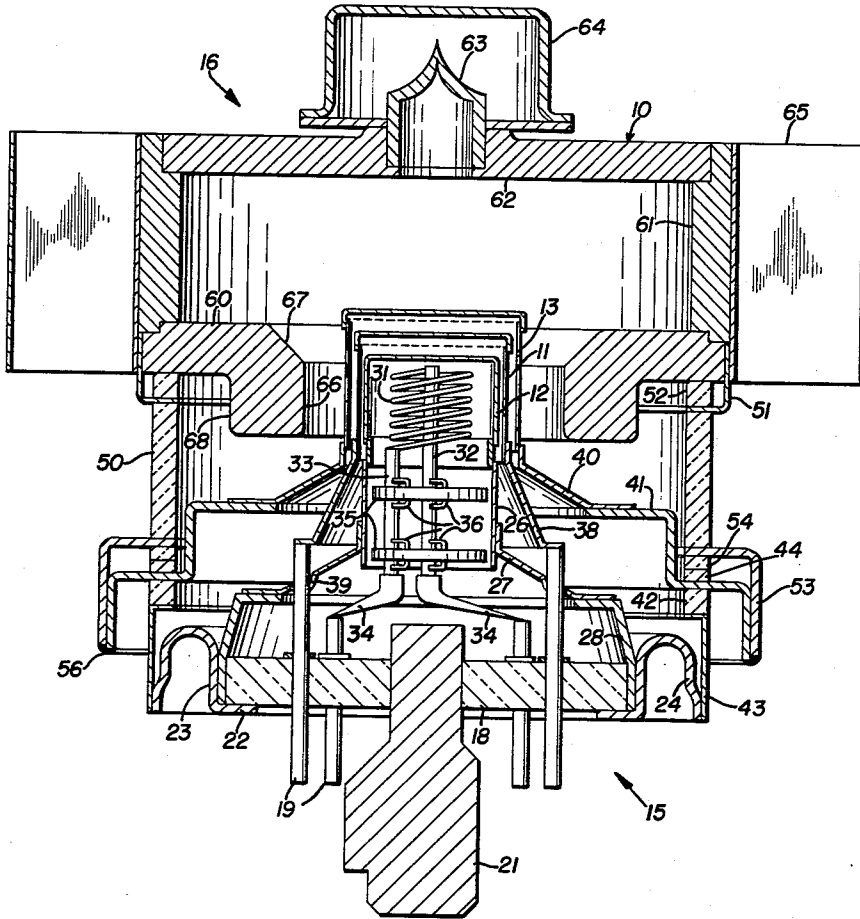


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HIGH FREQUENCY TUBE HAVING A CATHODE ELECTRODE
BETWEEN THE GRID AND ANODE TERMINALS
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HIGH FREQUENCY TUBE HAVING A CATHODE ELECTRODE BETWEEN THE GRID AND ANODE TERMINALS

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This invention relates to electron tubes, and more particularly to the electrode arrangement and envelope structure in such tubes.

With the advent of the distributed amplifier, a tube is required with features that will allow one to design a distributed amplifier for maximum performance. A distributed amplifier is an amplifier that provides amplification over a broad frequency bandwidth which is much broader than the bandwidth of a conventional cascade amplifier. To make the distributed amplifier competitive in price and to improve its performance over other systems, the amplifier requires a tube that has a large gain-bandwidth product and a good physical separation between grid and plate terminals, such as a ground plane in between, and the tube should present a minimum of grid loading. The tube should also be economical to build.

A small, compact, economical tube capable of producing a relatively large amount of power in the higher frequency range is described in Patent No. 2,471,005. The tube has the following features: external anode and a socketing base consisting of eight pins disposed in a circle around a center prong. The control grid terminal is the center prong and the cathode terminal is one or more of the eight pins. The screen grid terminal is an annular metal ring coaxial with the eight pins. This tube has the advantages of producing high power, being capable of operating at high frequencies, and having simple socketing means.

An object of this invention is to provide a tube with the above advantages for distributed amplifier service.

The main object of this invention is to provide an improved electron tube for use in distributed amplifier service.

Another object of this invention is to provide a tube with a high gain-bandwidth product and with a low grid loading.

Another object of this invention is to provide a tube which can be operated with a gain less than one and which will have a corresponding increase in bandwidth over a tube with a higher gain.

Another object of this invention is to provide a tube with reduced cathode-grid capacitance and reduced cathode-plate capacitance.

Another object of this invention is to provide a tube with low inductance.

Another object of this invention is to provide a tube with coaxial terminals and with the cathode terminal disposed between the plate terminal and control grid terminal.

Another object of this invention is to provide a tube which permits simple, effective wide bandwidth screen bypassing.

