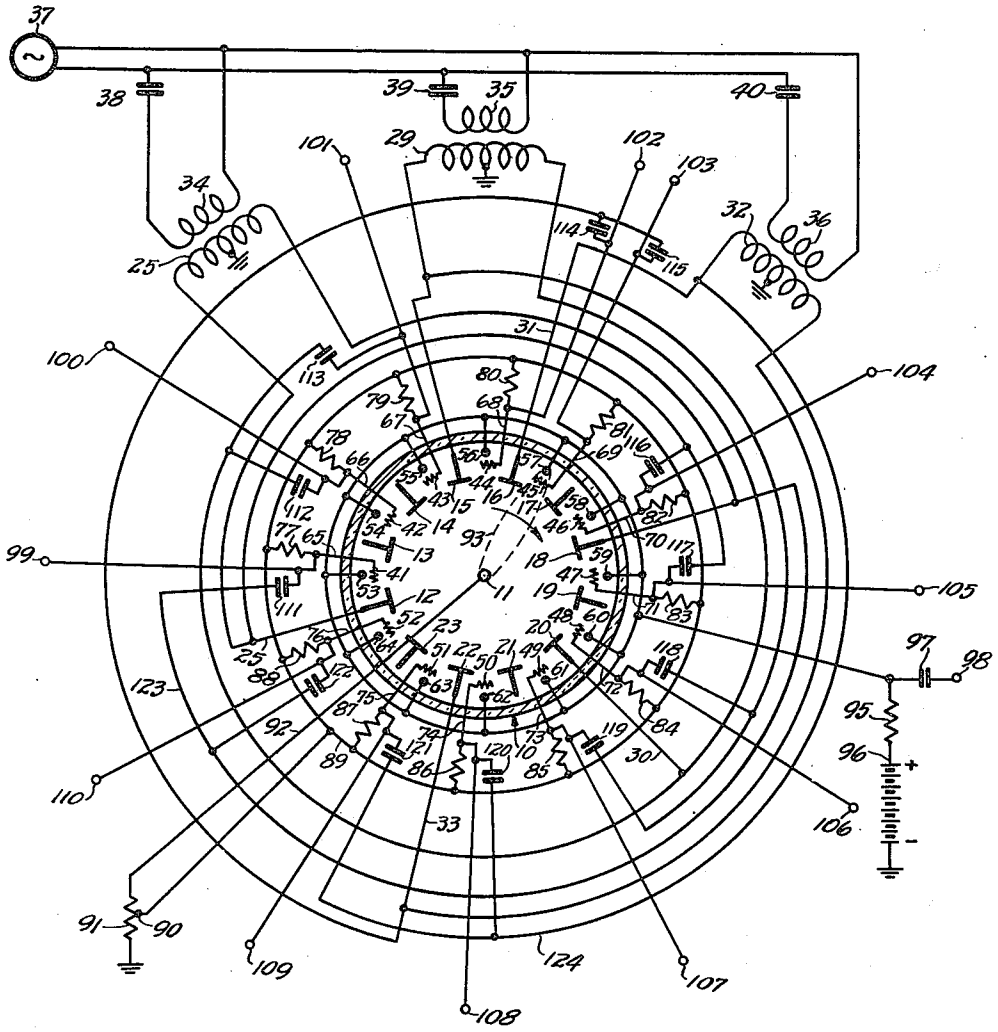
Dec. 2, 1952 A. M. SKELLETT 2,620,454

FOCUSED RADIAL BEAM ELECTRON TUBE

Filed April 5, 1950 2 SHEETS—SHEET 1

FIG. I.



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FIG. 2.

