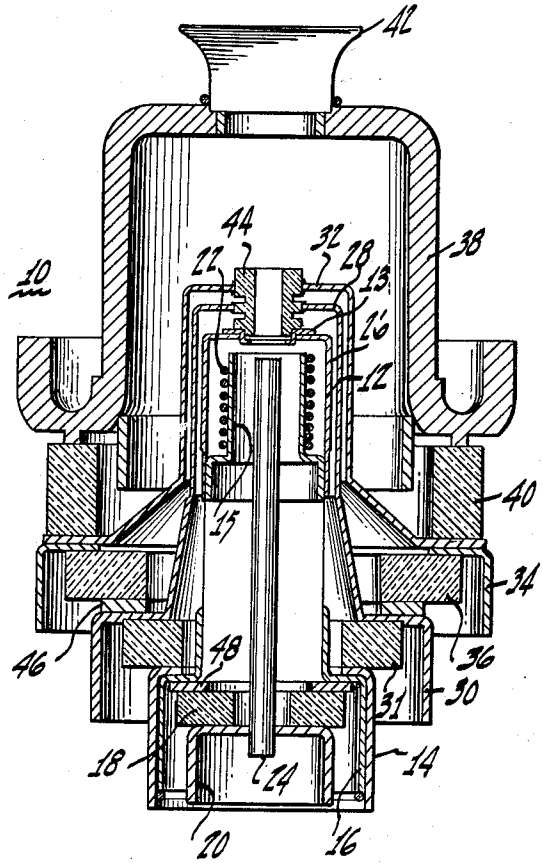
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GRID SUPPORT STRUCTURE

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# GRID SUPPORT STRUCTURE

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This invention relates to electron discharge devices. In particular, this invention relates to an electron discharge device having a ruggedized control grid, screen grid and cathode assembly.

In the prior art there are several known tube types in which the components of the tube are concentrically arranged and comprise hollow tubular members each having an enlarged flanged end. The tube components are assembled by brazing the flanged ends to the components and to annular ceramic envelope members. This brazing operation provides a vacuum tight envelope as well as a cantilever type support for the tube components. This particular type of assembly is used in many tube structures, particularly in the small and medium power tube field.

One of the disadvantages of the type of structure briefly described above, is that certain microphonic effects are produced between the various tube elements, when tubes of this type are subjected to impact shocks resulting in accelerations, vibrations and other motions of the tube. These microphonic effects may cause spurious variations in the electrical output signal of the tube.

A further problem encountered in tubes using the cantilever type support structure is that, when the tube is subjected to relatively high amplitude vibrations, actual shorting of the various tube electrodes to each other may occur. Any such shorting may destroy further utility of the tube and/or the associated circuitry. This shorting problem is particularly pronounced in the high frequency tube types because of the extremely close spacing between the tube components which spacing is required for high frequency operation.

It is therefore an object of this invention to provide an improved electron discharge device.

It is another object of this invention to provide a novel ruggedized structure for an electrode assembly comprising cantilever supported electrodes.

These and other objects are accomplished in accordance with this invention by providing an electron discharge device including a cantilever supported type cathode, control grid, and screen grid which are physically bonded at their otherwise free ends to a common ceramic pin and electrically insulated from each other by the pin.

The invention will be more clearly understood by reference to the following specification when read in conjunction with the accompanying single sheet of drawings wherein:

The single figure is a sectional view of an electron discharge device including a ruggedized structure in accordance with this invention.

Reference now to the single figure, will reveal that the electron discharge device **10** comprises an evacuated envelope including cantilever supported electrodes. The electrodes comprise a hollow tubular cathode electrode **12**, which may be made of a material such as for example, electrolytically pure nickel, and which has an enlarged flange **16** on the lower end thereof. Between the cathode **12** and the enlarged flanged end **16** is an area of the cathode that is very thin so that it functions, during tube operation, as a heat dam. The enlarged cathode flange **16** is positioned on and sealed to a sealing ring **48**, which in turn is sealed to an annular ceramic member **18**. The upper end of the tubular cathode **12** is apertured for reasons which will subsequently be explained. A brazing



eyelet **13** is fixed, for example by spot welding, to the top, apertured end of the cathode **12**. Within the hollow tubular cathode **12** there is provided a heater support cylinder **15** which is fixed, for example by spot welding, to the inner surface of the cathode **12**. Supported around the cylinder **15** is a heater coil **22**, one end of which is connected to a lead rod **24**, and the other end of which is connected to the cathode **12**. The flange end of the cathode **16** is positioned upon and sealed to the cathode sealing ring **48**, which in turn is sealed to the ceramic member **18**. The ceramic member **18** is positioned upon and sealed to an end plate **20** which, in turn, is sealed to the lead rod **24**. The outer, active portion of the cathode **12**, above the thin heat dam portion, is coated with an electron emissive coating **26**, which may be, for example, barium and/or strontium oxide. The parts of the tube that have been described will hereinafter be referred to as the complete cathode assembly for simplicity of discussion.