Yet another object of this invention is to provide a tube which is specifically designed for a distributed amplifier and yet employs the widely accepted eight-pin socketing arrangement employed by the tube disclosed in Patent No. 2,471,005.

A still further object of this invention is to provide an improved electron tube.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the invention. The invention is not limited to this specific embodiment,

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but other embodiments may be adapted within the scope of the claims.

Referring to the drawing:

The single FIGURE of the drawing is a vertical cross-sectional view of the novel tube.

Basically the novel tube comprises a vacuum envelope containing concentric tubular electrodes, an anode 10, a control grid 11, and a cathode 12, and a plurality of coaxial terminals axially spaced along the envelope wall with the cathode terminal disposed between the plate terminal and the control grid terminal. A screen grid 13 is shown in this embodiment.

The envelope is made of two sections, a header section 15 and an anode section 16. The header section 15 includes a dielectric disk 18, preferably ceramic, with eight pins 19 protruding therethrough and bonded airtight to the disk 18. The pins 19 are disposed in a circular array around a central indexing prong 21 disposed concentrically on disk 18 and bonded airtight thereto. Around the periphery of one surface of disk 18 is bonded U-section metal ring 22 with its flanges 23 and 24 turned away from the anode section 16. The cathode 12, being tubular, is supported on a tubular support 26, mounted on a conical ring 27, which is brazed to a ring 28. One end of ring 28 is bonded to flange 23 of ring 22. The cathode 12 is heated by a resistance coil 31 which is mounted across two electrical leads, a long central lead 32 and a short laterally displaced lead 33. The leads 32 and 33 are connected to two of the pins 19 by metal ribbons 34. Two ceramic heat shield disks 35 are supported on leads 32 and 33 by wires 36.

The control grid 11 being of wire construction and cylindrical in form is disposed outside of and concentric with the cathode 12 and is mounted on a conical metal ring 38 which is in turn mounted on the inner end of the six remaining pins 19. The conical ring 27 which supports the cathode has suitable apertures 39 through which the six pins 19 extend. The screen grid 13, like the control grid, being also of wire construction and cylindrical in form, is disposed outside the control grid and concentric thereto. A conical ring 40 mounted on the inner end of an M-section metal ring 41 supports the screen grid in place. The M-section ring 41 is insulated by a ceramic ring 42 from an L-section ring 43 which has one of its legs brazed to the flange 24 of ring 22. A ceramic backing ring 44 is bonded to ring 41 opposite the ceramic separating ring 42. Ring 41 and ring 43 form separate concentric external terminals for the screen grid and cathode respectively. The close proximity of these similar concentric terminals permits simple, effective, wide bandwidth high frequency bypassing between the cathode and screen grid electrodes with the aid of a simplified capacitor built into a suitable socket.

As mentioned above, the object of this invention is to provide an improved tube for a distributed amplifier system. A typical distributed amplifier system is disclosed in an article by E. L. Ginston, W. L. Hewlett, J. H. Jasberg, and J. D. Noel published in volume 36, page 956 of the Proceedings of the Institute of Radio Engineers. One of the main purposes for using this system is to obtain an amplifier system which is not limited to the maximum "bandwidth-gain product" for a given tube type as governed by a cascade amplifier system. The distributed amplifier system will amplify a signal, even though a tube type used therein has a gain less than unity, because a distributed amplifier adds in phase the output signal from each tube. Thus in a distributed amplifier system the total gain is the product of all the individual gains in each tube.

Since in a distributed amplifier system the object is to obtain an amplifier with a broader bandwidth than the cascade amplifier system, the distributed amplifier can

be made still broader by using a tube type which is inherently broad-band and developed for use in the amplifier. The bandwidth of a tube is known to increase by decreasing its gain or by decreasing the cathode-control grid capacitance and by decreasing the plate-cathode capacitance. One of the features of this novel tube which enables the reduction of the grid-cathode capacitance is the conical grid support ring 38 which flares away from the cathode support 26. The bandwidth is also increased by having the inductances of the electrode leads reduced to a minimum by the use of coaxial leads, such as rings 28, 27 and 26 for the cathode, and ring 38 connected to the six pins 19 for the grid, and by making these terminal rings large. In this embodiment the screen grid terminal and the cathode terminal are on the circumference of the envelope, and the terminal for the control grid is the plurality of pins 19. This structural arrangement for supporting the control grid not only lowers the inductance of the tube but supports the control grid more rigidly within the envelope than the structural arrangement used in the prior art, and permits greater isolation of the input and output circuits by reducing the common lead inductance which is the inductance of the cathode lead. The grid 11 is supported on at least six pins 19, but all eight pins 19 can be used to support the grid 11 or any number less than six. However, since the inductance of the grid-lead is determined by the number of pins 19 which are used as the grid terminal, the inductance is decreased by the use of more pins. The control grid terminal is not restricted to pins but can be a concentric metal ring. The disclosed embodiment is preferred because of its simplified socketing.

