

May 30, 1939.

V. L. RONCI ET AL

2,160,086

ELECTRON DISCHARGE DEVICE

Filed Dec. 5, 1936

FIG. 1

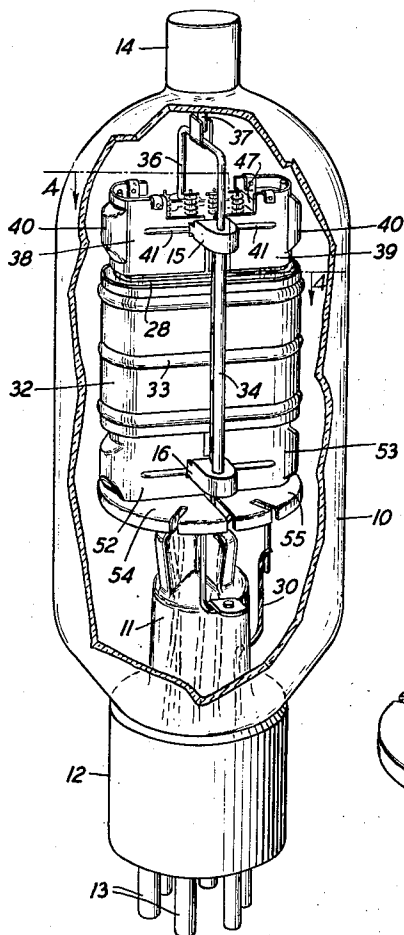


FIG. 2

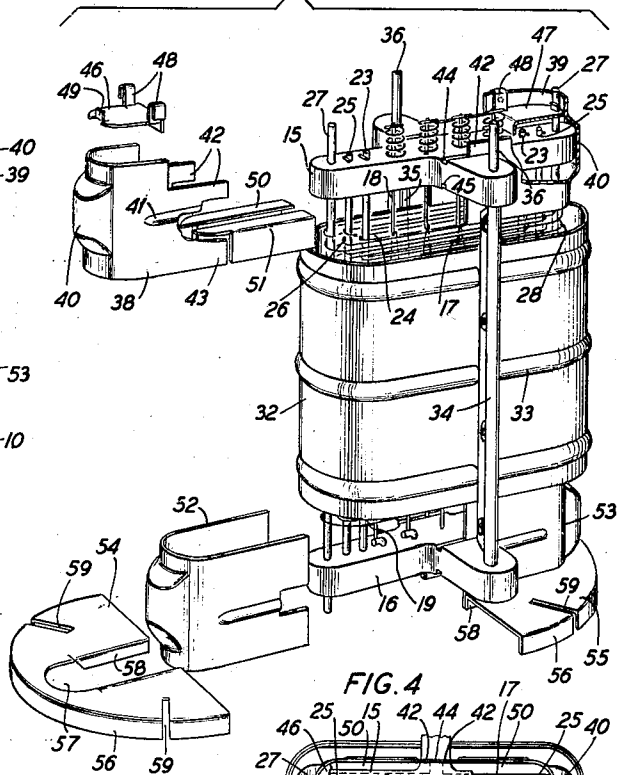


FIG. 4

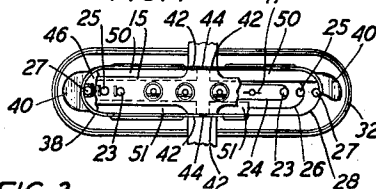


FIG. 5

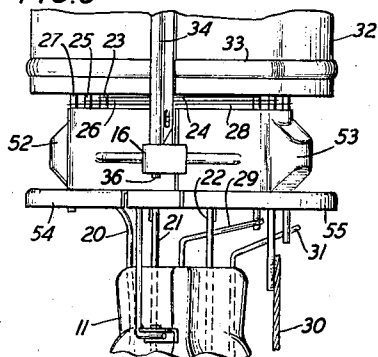
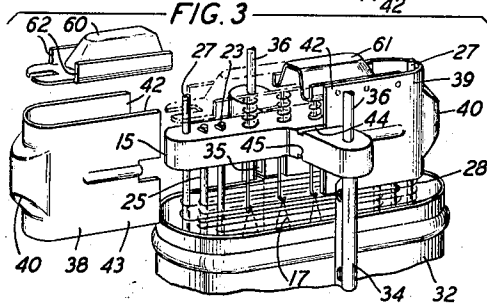


FIG. 3



INVENTORS: V. L. RONCI
J. W. WEST
BY

Oralter C. Kiesel
ATTORNEY

UNITED STATES PATENT OFFICE

2,160,086

ELECTRON DISCHARGE DEVICE

Victor L. Ronci, Brooklyn, and John W. West,
Woodside, N. Y., assignors to Bell Telephone
Laboratories, Incorporated, New York, N. Y., a
corporation of New York

Application December 5, 1936, Serial No. 114,378

11 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices of high power efficiency.