Closely spaced, for example 0.0085 inch, around the cathode **12** is a hollow tubular grid electrode structure **28** which may be formed of a continuous hollow tubular member through which the apertures are subsequently cut, and which may be made of a material such as a copper-nickel-phosphor alloy. The grid **28** has a flanged end **30** which is positioned upon and sealed to an annular ceramic sealing and insulating ring **31**. The control grid **28** also includes an apertured plate-like portion at its upper end, as viewed in the drawing.

Closely spaced, for example 0.008 inch, around the control grid **28** is a hollow tubular shaped screen grid **32**, which may also be formed of continuous tubing through which apertures are subsequently cut. The screen grid **32** may be of a material such as copper-nickel-phosphor alloy and also includes a flanged end **50**. The flanged end **50** is positioned between and sealed to and between ceramic sealing and insulating ring **40** and a metal flange **34** sealed to ceramic ring **36**. It should be noted that the screen grid **32** also includes an apertured plate-like portion extending partially across the upper end thereof. A ceramic pin **44** is received in the apertured plate-like portions of both the control grid **28** and the screen grid **32** and is bonded to said portions by a furnace brazing technique hereinafter to be described. The assembly including the control grid **28**, the screen grid **32**, and the ceramic pin **44**, are hereinafter referred to as the complete grid assembly. The complete grid assembly includes a sealing ring **46** which is made of a material, e.g. a nickel alloy, which helps match the expansion characteristics of the ceramic ring **36** and the flanged end **30**.

Surrounding the screen grid **32**, for example 0.125 inch therefrom, is an anode **38**. The anode **38** is positioned upon and sealed to the top surface of the ceramic sealing and insulating ring **40**. The anode **38** includes an exhaust tubulation **42**.

All of the ceramics mentioned may be made of any high alumina ceramic material, such as, for example, high purity aluminum oxide, which, after processing, will readily seal to the flanged ends of the various electrode structures. The processing of the ceramics **18**, **31**, **36** and **40** may be conventional. An example of such processing is to metallize the ceramics by silk screening molybdenum coatings, approximately ½ mil thick, and firing the coating at a temperature of approximately 1550° C. in a protective atmosphere. The seals between the ceramics and the flanged ends are conventionally formed by furnace-brazing in a restricted atmosphere, for example, line hydrogen to a temperature of approximately 820° C., while a soldering material, such as a copper-silver alloy, is positioned therebetween.

It should be noted that the top portion of the cathode

12, the top of the control grid 28 and the top of the screen grid 32 are all bonded, or firmly fixed, to the electrically insulating ceramic pin 44. This fixed engagement of the top ends of the electrodes in combination with the fixed engagement of the lower flanged ends thereof, renders impossible any movement of the electrodes, i.e. the cathode 12, the control grid 28 and the screen grid 32, with respect to each other, as a result of physical vibration. The only result of such vibration may be a movement of the cathode, control grid, screen grid structure as a unit. If this latter movement should occur, it is relatively harmless because of the rather large spacing that exists between the screen grid 32 and the anode 38.

It should also be noted that the ceramic pin 44 is annularly notched in an area between the area of contacts therewith of the cathode 12 and the control grid 28, as well as in an area between the areas of contacts therewith of the control grid 28 and the screen grid 32. The purpose of these notched areas is to provide a good electrical insulation, in that short electrical leakage paths are avoided between the various electrodes. The ceramic pin 44 may be made of a material such as high purity aluminum oxide.

In order to assemble the discharge device 10, three separate sub-assemblies are first produced. One sub-assembly is constructed as follows: The control grid 28 is furnace-brazed in a line hydrogen atmosphere to the ceramic pin 44 by means of a solder material such as a gold-copper paste of approximately 50% gold and 50% copper. After this, the cathode contact flange 14, the cathode to grid sealing ceramic 31, the grid flange 30, the control grid 28 with ceramic pin 44, the control grid to screen grid sealing ceramic 36, the screen flange 34, the screen grid 32, and the screen flange to anode sealing ceramic 40, are assembled and positioned in brazing jigs (not shown). An example of a material which has been found suitable to use as a solder material to braze the metal flanges to the ceramic insulators is an alloy of approximately 72% silver and 28% copper. This same alloy is used to bond the ceramic pin 44 to the apertured end of the screen grid 32. When this alloy is heated to a temperature of approximately 820° C. or greater, the alloy will form a vacuum tight seal between the flanges and the preprocessed ceramic rings. The brazing operation is normally done in a line hydrogen atmosphere to prevent any oxidation of the aforementioned components. After this, the material in the spaces between desired grid wires is removed by simultaneously cutting through both the control grid cylinder and the screen grid cylinder, so that the openings between the resultant "wires" of the screen grid 32 and the control grid 28 are registered radially of the grids. This grid cutting operation may be done by any conventional grid cutting technique, such as by electrical discharge machining.

The second sub-assembly is the anode sub-assembly which includes the anode 38 and the exhaust tubulation 42. When the grids have been cut as aforementioned, the anode 38 is brazed, e.g. by radio frequency (RF) heating to the upper side of the ceramic ring 40, as viewed in the drawing, for consolidation of the two sub-assemblies described.