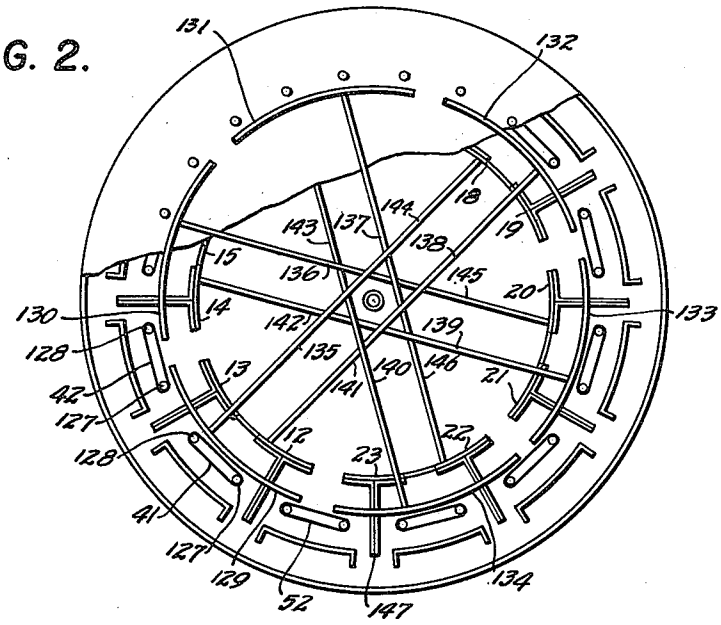
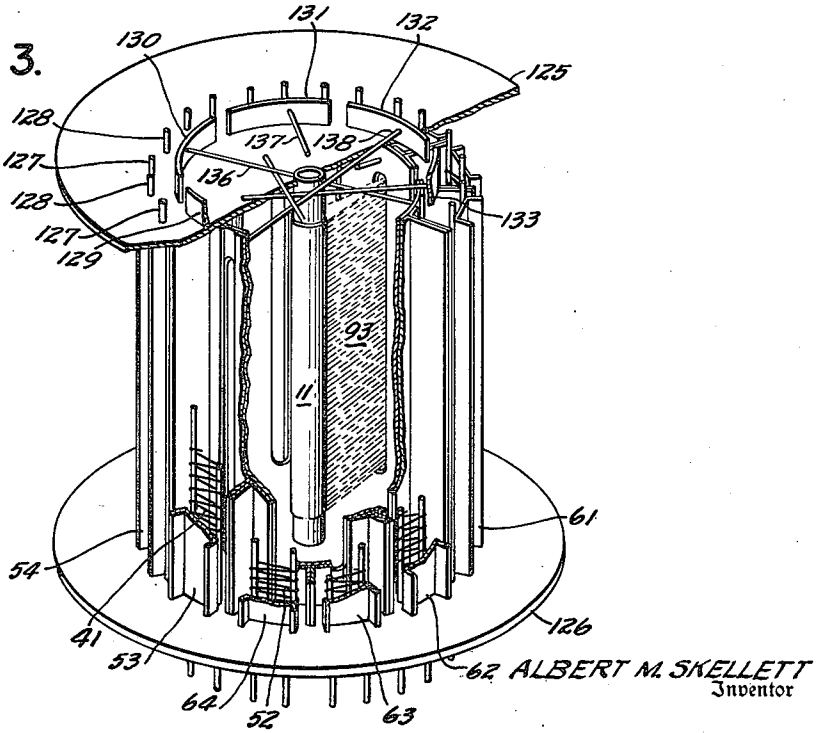


FIG. 3.



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FOCUSED RADIAL BEAM ELECTRON TUBE

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10 Claims. (Cl. 315—21)

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This invention relates to electron tubes of the rotating focussed radial beam kind.

A principal object of the invention is to provide an improved tube of the concentric cathode focussed rotary beam type, such as disclosed for example in U. S. Patent No. 2,433,403, and further described in detail in the "Proceedings of the I. R. E.," Volume 36, Number 11, November 1948.

A feature of the invention relates to a concentric cathode focussed radial beam tube having a series of slotted screen electrodes energized by polyphase current, certain of the screen electrodes being electrically interconnected to the control electrodes of the tube to improve the operating characteristics thereof.

Another feature relates to a concentric cathode focussed radial beam tube having a series of slotted screen electrodes arranged in sets concentrically around the cathode, and a series of input control grids concentrically arranged around the screen electrodes in radial alignment with the screen slots; together with special capacitive plates or elements for cross-connecting the grid and slat elements to improve the operating characteristics of the tube.

A further feature relates to the novel organization, arrangement and relative interconnection of parts which cooperate to provide an improved electron tube of the concentric focussed rotary beam type.

Other features and advantages not particularly enumerated, will be apparent after a consideration of the following detailed description and the appended claims.