5 In the usual power amplifier three-electrode discharge device and particularly in the pentode type device, the power output efficiency is counteracted by the effective reactance of the device due, in part, to the inter-electrode capacities present in the device. This results in a decrease
10 of amplification over the general frequency range and particularly when high frequencies are encountered. Consequently, the loss causes an unbalance between the ratio of output to input in the operation of the device and distortion occurs. In discharge devices of high power rating,
15 it will be evident that the inter-electrode capacities cause a considerable loss in operating efficiency and also change the dynamic and electrostatic characteristics of the device.

20 An object of this invention is to eliminate inter-electrode capacity, particularly between the high voltage anode and the control electrode and other cooperating electrodes in the device.

25 Another object of the invention is to annul the effect of stray fields of the anode with respect to the leading-in conductors of the various cooperating electrodes.

30 A further object of the invention is to protect the cooperating electrodes of the device from the effect of conductance paths established by the anode along the common spacer element supporting the electrodes as a unit.

35 In accordance with this invention, the discharge device comprises a unit structure of a cathode and anode and a plurality of grids interposed therebetween and spaced in suitable relation by insulating members at opposite ends and the end portions of the grids are encompassed by metallic shielding members which
40 form barriers between the anode field and the various cooperating electrodes. The shielding members prevent the establishment of collateral capacitative coupling paths between the anode and the respective associated electrodes and
45 thereby eliminate inter-electrode capacity therebetween.

50 In a specific embodiment of the device of this invention, the insulating spacer members for the electrodes are cross-shaped with the anode supports extending through pairs of arms of the spacers while a filamentary cathode and three grids have their supporting elements arranged in alignment in the other arms which are at right angles to the anode supporting arm. The
55 assembly forms a unit which is supported at one

end of an enclosing vessel by suitable leading-in conductors sealed in a stem and is supported at the other end by a bridge member which is connected to a conductor extending through the top of the vessel. This construction prevents vibration or shock affecting the spacial relationship of the electrodes and insures adequate insulating paths between the current conductors of the various electrodes. The shielding structure of this invention as applied to an assembly of electrode elements as described above, involves opposed
5 U-shaped members having guiding extensions which embrace the spacer arms supporting the grids and cathode, the extensions being seated in slots formed in the other arms of the spacer supporting the anode. These members are provided with embossments following the contour of the ends of the arms so that the end portions of the members may be secured to the supports of the outermost grid electrode to provide
10 a rigid assembly. One feature of the split construction of the shields is the freedom from deleterious heating effect during the exhaust treatment of the electrode unit when high frequency induction heating is employed to expel occluded
15 gases from the electrode material.

20 The shielding structure at the top of the electrode assembly, which is adjacent the current conductor of the anode, is provided with channel inserts which extend along parallel sides of the shield members and form a barrier in the space between the insulator edge and the wall of the U-shaped shield members. These inserts are arranged adjacent the lower surface of the cross-shaped insulator and prevent the establishment
25 of capacity paths intermediate the spacer and shield in a direction parallel to the axis of the electrode unit.

30 Another feature of this shielding section is the provision of separate cover shields arranged at the ends of the spacer arms, which are seated in the curved portions of the U-shaped members to enclose the ends of the grid supporting members and protect them from the effects of the capacity field. A modification of the latter feature comprises flanged hoods which completely
35 enclose all the extending supporting portions of the grids and the cathode positioned in the arms of the spacer member.

40 Another feature of the shielding structure relates to the assembly at the bottom of the electrodes in which the U-shaped shields are provided with semi-circular wings which form
45 shielding barriers between the anode and the

conductors of the other electrodes sealed in the stem.

The complete shielding arrangement effectively eliminates capacity coupling between the anode and the other cooperating electrodes and improves the amplifying properties of the discharge device even at ultra-high frequencies such as are employed in short-wave transmission and receiving systems.

These and other features of this invention will be realized from a consideration of the following detailed description taken in connection with the accompanying drawing.

