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R. A. HEISING

2,067,529

ELECTRON DISCHARGE DEVICE

Filed Feb. 20, 1934

2 Sheets-Sheet 1

FIG. 1

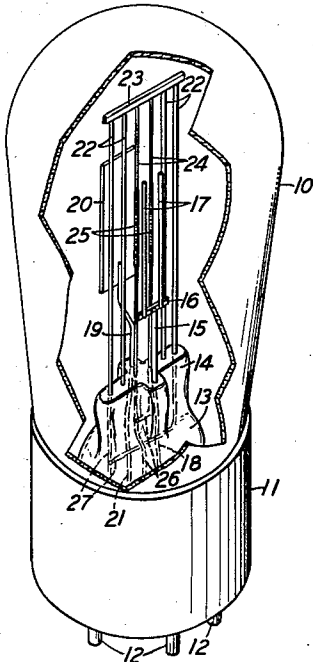


FIG. 2

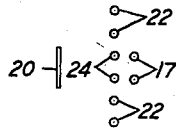


FIG. 6

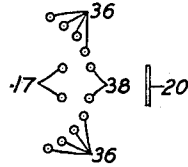


FIG. 3

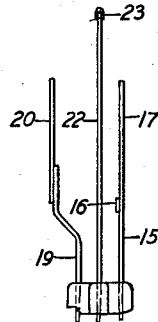


FIG. 7

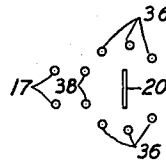


FIG. 4

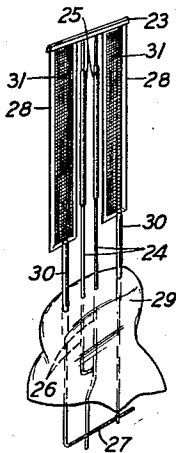


FIG. 5

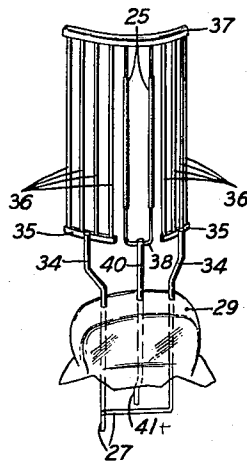


FIG. 8

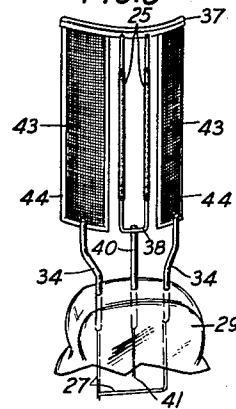
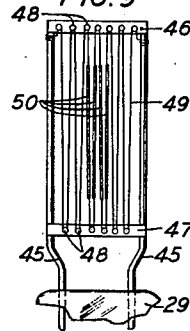


FIG. 9



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ELECTRON DISCHARGE DEVICE

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Application February 20, 1934, Serial No. 712,108

13 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices wherein the control electrode and the anode are shielded or screened from each other.

One object of this invention is to effectively shield the control electrode in an electron discharge device from the anode.

Another object of this invention is to simplify the structure and to reduce the number of elements in electron discharge devices of the shielded control electrode type.

In one embodiment of this invention, an electron discharge device comprises an anode, a control electrode, and a cathode disposed between the anode and the control electrode.

In accordance with one feature of this invention, the cathode is so designed and positioned as to shield the control electrode and anode from each other. In one form, the cathode may comprise an electron emitting portion confined between the longitudinal extremities of the control electrode, and non-emitting portions extending beyond the longitudinal extremities of the control electrode.

In accordance with another feature of this invention, metallic members, which may serve as supports for the cathode and may be electrically connected to the cathode, are provided on opposite sides of the cathode and disposed in a surface extending between juxtaposed or aligned portions of the control electrode and the anode to increase the shielding between the anode and the control electrode.

In accordance with a further feature of this invention, the cathode and the metallic members are arranged on an arcuate boundary about either the control electrode or the anode to insure highly effective shielding between the control electrode and the anode.