In the drawing,

Fig. 1 is a schematic diagram of a tube and associated circuits according to the invention.

Fig. 2 is a top plan view of a modification of the tube of Fig. 1.

Fig. 3 is a front elevational view, partly broken away, of the tube of Fig. 2.

Referring to Fig. 1, numeral 10 represents the evacuated enclosing bulb or envelope of a focussed radial beam tube, such as disclosed in U. S. Patent No. 2,433,403 and in the "Proceedings of the I. R. E.," Volume 36, Number 11, November 1948, to which reference can be had for a detailed description of the construction of such a tube. The tube comprises a central rod-like or cylindrically-linear cathode 11 which is arranged to be raised to thermionically-emissive temperature by a suitable heater element (not shown). Concentrically surrounding the cathode is a series of screen elements consisting, for example, of a series of twelve equally-spaced metal slat members 12—23. These slat members are mechanically formed as a unit in pairs. For example, one pair may comprise the slats 12, 13, with a slot 24 between each pair. For convenience in manufacture, the elements 12, 13, may be formed of a single cylindrically-arcuate metal plate, as described in the above-noted references, with the elongated slot or window 24 cut centrally out of the body of the plate. In other words, the two slats of each pair are electrically at the same potential. Thus in the particular example shown, there are twelve slats, and the slats are equally spaced, thus providing twelve equally circumferentially spaced windows 24.

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Each slotted plate is connected to one terminal of the secondary winding of an exciting coil, the opposite terminal of this coil being connected to the radially-opposite slotted plate. Thus the slotted plate formed of slats 12, 13, is connected by an appropriate lead-in conductor 25 to one end of the transformer winding 26. The opposite end of this same winding is connected through lead-in conductor 27 to the diametrically opposite slotted plate formed of slats 18, 19. Likewise the slotted plate formed of slats 14 and 15 is connected by lead-in conductor 28 to one end of excitation coil 29, the other end of which is connected to lead-in wire 30, and thence to the slotted plate constituted of slats 19 and 29. Similarly, the slotted plate formed of slats 16 and 17 is connected through lead-in conductor 31 to one end of the excitation winding 32, the opposite end of which is connected through lead-in conductor 33 which connects to the slotted plate formed of slats 22, 23.

The windings 26, 29 and 32 may form the secondary windings of respective excitation transformers whose primary windings 34, 35, 36, are excited from the single-phase alternating current source 37. However by means of the corresponding condensers 38, 39, 40, the single-phase supply is split into six phases, the mid-points of the secondary windings 26, 29 and 32 being electrically grounded.

Also concentrically surrounding the various slotted plates are twelve control grids 41—52, each of these grids being in radial alignment with a corresponding one of the twelve windows 24. Also mounted in alignment with each of the control grids is a respective one of the twelve anodes 53—64. Each of the control grids is provided with a separate one of the twelve lead-in conductors 65—76. Each of these grid lead-ins is connected through the respective resistors 77—88 which are returned in multiple through the com-

mon conductor 89, and thence to ground through adjustable contact arm 90 of a potentiometer resistor 91. The cathode 1 is also connected through its lead-in 92 to the ungrounded end of resistor 91. The resistor 91 therefore acts to provide the grid bias and beam focussing voltage for the electron beam 93, as described in the above-identified reference publications. The anodes 53—64 are connected in multiple by means of conductor 94 through the anode load resistor 95, and thence to the positive terminal 96 of the conventional direct current plate power supply. The various voltages developed across the load resistor 95 are coupled through condenser 97 to the output terminal 98. Each of the control grids is provided with a separate input terminal 99—110 which can be connected to respective signal supply circuits.

As explained in the above-identified publications, by proper adjustment of the bias on the cathode 1, and by means of the polyphase excitation of the slat electrodes 12—23, the electron beam 93 is focussed upon each respective anode in succession, and the beam is continuously rotated at a predetermined fixed rate.

Since the control grids 41—52 are relatively close to the slat electrodes 12—23, and since these latter electrodes are directly excited from the polyphase alternating current supply circuit, there is a certain amount of capacity coupling between each control grid and the associated slat electrodes. When the input impedance of each grid circuit is very high, the control grids pick up a certain percentage of the polyphase excitation current, and tend to drive the control grids positive with respect to the cathode 1, so that these control grids then tend to collect some of the beam current. This effect detracts from the desirable operation of the tube and may affect the focussing of the beam.

