Sept. 16, 1952 A. C. ROCKWOOD ET AL 2,611,098

BEAM POWER TUBE

Filed June 27, 1950

FIG.2

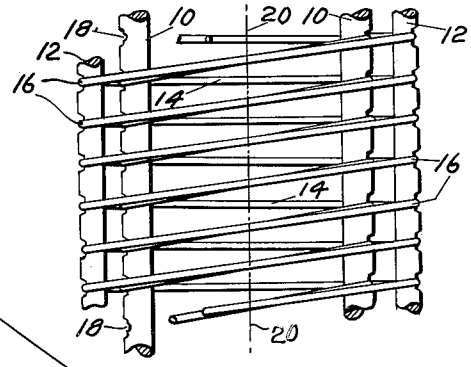


FIG.1

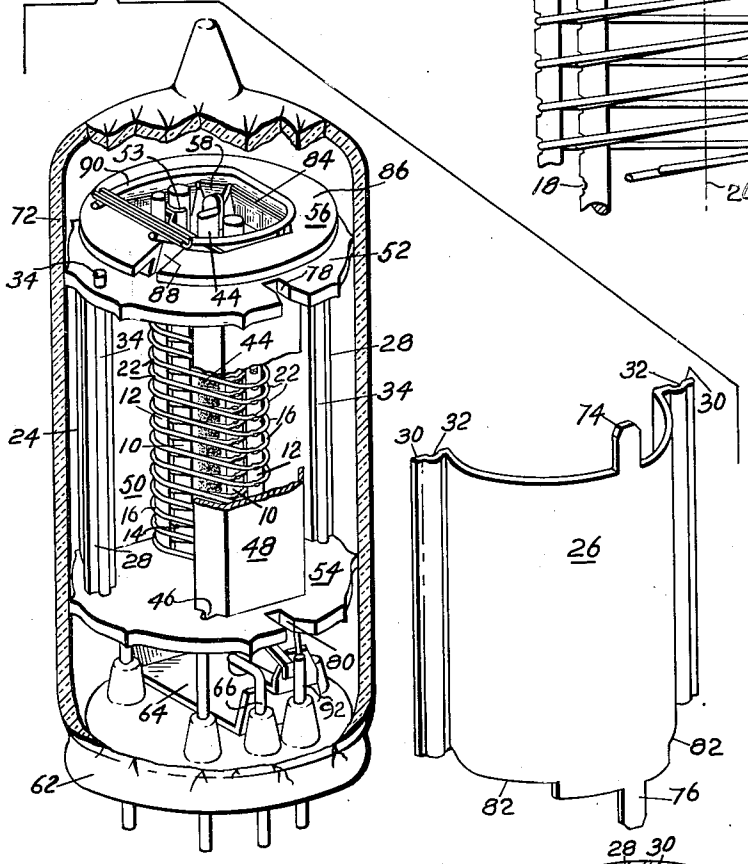


FIG3

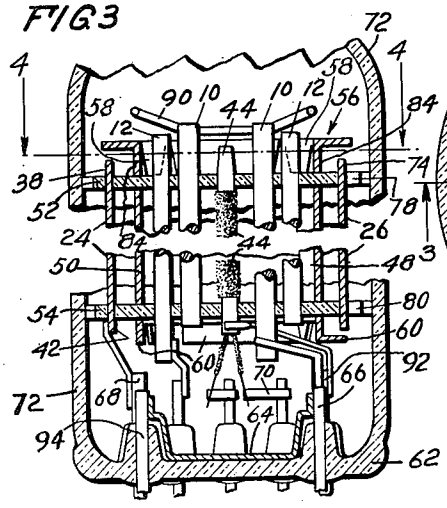
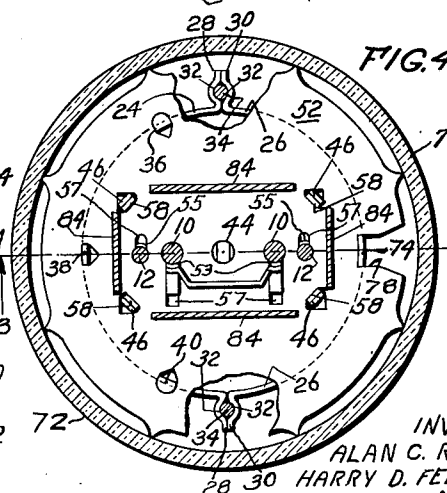


FIG.4.



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BEAM POWER TUBE

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13 Claims. (Cl. 313—69)

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This invention relates to beam power tubes and components thereof.