The invention and the features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawings in which:

Fig. 1 is a perspective view of an electron discharge device illustrative of one embodiment of this invention, portions of the enclosing vessel being broken away to show the electrodes more clearly;

Fig. 2 is a diagrammatic view illustrating the relative positions of the electrodes in the device shown in Fig. 1;

Fig. 3 is a side view in elevation of the electrodes of the device shown in Fig. 1;

Fig. 4 is a perspective view of a cathode and shield structure which may be substituted for the

cathode and shield structure shown in Fig. 1 in accordance with this invention, wherein the shield comprises mesh screens;

Fig. 5 shows a modification of the shield members and the cathode which are arranged in an arcuate boundary in accordance with this invention;

Fig. 6 is a diagrammatic view showing the relative disposition of the three electrodes in a device embodying a cathode-shield structure of the form shown in Fig. 5;

Fig. 7 is another diagrammatic view wherein the cathode and shield members are arranged in an arcuate boundary partly encompassing the anode;

Fig. 8 is a perspective view similar to Fig. 5, in which the shielding members are arcuate mesh screens;

Fig. 9 illustrates another modification in which the cathode and shielding members are formed of a continuous element;

Fig. 10 is a perspective view of an electrode assembly illustrative of another embodiment of this invention wherein the cathode and shield members are disposed in a cylindrical boundary completely encircling the control electrode, a portion of the anode being broken away to show the other electrodes more clearly;

Fig. 11 is a plan view of the stem of Fig. 10 on the line 11—11 showing the disposition of the supports thereon; and

Fig. 12 is a view in elevation of the electrode assembly shown in Fig. 10.

The electron discharge device illustrated in Fig. 1 comprises an evacuated enclosing vessel 10 which is suitably secured, as by cement, to a base 11. The base 11 has a plurality of terminal prongs 12 thereon through which electrical connection may be made between the electrodes of the device and an external circuit. The enclosing vessel 10 is provided with a reentrant stem 13 terminating in a cross-shaped press 14. A rigid support or wire 15 is embedded in one of the arms of the press 14 and has mounted thereon a lateral metallic member 16 which has secured thereto two spaced parallel wires or rods 17 constituting the control electrode of the device. The control electrode is electrically connected to one of the terminal prongs 12 by a conductor 18 sealed in the stem 13 and connected to the wire 15.

A rigid support or rod 19 is embedded in the opposite arm of the press and carries a flat, metallic plate 20 which serves as the anode of the device. As shown more clearly in Figs. 2 and 3, the anode 20 is parallel to a plane common to the

wires or rods 17. The anode is electrically connected to one of the terminal prongs 12 by a suitable conductor 21 connected to the support or rod 19.

5 A plurality of parallel supports or wires 22 extend from the press 13 and these wires are disposed in a plane intermediate the anode 20 and the control electrode 17 and parallel to the anode and the control electrode, as shown more
10 clearly in Fig. 2. The wires 22 extend upwardly beyond the anode and control electrode and are coupled together by a metallic member 23 which may be a channel-shaped band crimped or otherwise secured to the ends of the wires. A pair of
15 wires 24 supported between the press and the metallic member 23 are disposed in the same plane as the wires 22 and these wires serve as the cathode or emitting electrode of the device. The wires 24 have portions between the longitudinal extremities of the anode 20 and control electrode 17 which may be coated with a thermionically active material, for example, barium and strontium oxides, as shown at 25 in Fig. 1. The
20 wires 24 may be electrically connected together and to one of the terminal prongs 12 by conductors 26, and the end wires 22 may be electrically connected to each other and to another of the terminal prongs 12 by conductors 27. The circuit for the cathode heating current, then, includes the conductors 27, wires 22, metallic member 23, wires 24, and conductors 26. Preferably the conductors 27 are connected to the negative terminal of the heating current source.