Fig. 1 is a perspective view of a discharge device with the enclosing vessel broken away to represent the internal electrode assembly embodying the shielding structure of the invention;

Fig. 2 is a perspective view of the electrode unit alone with parts of the shielding structure displaced from their proper relation in the unit to clearly show the details of the assembly;

Fig. 3 shows a partial view in perspective of the electrode unit with a modified arrangement of the top shielding structure, parts of the shielding elements being shown in exploded fashion;

Fig. 4 is a top plan view partly in cross-section, taken on the line 4-4 of Fig. 1, of the device of this invention to illustrate the spacial relationship of the various electrodes and other elemental members of the electrode unit; and

Fig. 5 is a partial view in elevation of the lower end of the assembly unit to show the connection of the unit to the glass stem of the enclosing vessel.

Referring to the drawing, and particularly to Fig. 1, the electron discharge device of this invention embodies an enclosing vessel 10 having a reentrant stem 11, in which the leading-in conductors of the electrodes are sealed and brought out to a base 12 which carries a plurality of terminals 13. An electrode unit is supported within the vessel by the leading-in wires sealed in the stem 11 and by a cap terminal 14 at the top of the vessel 10. This unit comprises a plurality of electrodes mounted between cross-shaped insulating spacer members 15 and 16 to form a compact assembly. As shown in the drawing these electrodes comprise a double M-shaped filamentary cathode 17 supported in the center portion of a pair of aligned arms of the spacer members 15 and 16 by a plurality of resiliently supported hooks 18 in the upper insulator 15 and a plurality of rigidly supported hooks 19 in the lower insulator 16. The rigidly supported hooks 19 are coupled to suitable tie wires in the insulator 16 in a manner disclosed in D. A. S. Hale et al., Patent 2,019,492, issued November 5, 1935. The various sections of the double M-shaped filament are connected to three leading-in wires 20, 21 and 22 and these wires are connected to suitable terminals on the base 12 in order that the filament may be heated in series parallel relation to generate sufficient electrons from all sections of the filament to realize the desired power output of the device.

A pair of parallel wire supports 23 extend through the insulator spacers 15 and 16 on opposite sides of the cathode 17 to which is attached a flattened helical grid 24 which surrounds the filament 17. A second pair of supports 25 extend through the insulating spacers in alignment with the cathode and first grid supports and carry a second helical grid 26 coaxial with the grid 24. A third pair of supports 27 extend through the arms of the insulators at opposite ends thereof

and carry a larger diameter grid 28 having a diameter greater than the cross-section of the insulating arms of the spacers 15 and 16. It will be noted that all the supports for the cathode and the various grids are arranged linearly in opposed arms of each cross-shaped insulating spacer so that these cooperating electrodes may be effectively shielded in accordance with the purposes of this invention.

The three grids are connected to suitable leading-in conductors 29, 30 and 31 which are sealed in the stem 11 and connected to the remaining terminals on the base 12. A flattened cylindrical anode 32 surrounds the cathode and the grids and may be provided with corrugations 33 to stiffen the sheet metal. The anode consists of two similar U-shaped flanged sections held together by parallel hollow socket members 34 and 35 which extend between the transverse arms of the insulating spacers 15 and 16. The anode is held in position by an inverted U-shaped bridge member 36 which spans the top of the electrode unit and is connected to a conductor 37 at a medial point. The legs of the member 36 fit slidably in the sockets 34 of the anode. The conductor 37 is secured to the cap 14 on the top of the vessel. This arrangement of unit support permits the electrodes to expand and contract without causing distortion in the elements thereof and is more clearly described and claimed in U. S. Patent 2,105,507, issued January 18, 1938, to V. L. Ronci.

The magnitude of power dissipated by the device of this invention is exceedingly high, being of the order of 65 to 100 watts output, with the plate or anode voltage being of the order of 1000 to 1250 volts. Since the various cooperating electrodes are normally operated at low voltages, it is evident that disturbing capacitative reactances may be introduced in the operating circuit of the device by the large difference of potentials to cause distortion and unstable operation which considerably reduce the efficiency of the device. In accordance with this invention the capacitative paths between the high voltage and the low voltage electrodes of the device are materially diminished or eliminated by a system of shielding which forms a barrier between the anode and the cooperating electrodes so that the anode field does not affect the proper functioning of the cooperating electrodes or impair the efficiency of the device. This is accomplished by surrounding the ends of the grids and the cathode with enclosing shields and placing a deflector shield between the electrodes and the stem of the device to protect the leading-in conductors of the various cooperating electrodes.