By a beam power tube is meant an electron beam tube in which use is made of electron beams to contribute substantially to its power-handling capability and in which the control grid and screen grid are essentially aligned.

In the above an electron beam tube is an electron tube, the performance of which depends upon the formation and control of one or more electron beams.

In beam power tubes the alignment of the grids is an important feature for proper operation. For example, where a control grid and screen grid are used, the screen grid wires should be aligned so that they fall in the electron shadow of the control grid wires. By such alignment, the screen grid wires will not be in the direct path of the electron stream. The screen grid current is thereby minimized and the output characteristics are generally improved.

Properly aligned condition of the control and screen grids is characterized by the appearance of a symmetrical pattern formed by the grid windings which lends itself to visual checking either with the naked eye or with the aid of a microscope. At the time of checking, manual adjustments may be made where found necessary for proper alignment. To insure such proper alignment, it is therefore important that during assembly of the tube the full length of the control and screen grids be visible and accessible for adjustment until securely fixed in position.

In addition to the electrical power output requirements, there are many applications where physical structure with greater than normal ability to resist mechanical shock and vibration is required. It becomes difficult to achieve such a structure which also permits the desirable full length inspection and alignment during assembly. Satisfying these requirements is further complicated in tubes of miniature size and smaller. In such small envelope tubes, space requirements prevent the use of conventional support rods protruding from the tube base or button as the rigid nucleus or starting point for assembly. Also, because tubes of this size must be produced at low cost for commercial reasons, a relatively simple structure adaptable to easy and rapid production line methods of assembly is essential.

Pursuant to the present invention, a structure has been obtained incorporating the above desirable features even in tubes of miniature size or smaller. This is achieved generally by using a two-section anode and combining one of the

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anode sections with the cathode and grid positioning spacers to form a rigid jig-like construction. In the present embodiment two flanged half sections for the anode are used. One of the half sections is provided with projections or tabs at its upper and lower ends. The tabs of this half section are fitted into receiving slots for this purpose in the top and bottom spacers. The tabs are then bent over thereby providing a sub-assembly sufficiently rigid to form the support and nucleus for proper fixing, alignment and setting of the grids. After the grids have been aligned, the second half section of the plate is then set in place with its flanges located on the flanges of the first-mentioned half of the plate. The second half of the plate is also provided with a projection or tab at each of its ends. These tabs fit into locating slots on the periphery of the spacers thereby properly locating the second half of the plate with respect to the first half. The side flanges are then welded together in a finished rigid subassembly which, together with the support of the spacers against the wall of the envelope, is capable of withstanding relatively high shock loading and abuse without malfunctioning. Properly located recesses in the second half of the plate also provide for final rough-checking of the alignment of the grids. These recesses also insure proper gas evacuation in subsequent rapid manufacturing operations in the sealing of the envelope.

To further increase the rigidity of the assembly, metal rods may be inserted between the flanges of the plate half sections. By making these rods sufficiently long to extend through holes for this purpose through both the top and bottom spacer and welding the flanges integrally with these rods, increased shock resistance of the structure may be achieved.

To insure a low order of grid plate capacitance and particularly to minimize the capacitive effect of the anode tabs protruding through the spacers, a novel arrangement for internal shielding has been provided. The shield consists generally of a circular plate having a substantially rectangular center portion opening. The four sides of the rectangular portion are formed downwardly to define walls resting on the top spacer. These walls are located so that together with the circular plate portion they isolate the protruding plate tabs from the protruding grid rods which are located in the rectangular center portion. The substantially rectangular portion has diagonal flanged corners. The flanges protrude downwardly and are fixed as by welding to pro-

truding tabs from beam confining plates within the above subassembly. The shield being held firmly in place in this manner also provides support for a getter which is fixed to the plate portion as by welding. An opening across the entire circular plate and extending from the rectangular center portion through the outside rim provides an electrical discontinuity in the shield for minimizing eddy current formation.

In addition to suitable shielding at the bottom spacer, an interlead shield is used at the base of the tube and shields the grid stem lead from the plate stem lead. These and other advantages, features, and objects of the invention will become more apparent from the following description taken in connection with the accompanying drawings wherein:

Fig. 1 is a cutaway isometric view with a half section of the anode plate detached and shown separately for more clearly illustrating the general construction of the invention;

Fig. 2 is a fragmentary view of a typical control grid and screen grid arrangement for illustrating proper alignment;

Fig. 3 is a fragmentary cross-sectional view of the upper and lower segments of the embodiment in Fig. 1 taken on line 3—3 of Fig. 4 for more clearly illustrating the internal shielding and other structural features of the invention; and

Fig. 4 is a view taken on line 4—4 of Fig. 3.