35 As shown clearly in Fig. 2, the cathode wires 24 are disposed in alignment with the control electrode wires 17. Preferably the wires 22 and 24 are spaced a distance commensurate with the diameter of the wires 22 and 24, for example, two
40 times the diameter of the wires 22. In order to obtain a large amplification factor, the control electrode 17 is preferably positioned close to the cathode wires 24 and the anode 20 is widely spaced from the cathode wires 24.

45 The cathode wires 24 and the cathode supporting wires 22 serve as a screen between the anode and the control electrode and thereby shield the control electrode from any varying potential on the anode. As is apparent from Fig. 2,
50 the wires 22 and 24 form a shield extending laterally beyond the anode 20 and control electrode 17, and as is apparent from Fig. 3, the wires 22 and 24 form a shield extending longitudinally beyond the anode 20 and control electrode 17.
55 Preferably the wires 22 and 24 extend into the press an appreciable distance so that they shield the rod 15 and wire 18 from the rod 19 and wire 21.

60 Although the cathode 24 has been shown and described as of the directly heated filament type, it may, of course, be of the indirectly heated equipotential type.

In Fig. 4, two U-shaped frames 28 are supported from a press 29 by supports or rods 30 and are interconnected at the upper end by a metallic member 23. Each of the frames 28 has mounted thereon a flat mesh screen 31, the screens and frames being disposed in a common plane. A pair of parallel wires 24 forming the cathode
70 are disposed between the inner arms of the frames 28 and parallel to the screens 31, the wires 24 being embedded in the press at one end and secured to the metallic member 23 at the other end. Preferably the wires 24 are spaced closely adjacent
75 each other and the inner arms of the frames 28

to form a highly effective screen. The wires 24 may be coated with a thermionically active material, as indicated by the portions 25. The wires 24 are electrically connected together by conductors 26 and the frames 28 are electrically connected together by conductors 27. The cathode and screen assembly shown in Fig. 4 may be utilized in an electron discharge device of the general construction indicated in Fig. 1, and may be positioned between an anode 20 and control electrode 17 in substantially the same relation as indicated in Figs. 2 and 3.

Fig. 5 shows another modification of the cathode-screen assembly which includes a press 29 in which bent supports or rods 34 are embedded.
15 Each of the supports or rods 34 has secured thereto, by welding, an arcuate channel-shaped metallic member 35 which is secured, as by crimping or welding, to one end of a plurality of rigid parallel wires or rods 36. The wires or rods 36
20 are spaced at the other end by an arcuate metallic member 37 which is secured to the wires or rods in any suitable manner. A U-shaped filamentary cathode 38, having portions 25 coated with a thermionically active material, is positioned between the innermost wires or rods 36 and is secured at one end to the metallic member 37 and is supported from the press 29 at the other end by a rigid support or wire stub 40. The side arms of the cathode, preferably, are parallel to the wires or rods 36. The heating current for the cathode may be supplied through a circuit including a conductor 41 connected to the support or stub 40, the cathode 38, member 37, wires or rods 36, supports 34, and conductors 27 connected to the supports 34. Preferably the wires or rods 36 are connected through the conductors 27 to the negative terminal of the source of cathode heating current. It will be understood, of course, that although the cathode has been
30 illustrated as of the filamentary type it may be of the heater type. The side arms of the cathode 38, and the wires or rods 36 are positioned closely adjacent and are spaced a distance preferably not more than two times the diameter of the
45 wires or rods 36.

As illustrated in Fig. 6, the cathode 38 and the wires or rods 36 are arranged in an arcuate boundary partly encompassing the control electrode 17, the side arms of the cathode 38 being
50 disposed parallel to and in alignment with the control electrode wires. This arrangement increases the shielding of the control electrode from the anode. Preferably, the cathode 38 and wires or rods 36 extend materially beyond the longitudinal extremities of the control electrode 17 and anode 20, substantially as shown in Fig. 3.