The anode section 16 consists of the anode 10 bonded to a ceramic ring 50 by the aid of an L-section metallic sealing ring 51 which has one leg bonded to ring 50 and the other leg brazed to the anode. A ceramic backing ring 52 is bonded to the ring 51 opposite ring 50. Another L-section metal sealing ring 53 is bonded to the other end of ring 50 with another ceramic backing ring 54 bonded to ring 53 opposite ring 50. The two sections 15 and 16 are assembled and a weld 55 is formed on the ends of rings 41 and 53, sealing the sections airtight. The anode 10 in this embodiment comprises a multiplicity of parts including a heavy ring 60, a short tube 61, and an apertured disk 62 through which a "nipped-off" exhaust tubulation 63 is inserted and protected by cap 64. Cooling fins 65 are brazed to the anode.

The heavy ring 60 of the anode has a cylindrical aperture 66. To reduce the cathode-plate (i.e., output) capacitance to a minimum, the length of aperture 66 is equal to the length of the active cylindrical-section of the cathode 12 and grids 11 and 13. This is accomplished by countersink 67 formed on one side of ring 60. The conical surface of the countersink 67 since it slopes away from the cathode causes the output capacitance to diminish. Only the cylindrical wall of the aperture 66 is very close to the cathode thereby contributing to the increase of the output capacitance. The short tube 61 being attached to the outer periphery of ring 60 spaces the disk 62 from the cathode whereby an enlarged chamber is formed above the cathode. This novel structure of the anode further contributes to lowering the capacitance of the output circuit by placing disk 62 and tube 61 further from the cathode. Since the electrical characteristics of the tube determine the spacing between the aperture 66 and the cathode, this spacing is fixed and the cathode-plate capacitance will have a minimum value. The other portions of the anodes, such as countersink 67, tube 61, and disk 62 being placed a substantial distance from the cathode, the capacitance between them and the cathode is very small and they add very little to the cathode-plate capacitance.

The inductance of the input circuit, that is the cathode inductance and the control grid inductance is further re-

duced by a "stepped" portion 63 on the heavy ring 60. This stepped portion 63 allows the anode to extend towards the cathode thereby shortening the over-all length of the tube. This shortening of the tube of course means that the supporting structures for the cathode and control grid are shorter and therefore have less inductance. It should be noted that the use of stepped portion 63 permits the tube to be shortened while at the same time maintaining sufficient space between rings 51 and 53 to prevent arcing across these rings on the outside of the tube. The combination of "stepped" portion 63 and countersink 67 on ring 60 provides a ring which has sufficient thickness to conduct heat from the center of the tube to the cooling fins 65, reduces the cathode-plate capacitance, prevents external arcing between electrode terminals, and minimizes the inductance of the cathode lead and the control grid lead.

What is claimed is:

1. An electron tube comprising a vacuum envelope, electrodes including a control grid, a cathode, and an anode, said electrodes having terminals extending to the outside of said envelope wall, the terminal for said cathode being annular and disposed between the terminals of said anode and said control grid.
2. An electron tube comprising a tubular vacuum envelope, coaxial electrodes including a control grid, a cathode, and an anode, said electrodes having terminals extending to the outside of said envelope wall, the terminal of said anode being disposed adjacent one end of said envelope, the terminal of said grid extending through the other end of said envelope and comprising at least two terminal pins, and the terminal of the cathode disposed between the terminals of said anode and said control grid.
3. The electron tube of claim 2 wherein said cathode is supported on a first conical ring, the terminal for said cathode is a metal ring extending through said envelope wall, said first conical ring is mounted on the interior end of said metal ring, and said grid is mounted on a second conical ring, said second conical ring being mounted on the interior end of said pins.
4. An electron tube comprising a tubular vacuum envelope, coaxial cylindrical electrodes including a cathode, a control grid, a screen grid and an anode disposed within said envelope, said electrodes having terminals extending to the outside of said envelope wall, the cathode terminal being annular and disposed between the terminals for said anode and said control grid.
5. An electron tube comprising a tubular vacuum envelope, coaxial cylindrical electrodes including a cathode, a control grid, a screen grid and an anode disposed within said envelope, said electrodes having coaxial terminals extending to the outside of said envelope wall, the terminal of said anode being disposed adjacent one end of said envelope, the terminal of said control grid extending through the other end of said envelope, and the terminal of the cathode being annular and disposed between the terminals of said anode and said control grid.
6. The electron tube of claim 5 wherein the coaxial terminal of said control grid comprises a plurality of pins extending through said other end of the envelope and spaced around a circle which is coaxial with said annular cathode terminal.
7. The electron tube of claim 6 wherein said cathode is supported on a first conical ring having oversized apertures through which said pins extend, the terminal for said cathode is a metal ring extending through said envelope wall, said first conical ring is mounted on the interior end of said metal ring, and said control grid is mounted on a second conical ring, said second conical ring being mounted on the interior end of said pins, and said screen grid is mounted on a third conical ring, the terminal for said screen grid comprises a second metal ring extending through the envelope wall, and said third conical ring is supported on the inner end of said second metal ring.
8. An electron tube including an envelope comprising