Referring first to Fig. 2, control grid support rods 10 and screen grid support rods 12, portions of which are shown in Fig. 2, hold the control grid wires 14 and screen grid wires 16, respectively, in position by grooves 18 suitably spaced on the support rods 10 and 12. The positions of the control grid and screen grid wires in Fig. 2 are shown in proper alignment. In the case of proper alignment as shown in Fig. 2, it is noted that the control grid wires 14 and screen grid wires 16 present a distinctive pattern wherein corresponding turns, though nearly parallel, appear to intersect at the center line 20 which corresponds to the axis of cathode 44 (Figs. 3 and 4). Because of the distinctiveness of this pattern, the alignment of these grid wires may readily be checked visually. Thus if the control grid wires 14 are too high, the point of intersection with the corresponding screen grid wires will appear to the left of the center line 20 and more of each control grid wire 14 will be visible above the corresponding screen grid wire 16 to the right of the point of intersection than is visible below the screen grid wire 16 to the left of the point of intersection. When the control grid wires 14 are too low with respect to the screen grid wires 16, the pattern will appear just opposite to that explained above. Alignment may usually be secured by moving the control grid support rods 10 or screen grid support rods 12 in the proper direction, up or down, with respect to each other. Since the grooves 18 are evenly spaced and firmly hold the grid wires, such corrective movement may align all of the grid wires simultaneously. Such adjustment is more easily accomplished when the full length of the grid windings is visible, since it permits direct checking of all turns rather than depending upon uniformity pitch of the individual grids which would be necessary if control of alignment were dependent upon a small number of turns visible through a small inspection gap.

It should be noted that the screen grid wires 16 are supported in grooves 18 at a single point on the support rods 12 and extend laterally for some distance to clear the control grid wires 14 before making an angular turn to then run in a plane parallel to that of the control grid wires. This may be seen at 22 in Fig. 1. During manufacture and/or subsequent handling before assembly, it often happens that individual turns of the screen grid wires 16 become bent near the support point of grooves 18 thereby varying the effective spacing between wires 14 and 16. As a result, these bent portions are not properly aligned even after the support rods 10 and 12 are properly positioned. These misaligned portions may be discovered by visual inspection and may be individually corrected manually as with a suitable stylus. Such adjustment of these individual portions provides not only for improved operation of the tubes, but also for insuring that all similar tubes will have similar operating characteristics within close tolerances. In the present invention, such corrective adjustment is insured by a construction which permits manual access to and visual inspection of the entire length of the grid coils during assembly. This construction at the same time is sufficiently rigid to withstand relatively high shock loading.

Referring to Figs. 1 and 4, the anode consists of two circular half sections 24 and 26 having flanges 28 and 30, respectively, extending laterally at the sides of each of the plate half sections. The flanges 28 and 30 also have preferably circularly formed grooves 32 conforming to reinforcing rods 34 fitting between the respective flanges 28 and 30. The plate half section 24 also has at one end three projections or tabs 36, 38 and 40 (Fig. 4). Similarly, it has three projection tabs at its other end, only one of which is visible in Fig. 3 at 42. During assembly, cathode 44, control grid support rods 10, screen grid support rods 12, projections or tabs 46 (Fig. 4) on both ends of beam confining plates 48 and 50 (Fig. 1) and the above-mentioned projections or tabs on both ends of the anode half section 24 are inserted in corresponding holes shaped to receive these elements in spacer plates 52 and 54 of insulating material such as mica. By bending tabs 36 and 40 of the plate half section 24 which protrude through spacer plate 52, as shown in Fig. 4, and by similarly bending similar tabs (not shown) at the bottom end of the plate half section 24 protruding through the bottom spacer plate 54, a rigid unitary sub-assembly is achieved. Since, at this stage of assembly, the other half plate section 26 is not in position, it may be seen in Fig. 1 that the control and screen grid wires 14 and 16 are visible on both sides of support rods 10 and 12 the full length of the grid windings. The control grid support rods 10 and screen grid support rods 12 may, at this point, be moved relative to each other to generally align the grid windings as explained above. While the frictional contact between the spacer plates 52 and 54 and the protruding grid support rods 10 and 12 is sufficient to retain this alignment during subsequent assembly operations, it may be further insured by anchor straps 53 and 55 being fixed through opening 57 in the spacer plates 52 and 54 and to the support rods 10 and 12, respectively, as by welding. This sub-assembly may then have attached thereto an electrostatic shield 56 (Figs. 1 and 3) as by welding of the diagonal projections 58 (Figs. 3 and 4) at the corners of a rectangular opening in shield 56 to tabs 46 (Fig. 4) of the beam confining plates 48 and 50 pro-