As illustrated in Fig. 7, the cathode 38 and wires or rods 36 may be arranged in an arcuate boundary partly encompassing the anode 20.
60

A modification of the cathode-screen assembly shown in Fig. 5 is illustrated in Fig. 8 and comprises arcuate mesh screens 43 which are mounted on U-shaped frames 44 supported from the press 29 by bent wires 34. The screens 43 and cathode 38 are arranged in an arcuate boundary and may be positioned, as illustrated in Figs. 6 and 7, to partly encompass either the control electrode 17 or the anode 20.

In a further modification of this invention shown in Fig. 9, the cathode-screen assembly comprises a press 29 having embedded therein two upright supports or rods 45 which carry a pair of spaced insulating members 46 and 47. The insulating members 46 and 47 carry a plu-
75

rality of bent hooks 48 on which a continuous
 length of wire or ribbon 49 is supported. The
 ends of the wire 49 are secured to the upright
 supports or rods 45 so that the latter serve as
 leading-in conductors. The central sections of
 the wire 49 such as 50, may be coated with a ther-
 mionically active material, such as barium and
 strontium oxides or otherwise rendered thermi-
 onically active. The assembly shown in Fig. 9,
 may be associated with a control electrode and
 anode substantially as illustrated in Figs. 2 and 3,
 the insulating members preferably being posi-
 tioned beyond the longitudinal extremities of the
 control electrode and anode so that the control
 electrode is shielded both longitudinally and lat-
 erally from the anode.

In the embodiment of this invention shown in
 Figs. 10, 11, and 12, an electrode assembly com-
 prises a cross-shaped press having pairs of arms
 51 and 52 disposed at substantially right angles
 to each other. An upright support or rod 53 is
 embedded in each of the arms 52 and secured to
 oppositely disposed flanges 54 on a cylindrical
 anode 55. The ends of the rods are secured to
 the arms 56 of an insulating plate or member 57.
 A linear metallic rod 58 coaxial with the anode
 55 is embedded in the press at the intersection
 of the arms 51 and 52 and serves as the control
 electrode.

A plurality of inverted J-shaped supporting
 members or wires 59 are embedded, one in each
 of the arms 51 and 52 of the press, the members
 being bent and arranged in a substantially cylin-
 drical boundary as shown in Fig. 11. An equal
 number of elongated U-shaped members 60 is
 supported from the insulating member 57, the
 members 60 likewise being bent and arranged in
 a substantially cylindrical boundary coaxial with
 the boundary including the members 59. A con-
 tinuous filamentary cathode 61 is suspended be-
 tween the members 59 and 60 and comprises a
 plurality of V-shaped sections arranged in a cylin-
 drical boundary coaxial with the control elec-
 trode 58 and the anode 55. Preferably, only the
 portions of the cathode sections between the lon-
 gitudinal extremities of the control electrode are
 rendered thermionically active, for example, by
 coating with barium and strontium oxides. The
 heating current for the cathode may be supplied
 through conductors 62 and 63 each of which is
 connected to two oppositely disposed J-shaped
 members 59.

The cathode 61 and the supporting members
 59 and 60 form a cylindrical screen between the
 control electrode 58 and the anode 55 and which
 extends materially beyond the ends of the anode
 55 and the free end of the control electrode 58,
 and thereby shields the control electrode from
 the anode. Preferably, the arms of the members
 59 embedded in the press extend into the press
 for a relatively long distance to shield the por-
 tion of the rod 58 embedded in the press and the
 leading-in conductor 64 secured thereto from the
 anode supporting rods 53 and the leading-in con-
 ductor 65 secured thereto. The other arm of
 each of the members 59 preferably extends down-
 wardly to or beyond the plane of the top of the
 press.

Although a number of specific embodiments of
 the invention have been illustrated and described,
 it will be understood, of course, that modifications
 may be made therein without departing from the
 scope and spirit of this invention as defined in
 the appended claims.

What is claimed is:

1. An electron discharge device comprising an
 anode, a control electrode, a cathode between said
 anode and said control electrode, said control
 electrode and cathode having aligned wire por-
 tions and said anode having portions in align-
 ment with said cathode and control electrode,
 and shield members adjacent said cathode and
 having portions beyond the lateral extremities
 of said control electrode, said shield members
 being disposed in a surface extending between
 aligned portions of said anode and control elec-
 trode.