In a specific embodiment of the device, as shown in the drawing, the linear arms of the upper insulating spacer 15 supporting the cathode and the various grids are encased in two U-shaped metallic shields 38 and 39 each having an embossment 40 formed in the curved portion to form a seat for the ends of the arms of the insulator 15 so that these shields form a split oval enclosure for the linear arms of the spacer 15. This arrangement facilitates the anchoring of the shields to the support rods 27 of the outermost grid 28 above and below the arms of the insulator 15 so that the shield members may be securely attached to the rods by welds. The side portions of the shield members may be provided with a longitudinal rib 41, to reinforce the metallic shields. The U-shaped shields are also provided with extensions 42 and 43 which engage

guiding slots 44 and 45 formed across the transverse arms of the spacing insulator 15 on opposite surfaces thereof. It will be noted from Fig. 4 that the dimensional width of the shielding members is substantially the same as the outermost grid 28 so that the portions of the shield members below the insulating spacer 15 form a continuation of the closely spaced turns of the outer grid 28. This arrangement effectively shields the side portions of the various grids from the anode field prevalent at the upper end of the electrode unit and, therefore, the shields form a barrier which segregates the associated grids from disturbing capacitative fields or paths leading from the anode. Furthermore, the split construction of the shields 38 and 39 prevent excessive heating in the shields when high frequency induction heating is used to free the electrodes of gases. Therefore, it is possible to use inexpensive metals for the shields instead of high melting point metals which are costly.

In the device as illustrated, the anode leading-in conductor 37 is brought in through the top of the vessel to segregate the high voltage terminal from the low voltage terminals at the other end of the device, since this terminal is connected to the anode through the bridge member 36. In order to protect the cooperating electrodes, and especially the control grid 24 and the screen grid 26, from stray fields generated adjacent the bridge member 36, the U-shaped shielding members 38 and 39 are provided with cap inserts 46 and 47 which are seated in the curved portions of the shield members and are attached thereto by bent tabs 48 and an upturned ear 49 which is welded to the grid supporting rod 27. These cap members cover the extending supports of the grids and thereby shield these grids from the effect of the stray field of the anode conductor. The grids are also protected from the effect of the anode field adjacent the anode conductor 36 by horizontal angular fins 50 and 51 which are secured to the side walls of the U-shaped shield members and span the space between the edges of the insulating arms of the spacer 15 and the walls of the shield members beneath the lower surface of the insulating spacer. These fins cut off the path between the spacer and the shield members. This arrangement effectively shields the grids of the device against all stray paths leading from the anode or the anode conductor and substantially eliminates the inter-electrode capacity effects which endanger the stability of the device.

The lowest spacer member 16 is surrounded by similar U-shaped shield members 52 and 53 which are mounted in the same manner as the members 38 and 39 to form a barrier between the supporting wires of the cathode and the grids and the anode. The leading-in wires of the various electrodes positioned in the glass stem 11 are protected at the lower end of the anode by forming a barrier therebetween to nullify the effect of the anode field and prevent capacity effects being introduced into the cooperating electrodes through the leading-in conductors. This arrangement comprises a pair of semi-circular disc shields or wings 54 and 55 which extend outwardly and are provided with a flanged edge 56 to strengthen the members. These shields have cut-out portions 57 to fit around the U-shaped shield members 52 and 53 and are attached thereto by a flanged extension 58 on opposite sides of the U-shaped shield members. These outwardly extending shield barriers are provided with slots 59 to

diminish the heating effect of the disc when the device is outgassed at a high temperature by high frequency current. The complete shielding system effectively eliminates all stray paths which might introduce inter-electrode capacity which would endanger the efficiency of the operation of the device.

In Fig. 3 is shown a modified arrangement of the upper shielding structure in which the cap members 46 and 47 and the flanged fins 50 and 51 are eliminated and the supporting members of the grids and the cathode are completely covered by a pair of sectional hood members 60 and 61 which fit into the boundaries of the U-shaped shields 38 and 39 and are attached thereto by welding the flanged portion 62 to the side walls of the shield members.

While the invention has been disclosed with respect to a specific combination of elements constituting the shielding system of this invention, it is, of course, understood that various modifications may be made in the detail assembly without departing from the scope of this invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising a vessel, an electrode unit supported in said vessel, said unit including a cathode, a grid and an anode mounted between a pair of insulating spacers, U-shaped pairs of complementary metallic members embracing portions of said spacers and having their free ends seated on other portions thereof to form enclosures around the ends of said grid for shielding the ends of the grid from the anode.

2. An electron discharge device comprising an enclosing vessel, an electrode unit supported in said vessel, said unit including an anode and other cooperating electrodes, a spacer member at one end of said unit having guiding slots therein, and opposed U-shaped shields embracing said spacer member and having portions seated in said slots.