truding through the top spacer plate 52. Bottom shield 60 (Fig. 3) may then also be attached by welding of similar diagonal portions to the bottom tabs (not shown) on beam confining plates 48 and 50 protruding through the bottom spacer plate 54. At this time also, button 62 containing suitable electrical stem leads and shield 64 for shielding grid stem lead 66 from plate stem lead 68 may be electrically attached to the sub-assembly as by directly welding the appropriate stem lead pins to the desired point or by welding connectors 70 between the desired points as shown in Fig. 3. As the final step before insertion in the envelope 72, the grid wires may be visually checked and individually adjusted as described above and the other plate half section 26 may be inserted in place and its flanges 30 fixed to flanges 28 and reinforcing rods 34 as by welding. A projection or tab 74 and a projection or tab 76 are provided at each end of the plate half section 26. The tabs 74 and 76 fit into slots 78 and 80, respectively, in the top and bottom spacers 52 and 54. This arrangement facilitates rapid production line assembly of the plate half section 26 to the plate half section 24 and also adds additional rigidity to the assembled structure. Recesses 82 at the bottom of the plate half section 26 provide both a rough means for checking of the final alignment of the grids after assembly and also serve to insure proper evacuation of the space within the anode plate enclosure in the rapid subsequent processing operations.

The shield 56 above the top spacer 52 has a rectangular opening or center portion with walls 84 at each of its four sides. The walls 84 enclose the cathode 44 and projecting grid support rods 10 and 12, and, together with the top plate-like portion 86, electrostatically shield them from the plate tabs 36, 38 and 40, and 74 and the protruding portions of reinforcing rods 34. A slot or opening 88 (Fig. 1) is provided through the flat portion 86 of the shield 56 and extends through the rectangular center wall portion 84 thereby creating an electrical discontinuity for minimizing eddy current formations and reducing the consequent heating effects under high frequency processing conditions thereby preventing melting of the shield and consequent leakage from volatilized metal. A getter 90 is secured in place on the flat portion 86 of the shield 56.

The interlead shield 64 rests on or near the surface of the button 62 and is electrically connected to the cathode stem lead 92 (Fig. 1) and on the opposite side of button 62 to an interlead shield stem lead maintained at cathode potential. The capacitive effects of the interlead structure are thereby reduced and become an important reduction under high frequency operation. This construction with its desirable low capacitances and efficient power output characteristics under high frequency conditions has been found to also have desirable shock-resisting characteristics. It has withstood shock-loading tests involving 40 blows with each blow causing an effect equivalent to more than 500 times the acceleration of gravity.

What is claimed is:

1. A beam power tube comprising an envelope, and an anode, a cathode, grids, and spacers positioning said cathode and grids in said envelope, said anode including a first and a second flanged sections, said first section having tabs fastened to said spacers, said second section being unattached to said spacers and being arranged to fasten to said first section at said flanges, thereby permitting full length visual inspection and alignment of said grids during assembly of said electron tube.

2. A beam power tube comprising an envelope, and an anode, a cathode, grids, and spacers positioning said cathode and grids in said envelope, said anode including a first and a second sections having laterally extending flanges for fastening said sections together, tabs at the extremities of said first section fixed to said spacers, and means permitting attachment of said second section to said first section after assembly of said grids and said first section in said spacers, thereby permitting full length visual inspection and alignment of said grids before assembly of said second section to said first section.

3. A beam power tube comprising an envelope, and an anode, a cathode, beam confining plates, grids, a top and a bottom spacer in said envelope, said spacers positioning said cathode, beam confining plates and grids and including openings for tabs, said anode including a first and a second sections having laterally extending flanges, tabs at the extremities of said first section, the tabs at one extremity of said first section fixed in corresponding openings in said top spacer, the tabs of the other extremity of said first section fixed in corresponding openings in said bottom spacer, a tab at each extremity of said second section located in corresponding recesses of said top and bottom spacers, said recesses extending to the edges of said spacers, means fastening said second section to said first section at said flanges, thereby permitting full length visual inspection and alignment of said grids during assembly of said tube.