2. An electron discharge device comprising an
 anode, a control electrode including a pair of
 parallel wires, a cathode positioned between said
 control electrode and said anode and including
 a pair of parallel wires each of which is parallel
 to and in alignment with a corresponding one of
 said first mentioned parallel wires, and shield-
 ing means laterally adjacent said cathode.

3. An electron discharge device in accordance
 with claim 2, in which said cathode and said
 shielding means extend beyond the longitudinal
 extremities of the anode and the control elec-
 trode wires.

4. An electron discharge device comprising a
 pair of cold electrodes one of which includes
 a plurality of wires disposed in a plane, a cathode
 positioned between said cold electrodes and in-
 cluding wires in alignment with said first wires,
 and a plurality of metallic elements disposed
 laterally adjacent and on opposite sides of said
 cathode wires, said elements being electrically
 connected to said cathode and extending beyond
 the extremities of one of said electrodes.

5. An electron discharge device comprising a
 flat anode, a control electrode including a plu-
 rality of wires disposed parallel to each other
 and in a plane parallel to said anode, a plu-
 rality of shield members, and a cathode includ-
 ing a plurality of parallel wires disposed between
 said shield members, said shield members and
 said cathode being disposed in a plane extending
 between said anode and the control electrode
 wires and parallel thereto, the cathode wires be-
 ing in alignment with corresponding control elec-
 trode wires.

6. An electron discharge device comprising an
 anode, a control electrode, a cathode disposed
 between said anode and said control electrode,
 and metallic mesh screens laterally adjacent said
 cathode and having portions beyond extremities
 of either of said anode or said control electrode.

7. An electron discharge device comprising an
 anode, a control electrode including a plurality
 of wires, a cathode positioned between said anode
 and said control electrode, said cathode having
 portions in alignment with said wires, and wire
 mesh screens electrically connected to said cath-
 ode and positioned laterally adjacent the cathode
 portions.

8. An electron discharge device comprising a
 flat anode, a control electrode including a plu-
 rality of parallel wires disposed in a plane paral-
 lel to said anode, a cathode including parallel
 wires in alignment with corresponding wires of
 said control electrode, and a plurality of mesh
 screens on opposite sides of the cathode wires
 and electrically connected thereto, the cathode
 wires and said screens being disposed in a sur-
 face extending between said anode and said con-
 trol electrode.

9. An electron discharge device comprising an
 anode, a control electrode, a pair of frames dis-

posed between said anode and said control electrode, wire mesh screens attached to said frames, a metallic member carried by said frames, and a cathode mechanically and electrically connected to said metallic member and disposed between said screens.

10. An electron discharge device comprising a pair of cold electrodes, a cathode between said cold electrodes, and metallic supports electrically connected to said cathode, said cathode and said supports being mounted in an arcuate boundary.

11. An electron discharge device comprising a pair of cold electrodes, a cathode positioned between said cold electrodes, and metallic shield members laterally adjacent and on opposite sides of said cathode, said cathode and said shield members being mounted in an arcuate boundary extending about one of said cold electrodes.

12. An electron discharge device comprising a pair of cold electrodes, one of said electrodes including a plurality of parallel wires, a cathode

including a plurality of parallel wires disposed between said cold electrodes and in alignment with said electrode parallel wires, and shield members laterally adjacent and on opposite sides of the cathode wires, the cathode wires and said shield members being mounted in an arcuate boundary extending about one of said cold electrodes.

13. An electron discharge device comprising a pair of cold electrodes, a plurality of spaced metallic members extending laterally between said cold electrodes, a plurality of shield members extending between said metallic members, and a cathode supported from one of said metallic members and positioned between certain of said shield members, said cathode and said shield members being mounted in an arcuate boundary extending between said cold electrodes and about one of said cold electrodes.

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