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a stacked alternate arrangement of metal rings and dielectric rings, the first of said metal rings forming an apertured anode, the second of said metal rings being spaced from the first and coaxially supporting a cylindrical screen grid within the aperture of said anode, the third of said metal rings being spaced from the second on the opposite side thereof from said first ring, said third metal ring coaxially supporting a cylindrical cathode within said screen grid, a control grid terminal disposed through said envelope and spaced from said third ring on the opposite side thereof from said second ring, and means for supporting a control grid coaxially between said cathode and screen grid and for connecting said control grid to said control grid terminal.

9. The electron tube of claim 8 wherein a dielectric disk closes one end of said envelope, said control grid terminal includes a plurality of pins disposed coaxially in a circular array and extending through said dielectric disk, a metal disk closes the other end of said envelope, a fourth metal ring is brazed between said metal disk and said first metal ring, and cooling fins are attached to said fourth metal ring.

10. An electron tube comprising a tubular cathode mounted on a straight cylindrical cathode support, a ring terminal for said cathode disposed coaxial thereto, a conical cathode support connecting said ring terminal to said straight cylindrical support, a cylindrical grid disposed outside of and coaxial with said cathode, a conical support for said grid, said conical grid support disposed outside of and coaxial to said tubular cathode support, and terminal pins for said grid connected to said conical grid support and extending through one end of said tube, said conical cathode support having oversized apertures therein through which said pins extend.

11. An electron tube comprising coaxial cylindrical electrodes including a cathode, a control grid, a screen grid, and an anode, a ring terminal for said cathode and a ring terminal for said screen grid, said screen grid terminal being interposed between said cathode terminal and said anode, said screen grid having a larger diameter than said cathode terminal, and said screen grid terminal being positioned so that it overlaps said cathode terminal along the tube axis.

12. An electron tube comprising coaxial cylindrical electrodes including a cathode and anode, said anode comprising a heavy ring portion surrounding the cathode, a tube portion at the periphery of the ring portion and extending away from said cathode, and a disk portion closing the other end of said tube portion, the inside wall of said heavy ring portion having a smaller diameter than the inside wall of said tube portion.

13. The electron tube of claim 12 wherein said ring portion has a countersink formed in one end of its aper-

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ture adjacent said disk portion and has a stepped portion on its side opposite said disk portion.

14. An electron tube comprising coaxial cylindrical electrodes including a cathode, a control grid, a screen grid and an anode, a coaxial tubular support for said cathode, a ring terminal for said cathode connected to said tubular support, a conical support for said control grid and disposed coaxial and outside said tubular support, said anode comprising a heavy ring portion surrounding the cathode, a short tube portion at the periphery of the ring portion and extending away from said cathode, and a disk portion closing the other end of said short tube, a ring terminal for said screen grid disposed coaxial and between said anode ring and said cathode ring terminal, said screen grid terminal having a larger diameter than said cathode ring terminal, said screen grid terminal being positioned so that it overlaps said cathode terminal along the tube axis, a coaxial terminal for said control grid disposed adjacent to said cathode ring terminal and opposite said screen grid terminal, means for connecting said control grid to said coaxial terminal.

15. An electron tube comprising a vacuum-tight envelope, electrodes including a cathode, a control grid, a screen grid, and an anode, said electrodes having terminals extending to the outside of said envelope, said cathode and screen grid terminals both being annular, and said cathode and screen grid terminals being positioned adjacent each other along said envelope with no other electrode terminal positioned between them.

16. An electron tube comprising an envelope, electrodes including an anode, a cathode, and a control grid interposed between said anode and cathode, terminals for said electrodes on the outside of said envelope, the terminal for said cathode being annular and interposed between the terminals for said anode and control grid, means inside said tube supporting said cathode on said cathode terminal, means inside said tube supporting said control grid on said control grid terminal, and said control grid supporting means extending through said cathode supporting means in insulated relation thereto.

17. An electron tube as claimed in claim 16 in which a screen grid is interposed between said control grid and said anode, and an annular terminal for said screen grid on the outside of said envelope, said anode terminal being positioned on one side of said annular cathode and screen grid terminals, and said control grid terminal being positioned on the other side of said annular cathode and screen grid terminals.

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