Since the slat electrodes in the particular embodiment disclosed are arranged in pairs, with the slats of each pair at the same potential, and since these slats are connected to the opposite ends of the respective excitation coils 26, 29 and 32, for any given slat electrode, for example electrode 12, the diametrically-opposite slat electrode 18 is at the same potential, but 180 degrees out of phase. In other words, as concerns any particular control grid, for example grid 41, the opposite slat electrode 18 is as much negative as the near slat electrode 12 is positive, or vice versa. In accordance with the present invention, this phenomenon is taken advantage of, to improve the operation of the tube. For this purpose, each of the control grids 41—52 has connected thereto a respective capacitor 111—122. Each capacitor is also connected to the diametrically-opposite slat electrode. Since the slat electrodes are in unipotential pairs, likewise each of the control grids are connected in pairs through a common conductor to the opposite slat electrode. For example, the control grids 41 and 52 are connected through their respective condensers 111, 112, to conductor 123, and thence to slat electrode 18. Likewise, control grids 50, 51, are connected through their respective condensers 120, 121, and thence by conductor 124 to slat electrode 16. Preferably, although not necessarily, the condensers 111—122 are adjustable or trimmer condensers, and they can be adjusted so that they balance-out the undesired capacity coupling between each pair of slat electrodes and the corresponding control grids which are located adjacent thereto.

Figs. 2 and 3 show a modification of Fig. 1, wherein the above-described effect is achieved by incorporating the condenser elements 111—122 structurally within the tube. The parts of Figs. 2 and 3, and the corresponding functionally identical parts of Fig. 1 are numerically designated alike. The various electrodes are assembled and held in the proper spaced relation by upper and lower mica discs 125, 126, in the manner well known in the electron tube art. Merely for clarity in Figs. 2 and 3, the enclosing evacuated bulb 19 (Fig. 1) is omitted. The control grids 41—52 may each be of the well-known side rod support type, each comprising a pair of parallel side rods 127, 128, and around each pair is helically wound the usual fine grid wire. All of the grid side rods extend upwardly a substantial distance beyond the mica 125. Suitably anchored to the mica 125 is a series of six arcuate metal plates 129—134 which are spaced from each other as shown, and are disposed in rather close but spaced relation to respective grid side rods. Thus the plate 129 is adjacent the side rods of grid 41 and may also extend so as to be adjacent one of the side rods of the adjacent grids 42, 52. The plates 129—134 are cross-connected by metal straps 135—146 to the diametrically opposite respective pairs of slat electrodes. For example, plate 129 is connected by strap 135 to the diametrically opposite slat electrodes 18, 19. Likewise the plate 130 is connected by strap 136 to the diametrically opposite slat electrodes 20, 21; the plate 131 is connected by strap 137 to the diametrically opposite slat electrodes 22, 23; the plate 132 is connected by strap 138 to the diametrically opposite slat electrodes 12, 13; the plate 133 is connected by strap 139 to the diametrically opposite slat electrodes 14, 15; and finally the plate 134 is connected by strap 140 to the diametrically opposite slat electrodes 16, 17.

Because of the close spacing of the curved plates with respect to their adjacent grid side rods, they act in the nature of coupling condensers corresponding functionally to the condensers 111—122 described above in connection with Fig. 1. They therefore act to feed back to each grid a potential derived from the potential of the diametrically opposite pair of slat electrodes. Since diametrically opposite slat electrodes are 180° out of phase, it is clear therefore that the induced potential on any given grid, as a result of the undesirable coupling with the adjacent slat electrodes, is compensated for by an equal and opposite voltage derived from the diametrically opposite slat electrodes.

It will be observed that the anodes 53—64 are in the form of channeled metal member, and that the slat electrodes have radially-extending fins 147, etc., thus providing effectively an enclosed chamber for each control grid, so that the rotating electron beam 93 can act on only one grid at a time as the beam is being rotated.

