COAXIAL POWER GRID Tube HAVING IMPROVED INTERNAL LEAD STRUCTURES

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References Cited

UNITED STATES PATENTS
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Abstract

In a coaxial power grid tube, the control grid lead passes into the envelope of the tube coaxially of and within the cathode lead structure. A cross-over structure is provided within the envelope for passing the control grid structure through the cathode lead structure in insulative relation thereto. The cathode lead structure includes a pair of concentric radially spaced cylinders (double wall) connected together for applying potential to one end of a directly heated thermionic cathode emitter, whereas the other lead for the cathode emitter is disposed in insulative relation within the interior of the double wall cathode lead structure for completely shielding the internal cathode lead from RF energy present in either the grid drive or output RF circuits of the tube.

10 Claims, 4 Drawing Figures
COAXIAL POWER GRID TUBE HAVING IMPROVED INTERNAL LEAD STRUCTURES

BACKGROUND OF THE INVENTION

The present invention relates in general to coaxial power grid tubes and more particularly to improved control grid and cathode lead structures therefor.

DESCRIPTION OF THE PRIOR ART

Hereinafter, coaxial power grid tubes have been proposed wherein the power grid lead structure comprised a plurality of axially directed circumferentially spaced pins passing through the envelope of the tube. The grid lead pins passed through apertures in a surrounding cylindrical cathode lead structure, thereby effectuating a physical cross-over of the control grid and cathode lead structures within the envelope of the tube. The tube employed a filamentary heater for indirectly heating the cathode emitter.

The filament current passed into the tube by a filament lead structure disposed on the axis of revolution of the tube and disposed adjacent the axially directed control grid leads. The other end of the filamentary heater was connected to the cathode lead structure. Thus, in this prior tube, RF control grid drive energy could be coupled directly from the control grid lead to the filament lead structure, thereby resulting in undesired parasitic oscillations and unwanted loss of grid drive power.

Moreover, in this prior tube, the cross-over of the control grid lead structure with the cathode lead structure occurred just inside the envelope of the tube such that a substantial portion of the cathode lead structure within the tube carried current for both the grid drive circuit and the output circuit. This deleteriously affects the high frequency gain of the power grid tube. Such a prior art tube is disclosed in U.S. Pat. No. 3,287,597 issued Nov. 22, 1966 and assigned to the same assignee as the present invention.

SUMMARY OF THE PRESENT INVENTION

The principal object of the present invention is the provision of a coaxial power grid tube having improved internal control grid and cathode lead structures.

In one feature of the present invention, the control grid lead structure is disposed axially of the tube and has an apertured radially directed portion through which axially directed spokes of the cathode lead structure project in insulative relation to effectuate a cross-over of the control grid and cathode lead structures within the envelope of the tube.

In another feature of the present invention, the cathode lead structure includes a double walled cylindrical lead portion for making electrical connection to one end of the directly heated cathode emitter. A second cathode lead portion is disposed between the two walls of the double walled cathode lead in insulative relation thereto for applying potential to the other end of the cathode emitter and thus serving as a filamentary lead, whereby the filamentary lead is completely shielded for RF from both the control grid and screen grid lead structures.

Other features and advantages of the present invention will become apparent upon a perusal of the following specification taken in connection with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view of a coaxial power grid tube incorporating features of the present invention.

FIG. 2 is an enlarged detail perspective view of a portion of the structure of FIG. 1 delineated by line 2—2,

FIG. 3 is a sectional view of the structure of FIG. 1 taken along line 3—3 in the direction of the arrows, and

FIG. 4 is a schematic circuit diagram of a coaxial power grid tube of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is shown a coaxial power grid tube 11 incorporating features of the present invention. More specifically, power grid tube 11 includes a hollow cylindrical anode 12, as of copper, forming a portion of the envelope of the tube. A directly heated cylindrical thermionic cathode 13 is coaxially disposed within the anode 12 for providing a copious supply of thermionic cathode emission. A cylindrical screen grid electrode 14 is coaxially disposed of the anode 12 between the anode 12 and the cathode 13. A cylindrical control grid 15 is coaxially disposed of the cathode 13 between the cathode 13 and the screen grid 14 for controlling the flow of electron current from the cathode emitter 13 to the anode 12 in response to RF energy applied between the grid and cathode.

