United States Patent [19]

Seifert

[11] **3,758,810**

[45] **Sept. 11, 1973**

[54] **ELECTRIC DISCHARGE TUBE COMPRISING A ROD GRID**

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[22] Filed: **Nov. 18, 1971**

[21] Appl. No.: **199,882**

[30] **Foreign Application Priority Data**

Nov. 21, 1970 Germany ..... P 20 57 331.3

[52] **U.S. Cl.** **313/356,** 313/295, 313/349

[51] **Int. Cl.** **H01j 1/46,** H01j 17/12, H01j 19/38

[58] **Field of Search** 313/348–350, 293, 356, 295–298, 265

[56] **References Cited**

UNITED STATES PATENTS

3,146,515	9/1964	Ragland	313/348 UX
2,157,595	5/1939	Cudney	313/356 X
2,980,984	4/1961	Shrader	29/25.14
1,696,103	12/1928	Seibt	313/348 X

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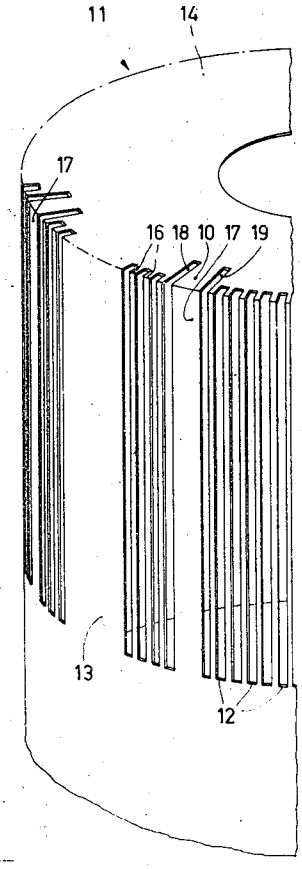
[57] **ABSTRACT**

A metal-ceramic tetrode or triode which comprises a cylindrical rod grid which is manufactured by means of a spark erosion process. In order to improve the mechanical stability of the grid and also to shift the resonant frequency to higher frequencies, the grid comprises wide and narrow rods. Since the wide rods bend inwardly or outwardly during the spark erosion process, the slots, to avoid said drawback, adjoining the wide rods extend in at least one inwardly extending flange of the cylinder farther in the direction normal to the curved surface of the cylinder than the slots present between the thin rods.