A further sub-assembly comprises a complete cathode sub-assembly, including the heater lead 24, the end plate 20, the ceramic 18, the sealing ring 48, the flange end 16 of the cathode, the brazing eyelet 13 and the cathode 12. This sub-assembly is separately formed and is sealed together in a suitable manner.

In the manufacture of each of the sub-assemblies described above, brazing jigs (not shown) are utilized to support the various components, during the assembling and brazing steps. The brazing jigs are normally made of a material, such as an oxidized chromium-nickel alloy, which will support the components during the brazing operations and which can be easily removed from the various tube components after the brazing operations.

When the separate sub-assemblies have been made, the grid sub-assembly is sealed into the anode sub-assembly. After the application of the electron emissive coating to the exposed cathode surface, a brazing washer (not shown) which may be made, for example, of approximately 37½% gold, 62½% copper, is inserted into the depression at the upper end of the brazing eyelet 13 and between the ceramic pin 44 and brazing eyelet 13 and is held in position by the application of a material such as polymethylmethacrylate.

The complete cathode assembly is then inserted into the grid sub-assembly, which is now within the anode sub-assembly. The ceramic pin 44 enters the depression in the eyelet 13 at the top of the cathode to engage the ceramic pin brazing eyelet 13. While in this position, the bottom of the complete cathode sub-assembly is brazed, by RF heating, to the cathode contact cylinder 14 to form a vacuum tight seal. When the exhaust tubulation 42 has been brazed, by radio frequency heating, to the anode, a complete mount assembly is formed.

During the standard processing of the complete mount assembly on exhaust, the cathode is heated, by passing current through the heater 22, to a temperature, e.g. 1,050° C., which is a higher temperature than that permitted during subsequent normal tube operation. The heat from the cathode 12 melts the solder washer (not shown) between the ceramic pin 44 and the brazing eyelet 13 to form a brazed joint between the complete cathode assembly and the base of the metallized ceramic pin 44.

Because of the ruggedized structure in which the cathode 12, the control grid 28 and the screen grid 32 are all fixed to a common ceramic pin 44, tubes using this structure are substantially more rugged than those found in the prior art. Thus, tubes utilizing this invention have been subjected to impact shocks involving as high as 40 G's of acceleration and a vibration of frequency in the range of approximately 70 to 2,000 cycles per second, without shorting of the elements or destruction of the tube.

What is claimed is:

1. An electron discharge device comprising a cantilever supported cathode, control grid, and screen grid, and means for mechanically joining the free end portions of said cathode, said control grid and said screen grid, said means comprising an insulating member engaging only said cathode and said control and screen grids, said grids and said cathode having inturned annular flanges at said free end portions thereof, the free edges only of said grid flanges engaging said insulating member, and a ring including a tubular portion and an annular flange, side surfaces of said tubular portion and flange engaging said insulating member and the free edge and a side surface of said cathode flange.

2. A sub-assembly for an electron discharge device comprising a co-axial arrangement of a hollow screen grid electrode, a hollow control grid electrode, a cathode electrode, two ceramic rings, and a ceramic pin, said electrodes being supported at one end by being sealed to said ceramic rings, said electrodes being physically and insulatingly bonded together at the other ends thereof by said ceramic pin, said pin being free from engagement with any other element.

3. An electron discharge device comprising an evacuated envelope, said envelope including a plurality of annular ceramic members, said envelope also including an end portion of an anode, an end portion of a screen grid, an end portion of a control grid and an end portion of a cathode, said portions being sealed to different ones of said ceramic members, said seals forming the sole support for said electrodes, said electrodes being hollow tubular members positioned one within the other around a common axis, and means physically bonding together and electrically insulating the other end portions of said cathode, said control grid and said screen grid, said means comprising a cylindrical insulating member, said control grid and said screen grid being bonded to axially spaced intermediate portions of said cylindrical member, said cylindrical member defining an annular recess extending

to one end thereof, said recess having a first annular surface coaxial with said cylindrical member, and a second annular surface normal to the axis of said cylindrical member, and a metal ring having a cylindrical portion telescoped over said first surface and a radial flange engaging said second surface, said cathode having an inturned flange, the free edge of said flange engaging said cylindrical portion of said ring, and a side of said cathode flange engaging a side of the flange of said metal ring, said cylindrical member being engaged solely by said control grid, screen grid and metal ring, said metal ring being engaged solely by said cathode.

4. An electron discharge device comprising three tubular electrodes disposed in concentric relation, an envelope housing said electrodes, a fourth tubular electrode defining a portion of said envelope, means engaging said envelope and fixing one group of adjacent ends of said electrodes to said envelope at a region thereof remote from said fourth electrode, and means within said fourth tubular electrode and free from engagement with said envelope, fixing the other group of adjacent ends with respect to each other, said last named means comprising a cylindrical member made of insulating material and having a metal ring fixed to one end portion thereof, said ring having a cylindrical portion, said three electrodes having inturned flanges at said other group of adjacent ends thereof, said flanges of two of said electrodes being in edge engagement with axially spaced side portions of said member, said flange of the third of said electrodes being in engagement with said cylindrical portion of said ring, said ring engaging only said third of said electrodes and said cylindrical member.



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