Coaxially disposed axially directed control grid, cathode, and screen lead structures 16, 17 and 18, respectively, are provided at the lower end or base of the tube 11 for making electrical connection to the respective electrodes 15, 13, and 14 through the base end portion 19 of the envelope of the tube. The base end portion 19 of the envelope of the tube 11 includes a hollow cylindrical ceramic screen grid-to-anode insulator 21 sealed, as by conventional metal-to-ceramic sealing techniques, between the cylindrical screen grid lead 18 and the anode 12. A ceramic insulative ring 22 is similarly sealed between an outer cylindrical wall 23 of the cathode lead structure 17 and the inner surface of the screen lead 18. A ceramic insulative ring 24 is sealed in a gas tight manner between the outer surface of the inner cylindrical cathode lead (filament lead) 25 and the inner surface of the outer cathode lead cylinder 23.

Another ceramic ring 26 is sealed between the inner surface of the filament lead 25 and the outer surface of the inner wall 27 of the double walled cathode lead structure 17. Another ceramic insulator ring 28 is sealed between the inner surface of the inner wall 27 of the cathode lead structure 17 and the outer surface of a metallic flange portion 29 of the cylindrical grid lead post 16.

The axially disposed grid lead post 16 includes a radially directed metallic flange portion 31 disposed at its inner end for making electrical contact to and supporting one end of the control grid 15. The radially directed flanged portion 31 includes a plurality of circumferentially spaced axial apertures 32 through which hollow spoke-like portions 33 of the cathode lead structure 17 extend axially in electrically insulative relation relative to the grid lead structure 16 and 31.
The hollow cathode spoke portion 33 are connected at their inner ends to the lip portions of apertures in a shallow metallic cathode cup structure 34, the outer lip of such cup 34 being connected to and supporting one end of the cylindrical thermionic cathode emitter mesh 13.

Thus, the spokes 33 which pass through the aperture grid lead portion 31 forms a cross-over structure within the tube near the base of the cathode emitter 13. Electrical connection to the other end of the directly heated mesh cathode 13 is effected via metallic inverted cup member 37 and central conductive post 38. A radially directed metallic flange 39 is secured to the bottom of the central port 38 and is connected to metallic axially directed filament lead rods 41 passing through the hollow cathode lead spoke portions 33 in insulative relation thereto. The rods 41 are connected at their bases to the upper end of the inner cylindrical cathode filament lead 25.

The upper ends of the control grid 15 and screen grid 14 are supported from a central ceramic insulator post 42 via the intermediary of inverted metallic cup members 43 and 44, respectively.

An advantage to the coaxial power grid tube 11 of the present invention is that the internal filamentary cathode lead structure 25 is completely shielded for RF from both the control grid drive and the output RF circuits. More particularly, by enclosing the filamentary lead 25 within the double walled cathode lead structure 17, the filamentary lead 25 is completely shielded for RF from the control grid drive circuit defined between the control grid lead structure 16 and 31 and adjacent surface of the inside wall 27 of the double walled cathode lead structure 17.

Another advantage to the lead structure of the present invention is that the control grid-cathode lead cross-over occurs at a point substantially at the base of the cathode emitter 13. In this manner only a relatively short portion of the outside wall 23 of the double walled cathode lead structure 17 carries RF current for the input grid drive circuit and the output RF circuit. Consequently, the cathode inductance is minimized, thereby reducing the input conductance and thus the high frequency power gain of the tube. In a typical example, the coaxial power grid tube 11 of the present invention provides a power gain of 21 db over the frequency range of 0 to 200 MHz with a power output of approximately 10 kilowatts cw.

What is claimed is:

1. In a coaxial power grid tube:
cylindrical cathode emitter electrode means for supplying copious thermionic cathode emission;
cylindrical anode electrode means disposed coaxially surrounding said emitter means for collecting electron current flowing from said cathode emitter to said anode means; cylindrical control grid means coaxially surrounding said cathode emitter means and being interposed between said cathode emitter means and said anode means for controlling the flow of electron current to said anode means; evacuated envelope means for containing said cathode and control grid; control grid and cathode lead structures passing through said envelope means and having axially coextensive portions; said control grid lead structure having a portion thereof disposed on the axis of revolution of and completely surrounded by said cathode lead structure; and
cross-over means within said evacuated envelope for passing said control grid lead structure through said cathode lead structure in electrically insulative relation thereto.