5 Claims, 2 Drawing Figures



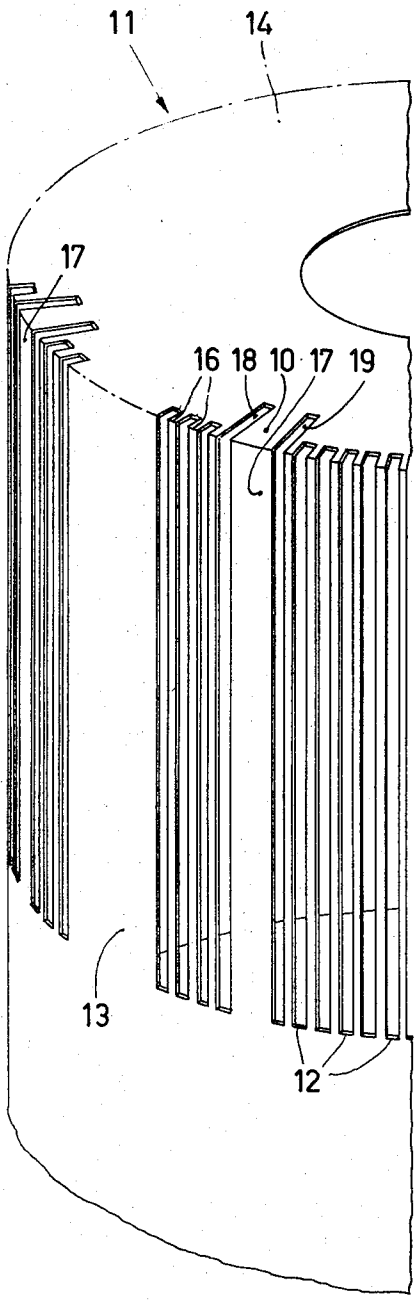


Fig. 2

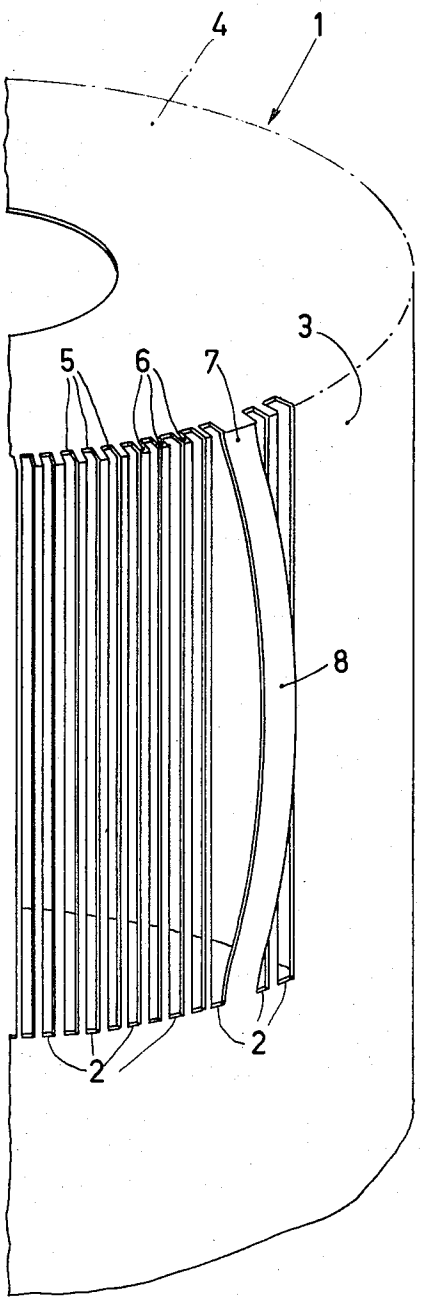


Fig. 1

ELECTRIC DISCHARGE TUBE COMPRISING A ROD GRID

The invention relates to an electric discharge tube which comprises one or more electrodes, each consisting of a hollow metal cylinder in which slots are provided by means of a spark erosion process, said slots extending in the axial direction and in at least one inwardly extending flange of the cylinder also in a direction normal to the curved surface of the cylinder.

Such electrodes are known from the United States Pat. No. 2,980,984 and 3,146,515. The spark erosion process is comparatively cheap while nevertheless high requirements as regards the tolerances can be fulfilled.

It has been found, however, that the mechanical stability of the electrode from the United States Patent No. 2,980,984 is insufficient. In the case in which the electrodes consist of a thinner and hence less rigid sheet, the mechanical stability should be increased since otherwise electric flashover occurs between the electrodes.

It is the object of the invention to provide an electrode of the type mentioned in the preamble which has a sufficient stability both mechanically and electrically.

For that purpose, the electrode according to the invention comprises, in addition to the thin rods of approximately equal cross-section obtained by a spark erosion process, a few wider rods which serve as supports and the adjacent slots of which in at least one inwardly extending flange of the cylinder extend farther in the direction normal to the curved surface of the cylinder than the slots present between the thin rods.

The presence of deeper slots beside the supports at first sight seems a measure which is inconsistent with the obtaining of a higher stability of the electrode. It has been found, however, that a sufficient mechanical stability was obtained by the wide supports but that flash-over occurred again and this time notably at the said supports. During the investigation into the cause hereof it has been found that during the spark erosion process in which all the rods are formed simultaneously, the specific thermal load of the thin rods is larger than that of the wider rods. As a result of this the thin rods are slightly upset which again has for its result that the wider supports after the erosion process are loaded for buckling in such manner that they bend inwardly or outwardly. At the area of the bend, the path of the electric field is disturbed while in addition the distance from the support to the nearest electrode, measured in the direction of bending, becomes so small that flash-over can occur between the said support and an adjacent electrode.