While certain embodiments have been disclosed herein, it will be understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A radially focussed rotary beam tube comprising a central electron-emitting cathode, a plurality of spaced electrodes surrounding the cathode forming a corresponding plurality of windows and polyphasally-excited with diametrically-opposite electrodes 180 degrees out of phase, a plurality of control grids and anodes

surrounding said electrodes, and electrostatic plates, one for each grid and electrostatically coupled thereto and also conductively connected to a diametrically-opposite one of said electrodes for neutralizing undesired inherent electrostatic capacity between each control grid and the adjacent one of said electrodes.

2. A radially focussed rotary beam tube, comprising a central electron-emitting cathode, a plurality of apertured electrodes surrounding said cathode, a plurality of control grids surrounding said apertured electrodes, output anode means also surrounding said apertured electrodes, circuit connections including a source of polyphase alternating current to energize said apertured electrodes with respect to the cathode to focus the electrons into a rotating beam to sweep said grids in succession, and electrostatic coupling means to compensate for undesired capacity coupling between each control grid and the adjacent apertured electrode, said coupling means comprising a series of conductive elements each element being mounted in spaced electrostatic coupled relation to a corresponding one of said grids and being conductively connected to one of said apertured electrodes which is of opposite phase.

3. A radially focussed rotary beam tube, comprising in combination a central cathode, a plurality of arcuate spaced apertured electrodes surrounding the cathode, a plurality of control grids each in proximity to a corresponding apertured element, a source of polyphase alternating current connected to said apertured elements to cause said beam to rotate, said source exciting said apertured elements in pairs and substantially in phase opposition, and means interconnecting each grid with an apertured element of opposite phase to neutralize the inherent capacity coupling between each grid and its corresponding apertured element of the same phase.

4. A radially focussed rotary beam tube, comprising an electron tube of the focussed rotary beam type arranged to be excited from a polyphase alternating current source to control the rate of beam rotation and including a central electron-emitting cathode, a series of aperture-defining plates concentrically surrounding the cathode, a series of grids each in alignment with a corresponding one of said apertures, a plurality of anodes each in alignment with one of said grids, and electrostatic means coupling each grid to a substantially diametrically opposite aperture-defining plate to neutralize the inherent capacity between each grid and its corresponding aligned plate.

5. Apparatus according to claim 4, in which said electrostatic means comprises a condenser electrically connected between each grid and a substantially diametrically opposite apertured electrode.

6. Apparatus according to claim 4, in which said electrostatic means comprises a series of spaced metal plates each located adjacent one of said grids and electrically connected to a substantially diametrically opposite apertured electrode.

7. A focussed rotary electron beam tube comprising an evacuated vessel containing an electron-emitting cathode, a series of aperture-defining plates concentrically surrounding said cathode said plates being arranged in pairs for connection to the corresponding phases of a polyphase alternating current source, a series of control grids each in alignment with one of said apertures, anode means surrounding said grids, and a plurality of discrete metal plates each mounted adjacent one of said grids and cross-connected to a substantially diametrically opposite aperture-defining plate.

8. A focussed rotary electron beam tube according to claim 7, in which the aperture-defining plates are in pairs connected respectively to a corresponding one of the phases of a polyphase alternating current source so as to be in substantial phase opposition.

9. An electron tube comprising a central electron-emitting cathode, electrode means defining a plurality of spaced apertures concentrically surrounding said cathode, a series of control grids each grid in alignment with a corresponding one of said apertures, a plurality of output anodes each anode in alignment with a corresponding one of said grids, each of said grids having at least one side rod support, a plurality of discrete metal plates each mounted adjacent one of said side rods and cross-connected directly to a substantially diametrically opposite one of said aperture-defining electrodes.

10. Electron tube apparatus comprising a central substantially linear electron-emitting cathode, a plurality of slat electrodes defining a series of equally-spaced apertures surrounding said cathode, a source of polyphase alternating current, means connecting diametrically opposite slat electrodes to a corresponding one of the phases of said source so that said diametrically opposite slat electrodes are in substantial phase opposition, a control grid adjacent each slat electrode, an anode adjacent each control grid, and electrostatic plates mounted in proximity respectively to said control grids, each electrostatic plate being conneteced to a slat electrode which is substantially in opposite phase with respect to the slat electrode adjacent said electrostatic plate.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,432,608	Desch et al.	Dec. 16, 1947

FOREIGN PATENTS

Number	Country	Date
590,463	Great Britain	July 18, 1947