4. For a beam power tube, spacer plates, a curved anode structure between said spacer plates, said anode structure including two half sections having flanges extending laterally therefrom, projections at the extremities of a first of said half sections, said projections being in rigid engagement with said spacer plates, projections at the extremities of a second of said half sections, said last-mentioned projections being in locating engagement with said spacer plates, thereby permitting full length visual inspection and alignment of grids within said anode structure during assembly of said tube.

5. For a beam power tube, top and bottom spacer plates, a curved anode structure between said spacer plates, said anode structure including two half sections having flanges extending laterally therefrom, projections at the extremities of a first of said half sections, openings in said spacer plates conforming to the cross-section of said projections receiving said projections and providing rigid engagement between said first half section and said spacers, projections at the extremities of a second of said half sections, recesses in said spacer plates adapted to position said second half section with respect to said first half section, said recesses extending to the edges of said spacers, thereby permitting full length visual inspection and alignment of grids within said anode structure during assembly of said electron tube.

6. For a beam power tube a shield comprising a flat plate section, a substantially rectangular recess formed at the center of said flat plate section, said rectangular recess defining four side walls extending downwardly from said plate sec-

tion, projections extending downwardly at the corners of said rectangular recess for providing support and electrical connection with beam confining plates in said tube, and an opening from said rectangular recess through said flat plate section for providing electrical discontinuity in said shield.

7. For a beam power tube, a shield comprising a circular flat plate section, a substantially rectangular recess formed at the center of said flat plate section, said rectangular recess defining four side walls extending downwardly from said plate section, and projections extending downwardly at the corners of said rectangular recess for providing support and electrical connection with beam confining plates in said tube.

8. An anode structure comprising a first and a second curved plate sections surrounding a cathode and grid structure, flanges at the sides of said plate sections for fastening said sections together, projections at the upper and lower ends of said first section, disks of insulating material for positioning said cathode and grid structure and having orifices for receiving said projections, said positioning disks being fixed to the upper and lower ends of said plate section by said projections, projections at the upper and lower ends of said second plate section, and slots extending in from the edges of said positioning disks for receiving said projections of said second plate section and locating said second plate section with respect to said first plate section.

9. In a beam power tube, an envelope, and an anode, a cathode, beam confining plates, grids and electrostatic shielding in said envelope, said anode including a first and a second curved plate sections for surrounding said cathode and grids and beam confining plates, flanges at the sides of said plate sections fastening said sections together, projections at the upper and lower ends of said first section, disks of insulating material for positioning said cathode, grids and beam confining plates and having orifices for receiving said projections, said positioning disks being fixed to the upper and lower ends of said first plate section by said projections, projections at the upper and lower ends of said second plate section, and recesses in said positioning disks for receiving said projections of said second plate section and locating said second plate section with respect to said first plate section.

10. In a beam power tube of the type having an anode, a cathode, beam confining plates, grids, and spacer plates pierced by projections of said anode, cathode, beam confining plates and grids, an electrostatic shield between said anode projections and said grid and cathode projections including a flat plate section above said anode projections, a substantially rectangular opening in said flat plate section defining four side walls extending downwardly from said plate section and between said plate projections and said cathode and grid projections, and projections extending downwardly at the corners of said rectangular recess for providing support and shielding connection with said beam deflecting plate projections in said tube, and an opening from said rectangular recess through said flat plate section for providing electrical discontinuity in said shield.

11. In a beam power tube of the type having an anode, a cathode, beam confining plates, grids, and spacer plates pierced by projections of said anode, cathode, beam confining plates and grids, an electrostatic shield between said anode projections and said grid and cathode projections, said shield having a split construction for providing electrical discontinuity thereby minimizing eddy current formations in said shield.

12. A beam power tube comprising an envelope, and an anode, a cathode, grids, and spacers positioning said cathode and grids, said anode including a first and a second flanged sections and reinforcing rod segments between the flanges of said sections, said first section having projections at its ends fastened to said spacers, said second section being arranged to fasten to said first section and said rods at said flanges, thereby providing a rigid construction permitting full length visual inspection and alignment of said grids during assembly of said electron tube.

13. For a beam power tube, a shield for providing electrostatic shielding between anode projections and grid and cathode projections in said tube, said shield comprising a flat plate section, and an opening formed at substantially the center of said flat plate section, the perimeter of said opening defining side walls extending downwardly from said flat plate section for positioning between said anode projections and said cathode and grid projections and for providing electrical connection with beam confining plates in said tube.

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