If in at least one inwardly extending flange of the cylinder the slots adjoining on either side of the supports extend farther in the direction normal to the curved surface of the cylinder than the slots present between the rods, it is achieved that the supports, during the spark erosion process, no longer bend inwardly or outwardly but that the comparatively larger elongation of the supports with respect to the rods and the associated buckling forces are compensated for by that part of the inwardly extending flange which is present between the farther extending slots. As a result of this, said part bends in the axial direction which is no objection because it lies outside the discharge space of the tube and therefore exerts no influence on the electric properties of the tube. These electric properties are not adversely influenced either by the wider supports, provided they

are uniformly distributed on the circumference of the electrode.

In spite of the deeper slots beside the supports, the mechanical stability of the electrode remains amply sufficient. In addition, the mechanical resonant frequency of the electrode becomes so high as a result of said supports that this also is not disturbing any longer.

The electrode according to the invention is preferably used as a control electrode in a metal-ceramic tetrode or triode. The shape of said control electrode preferably is circular cylindrical which does not mean that the application of the invention is restricted to said shape. The invention may equally successfully be used, for example, in a rectangular cylinder in which the grid, as is usual in many tubes, is formed in one or more side faces. It is not important either from what metal the hollow cylinder is manufactured. This may be, for example, copper, molybdenum or steel.

In general the invention may be used in those cases in which the above-mentioned drawbacks are to be avoided. It will therefore be obvious that many applications both in and beyond the field of electronics, are possible without departing from the scope of the invention.

In order that the invention may be readily carried into effect, it will now be described in greater detail, by way of example, with reference to the accompanying drawing, in which

FIG. 1 shows a grid for an electric discharge tube which comprises only a few wider supports, only one of which is shown;

FIG. 2 shows an embodiment of a grid according to the invention.

Referring now to FIG. 1, the hollow cylinder 1 is constructed as a circular cylinder. In the curved surface 3 of the cylinder the slots 2 are formed by means of a spark erosion process which slots terminate at the circular plane 4 and, as denoted by 5, extend in the radial direction. By providing the slots 2, the rods 6 and the supports 7 are formed. During the spark erosion process the rods 6 are slightly plastically deformed, i.e., buckled, by thermal expansion, as a result of which the support 7 is loaded for buckling and, as denoted by 8, bends slightly outwards. The distance to the nearest electrode thus has become smaller as a result of which electric flash-over will occur at 8 and the tube would be useful at a considerably lower voltage, which has for its result that the required specifications are no loner fulfilled.

In FIG. 2, the hollow cylinder 11 which has a wall thickness of approximately 0.1 mm, is constructed as a circular cylinder. In the curved surface 13 of the cylinder, slots are provided by means of a spark erosion process, which slots terminate at the circular plane 14 and, measured in the circumferential direction, have a width of approximately 0.17 mm. By providing said slots, the rods 16 and supports 17 are formed which have a width of approximately 0.1 mm and 1 mm, respectively. The slots 18 and 19 adjoining the supports 17 extend in the circular plane 14 in the radial direction farther than the slots 12 present between the rods 16. The comparatively larger elongation of the supports 17 relative to the rods 16 is compensated for in the circular plane 14 at 10 in that the material can easily be bent in the axial direction at that area as a result of the deeper slots 18 and 19. The deformation of the material at that area, however, lies outside the electric discharge space of the

tube and therefore has no influence on the electric properties of the tube. Moreover, the mechanical stability of the grid is amply sufficient in spite of the deeper slots **18** and **19**.

What is claimed is:

1. In an electric discharge tube of the type having at least one electrode consisting of a hollow metal cylinder in which slots are provided by means of a spark erosion process, said slots extending in the axial direction and in at least one inwardly extending flange of the cylinder also in a direction normal to the curved surface of the cylinder as a result of which a grid is formed which is constructed from thin rods of approximately the same cross-section, the improvement comprising

that in addition to the thin rods, the electrode comprises a few wider rods which are bounded on either side by two slots which extend farther in the direction normal to the curved surface of the cylinder than the slots present between the thin rods.

2. An electric discharge tube as claimed in claim **1** wherein said tube is a metalceramic tetrode.

3. An electric discharge tube as claimed in claim **1** wherein the electrode is a control grid.

4. An electric discharge tube as claimed in claim **1** wherein the hollow cylinder is a circular cylinder.

5. An electric discharge tube as claimed in claim **1** wherein said tube is a metal-ceramic triode.

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