially uniform spacing in respective grids. The two concentric grids are disposed to enclose therein a cylindrical cathode **8** at the centre, having a heater coil **9** mounted therein as usual. The electrodes **8** and **6** are mounted on a stem **10** by means of lead supports **13** and **14** as usual, and the screen grid **7** is provided with a longitudinal cylindrical extension which is secured to a flange member **11** fixed to the stem **10**. The insulating blocks **12** positively hold the concentric grids **6** and **7** in the accurate relative positions, and enable the formation of a concentric grid structure, perfect in radial alignment of fine wires and slits, respectively. However, the insulating blocks **12** necessarily remain in the grid structure to undesirably increase the interelectrode capacity and also to cause the interelectrode insulation to be deteriorated by conductive films that would be formed on the surfaces of insulating blocks **12** by virtue of known spattering.

According to the present invention, the grid structure is formed without employing such insulating blocks that would remain in the finished structure. Thus, referring to FIG. 3(B), a metallic blank cylinder **15** for the control grid and a metallic blank cylinder **16** for the screen grid are positioned accurately with respect to each other by utilization of known jigs, and then adhesive materials **17** are applied between the two cylindrical blanks **15** and **16** for fixedly securing them together. The cylindrical blanks **15** and **16** are preferred to have the tops closed as usual, and adhesive materials **17** are applied also between the top closure walls of two cylindrical blanks **15** and **16**, as illustrated. The adhesive material **17** should be such that it can be removed by fusion when it is heated to a high temperature or by dissolution or gassification when subjected to the action of appropriate chemical agent. Acrylic acid resin and nitrocellulose, for example, may be used as the adhesive material.

After the blanks **15** and **16** have been assembled with adhesive materials **17** holding them in the accurate relative positions as above-mentioned, a suitable electrode device **18** of electrical discharge machining apparatus, as shown in FIG. 3(A), is used for providing radially aligned slits in both blanks **15** and **16** as shown in FIG. 3(C).

The grid assembly **6**, **7** thus formed is then mounted on the stem **10**, as shown in FIG. 4, with a cylindrical cathode **8** having a heater **9** enclosed therein, surrounded by the grid assembly **6**, **7**. The control grid **6** is mounted on the stem **10** by means of rigid lead supports **14**, while the screen grid **7** is secured to a flange member **11** fixed to the stem **10**. After then, the adhesive materials **17** are removed by a high-temperature heating or by treatment with suitable chemical agent, such as, for example, acetone. The above-mentioned heating may be the so-called baking operation effected during the normal evacuation step in the manufacture of vacuum tube.

According to the invention, there is existing no supporting insulator between control and screen grids that would undesirably increase the interelectrode capacity, and also would cause the interelectrode insulation to be

leteriorated by virtue of spattering of electrode materials which would form conductive films on supporting insulators.

What I claim as my invention is:

1. An improved method of fabricating an electrode ube assembly by the steps of assembling at least two cylindrical metallic blanks in properly spaced coaxial nested non-abutting insulated relationship, holding said cylindrical blanks precisely fixed in said relationship with respect to one another, simultaneously forming radial aligned slits in said cylindrical blanks to form a coaxial electrode sub-assembly having the same number of electrodes as cylindrical blanks, fixedly mounting said coaxial electrode sub-assembly in a tube structure to form said electrode tube assembly, the improvement essentially consisting of holding said cylindrical blanks precisely in said fixed relationship with respect to one another solely by inserting and self-adherently securing to said cylindrical blanks spacer blocks of removable adhesive material and removing said adhesive material after said coaxial electrode sub-assembly has been fixedly mounted in said tube structure such that the interelectrode capacitance between said electrodes is reduced and the insulated relation between said cylindrical blanks is maintained in the finished tube.

2. The improved method of fabricating an electrode tube assembly as in claim 1 in which the adhesive material applied between said cylindrical blanks is removed by heating said electrode tube assembly at an elevated temperature.



3. The improved method of fabricating an electrode tube assembly as in claim 1 in which the adhesive material applied between said cylindrical blanks is removed by treating said adhesive material with a chemical agent.

4. The improved method of fabricating an electrode tube assembly as in claim 1 in which the adhesive material applied between said cylindrical blanks is acrylic acid resin.

5. The improved method of fabricating an electrode tube assembly as in claim 1 in which the adhesive material applied between said cylindrical blanks is nitrocellulose.

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