2. The apparatus of claim 1 wherein said cross-over means includes, generally axially directed spoke portions of said cathode lead structure passing through apertures in outwardly directed portions of said control grid structure.

3. The apparatus of claim 1 wherein said cathode lead structure includes first and second concentric radially spaced cylindrical wall portions closed together at their inner ends and having hollow axially directed spoke portions projecting from the closed inner ends of said cathode lead structure, said hollow spoke portions communicating with the hollow space between said first and second concentric cylindrical cathode lead wall portions, a third cathode lead electrode structure portion disposed within the hollow interior defined between said first and second concentric cathode lead wall portions, said third cathode lead portion having rod portions extending through said hollow spoke portions in electrically insulative relation thereto and being electrically connected to a first end of said cathode emitter electrode, and said first and second cylindrical portions of said cathode lead structure being connected to a second end of said cathode emitter means, whereby an operating electrical potential applied between said third cathode lead portion and said first and second cathode lead portions causes electrical current to flow through said cathode emitter for directly heating same to thermionic cathode emission temperature.

4. The apparatus of claim 1 including, cylindrical screen grid means disposed coaxially surrounding said cathode emitter means and being disposed intermediate said control grid means and said anode means, screen grid lead structure passing through said envelope means and having axially coextensive portions with said control grid and cathode lead structures, and wherein said screen grid lead structure is disposed surrounding said cathode lead structure.

5. In a coaxial power grid tube:
directly heated cylindrical cathode emitter electrode means for supplying copious thermionic cathode emission;
cylindrical anode electrode means disposed coaxially surrounding said emitter means for collecting electron current flowing from said cathode emitter to said anode means;
cylindrical control grid means disposed coaxially surrounding said cathode emitter means and interposed between said cathode emitter means and said anode means for controlling the flow of electron current to said anode means; evacuated envelope means for containing said cathode and control grid;
control grid and cathode lead structures passing through said envelope means and having axially coextensive portions; said control grid lead structure having a portion thereof disposed within and surrounded by said cathode read structure; and said cathode lead structure including first and second concentric radially spaced cylindrical wall portions
3,826,948

5 closed together at their inner ends and having hollow axially directed spoke portions projecting from the closed inner ends of said cathode lead structure, said hollow spoke portions communicating with the hollow space between said first and second concentric cylindrical cathode lead wall portions, a third cathode lead electrode structure portion disposed within in the hollow space defined between said first and second concentric cathode lead wall portions, said third cathode lead portion having portions extending through said hollow spoke portion in electrically insulative relation thereto and being electrically connected to a first end of said cathode emitter electrode, and said first and second cylindrical wall portions of said cathode lead structure being connected to a second end of said cathode emitter means, whereby an operating electrical potential applied between said third cathode lead portion and said first and second cathode lead wall portions causes electrical current to flow through said cathode emitter means for directly heating said thermionic cathode emission temperature.

6. The apparatus of claim 5 wherein said control grid structure includes a generally radially directed portion, and wherein said generally axially directed spoke portions of said cathode lead structure pass through said apertures in said control grid structure.

7. The apparatus of claim 5 including, cylindrical screen grid means disposed coaxially surrounding said cathode emitter means and intermediate said control grid means and said anode means, screen grid lead structure passing through said envelope means and having axially coextensive portions with said control grid and cathode lead structures, and wherein said screen grid lead structure is disposed surrounding said cathode lead structure.

8. The apparatus of claim 1, wherein said crossover means connects said control grid lead structure to the adjacent end of said cylindrical control grid means and connects said cathode lead structure to the corresponding adjacent end of said cylindrical cathode emitter electrode means.

9. The apparatus of claim 1 wherein said crossover means comprises a portion of each of said control grid and cathode lead structures shaped to provide an open space between conductive portions thereof, and each of said control grid and cathode lead structures having a portion thereof passing through the open space in the other.

10. The apparatus of claim 1 wherein said cathode lead structure comprises a first conductor surrounding said control grid lead structure, a second conductor surrounding said first conductor, a third conductor for connecting heater current to said cylindrical cathode emitter, and said third conductor being positioned between said first conductor and said second conductor.

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