3. An electron discharge device comprising an enclosing vessel, an electrode unit supported in said vessel, said unit including an anode and other cooperating electrodes, a spacer member at one end of said unit having guiding slots therein, and opposed U-shaped shields surrounding portions of said spacer member and said cooperating electrodes and having parallel portions seated in said slots, said shields being attached to one of said cooperating electrodes.

4. An electron discharge device comprising an enclosing vessel, an electrode unit supported in said vessel, said unit including an anode and other cooperating electrodes, a spacer member at one end of said unit for supporting said anode and said cooperating electrodes, a pair of U-shaped metallic shields embracing said spacer member, a conductor for said anode extending toward said cooperating electrodes, and metallic shielding means mounted within said metallic shields and interposed between said conductor and said unit to cut off conductive paths between said conductor and said cooperating electrodes.

5. An electron discharge device comprising a vessel having a stem, an electrode unit supported from said stem, said unit including a cathode, a grid and an anode mounted between insulating spacer members, leading-in wires in said stem for said cathode and said grid, a leading-in wire extending from the opposite end of said vessel for said anode, metallic shields embracing said spacer members and forming enclosures around the

ends of said grid, said shields having portions spaced from said members, and shielding inserts for said embracing shield remote from said stem blocking the space between said shield portion and the adjacent spacer member to serve as electrostatic barriers between said anode leading-in wire and the end of said grid adjacent thereto.

6. An electron discharge device comprising a vessel having a stem, an electrode unit supported from said stem, said unit including a cathode, a plurality of grids, an anode, and spacing insulators at opposite ends thereof, means for supporting said cathode and said grids in a line along one dimension of said insulators, means for supporting said anode in a transverse line in said insulators, U-shaped metallic shields enclosing portions of said insulators and said grids, said shields having embossed portions forming pockets for the ends of said insulators, and additional shielding members attached to said U-shaped shields at opposite ends of said unit.

7. An electron discharge device comprising a vessel having a stem, an electrode unit supported from said stem, said unit including a cathode, a plurality of grids, an anode, and spacing insulators at opposite ends thereof, means arranged in a line along one dimension of said insulators for supporting said cathode and said grids, means in a transverse line in said insulators for supporting said anode, a conductor for said anode remote from said stem, upper and lower U-shaped shields embracing said insulators and said grids, and metallic means carried by said upper shield interposed between said grids and the anode conductor.

8. An electron discharge device comprising a vessel having a stem, an electrode unit supported from said stem, said unit including a cathode, a plurality of grids, an anode, and cross-shaped spacing insulators at opposite ends thereof, a pair of upper and a pair of lower U-shaped shields embracing portions of said insulators and portions of one of said grids, a conductor for said anode remote from said stem, metallic means mounted within said upper shields and interposed between said grids and the anode conductor, and semi-circular transverse disc shield portions extending outwardly from said lower shields.

9. An electron discharge device comprising a

vessel having a stem, an electrode unit supported from said stem, said unit including a cathode, a plurality of grids, an anode, and spacing insulators at opposite ends thereof, a pair of upper and a pair of lower U-shaped shields embracing portions of said insulators and portions of one of said grids, and internal fins on the lateral walls of said upper shields extending toward the adjacent insulator substantially in the plane of one of the surfaces thereof.

10. An electron discharge device comprising a vessel having a stem, an electrode unit supported from said stem, said unit including a cathode, a plurality of grids, an anode, and spacing insulators at opposite ends thereof, upper and lower U-shaped shields embracing portions of said insulators and portions of one of said grids, said upper shield having portions spaced from the adjacent insulator, supports for said grids extending through said insulators, a conductor for said anode remote from said stem, internal fins on said upper shield interposed between the adjacent insulator and said shield, and metallic cover tabs mounted in the curved portions of said upper shield and enclosing the ends of said supports of said grids.

11. An electron discharge device comprising an enclosing vessel having a stem, an electrode unit within said vessel, said unit including a cathode, a plurality of grids, and an anode, cross-shaped insulators at opposite ends of said unit, extensions for said cathode and said grids located in the linear arms of said insulators, extensions for said anode located in the transverse arms of said insulators, leading-in conductors in said stem connected to said cathode and said grids, a conductor for said anode extending through the top of said vessel, U-shaped metallic shields surrounding the linear arms of said insulators and portions of said grids, said shields having extensions seated in the transverse arms of said insulators, internal metallic fins on said shields at the upper end of said vessel, metallic cap shields enclosing the extensions of said grids and supported by said U-shaped shields, and a semi-circular disc shield extending outwardly from each of said U-shaped shields intermediate said stem and said unit.

VICTOR L. RONCI.
JOHN W. WEST.