

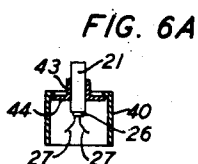
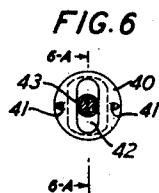
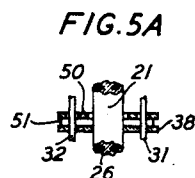
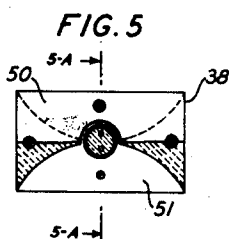
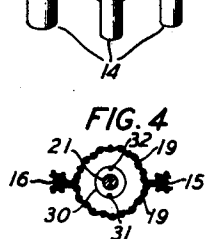
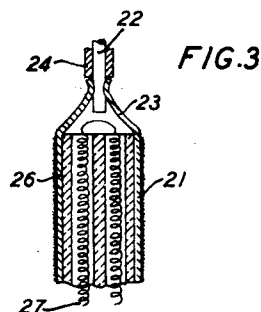
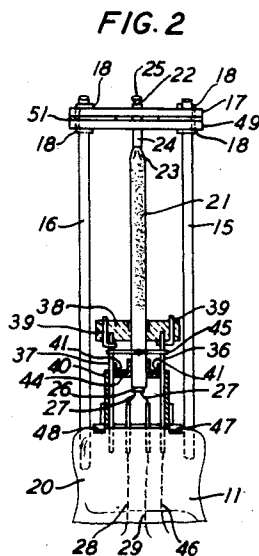
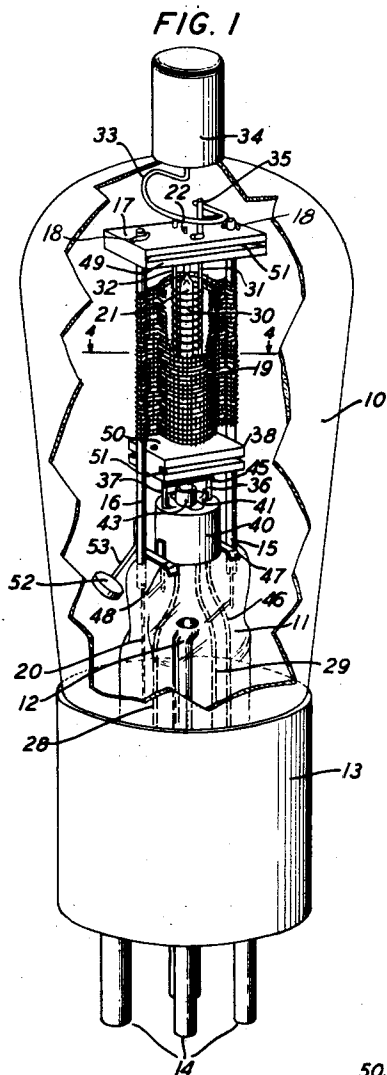
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ELECTRON DISCHARGE DEVICE

Filed May 23, 1931



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ELECTRON DISCHARGE DEVICE

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11 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices in which the cathode emits a copious supply of electrons.

5 In electron discharge devices, particularly of the equi-potential type in which the cathode surface is relatively large, considerable difficulty has been experienced in preventing the deposition of the highly emissive coating of the cathode on the electrode supporting structure. Usually the emissive substance is coated on a cathode which cooperates with other electrodes to perform various functions relating to the amplification and rectification of feeble electrical currents. The electrodes are generally combined into a unitary structure with the electrode supports held in close relationship by spacers or bridging members usually of insulating material. Due to the emissive material being thrown off the cathode during operation and depositing on the spacers to form conductive paths between the supports of the various electrodes and the close proximity of these supports the insulation between the supports is destroyed and the operating life of the device is considerably shortened.

An object of the invention is to prevent the formation of conductive paths between electrodes of discharge devices.

Another object of this invention is to assemble the electrode structure so that the device is substantially non-microphonic or possesses a relatively low noise level characteristic.

In accordance with this invention, the electrodes, such as a cathode, a grid and an anode of an electron discharge device are aligned in coaxial relationship by insulating spacing members at opposite ends of the electrodes. In a specific aspect of the invention, the insulating spacing member comprises an integral block having a spacing portion in which the electrode supports are fixed and a baffle or shield portion parallel to the spacing portion and having apertures through which the electrode supports extend without being in physical contact with the shield portion. The shield portion of the spacing member is closely adjacent the end of the electrodes while the spacing portion is beyond the shield portion. When conductive material from the cathode is deposited on the shield or baffle portion of the insulating spacer it cannot form a continuous path between the electrode supports due to the shielding effect of the baffle portion.

A feature of the invention is the unitary construction of the spacing and baffle portions of the insulating member whereby the apertures for the passage of the electrode supports may be easily aligned. This results in a considerable increase in assembly production and reduction of cost.

Another feature of the invention relates to the assembly of the electrodes in the device so that the noise level characteristic is relatively low and is substantially non-microphonic. In order to attain this objective, a substantially rigid main supporting frame for the electrodes is provided, the frame solely supporting the cylindrical anode and aiding in supporting one end of the tubular cathode and helical grid. An auxiliary frame within the boundary of the main frame serves to support the cathode and grid in coaxial relationship with the anode, the auxiliary frame also supporting a shield surrounding the heater terminations.

A feature of this construction is the support of the cathode in the bridging member of the main frame which consists in supporting the cathode by a wire extension which carries an insulating sleeve extending into the bridging member. This arrangement together with the rigid support of the grid and anode in the main frame bridging member substantially eliminates microphonic noise due to shock or vibration and also "sputter" noise due to loose connections.

Another feature of the invention which aids in reducing microphonic noise in the device is the rigid support of the cathode adjacent the stem. This is accomplished by providing a collar insert which extends through the shield and is rigidly fastened to the cathode and the shield. The shield is also provided with an elongated slot whereby the collar insert may be adjusted to axially align the tubular cathode with respect to the anode.

These and other features of the invention will be more clearly understood from the following detailed description in connection with the accompanying drawing;

Fig. 1 is a perspective view of a discharge device made in accordance with this invention with a portion of the enclosing vessel broken away to clearly illustrate the electrode structure;

Fig. 2 is an enlarged view in elevation of the cathode assembly and the main and auxiliary electrode frame supports with the auxiliary frame support and shield shown in cross-section to clearly illustrate the assembly;

Fig. 3 is an enlarged cross-sectional view of a portion of the cathode assembly showing the interior construction;

Fig. 4 is a cross-sectional view of the relative positions of the electrodes as shown in Fig. 1 on line 4—4;

Fig. 5 is an enlarged view of the auxiliary frame bridging member with one half shown in cross-section to show the configuration of the longitudinal slots which separate the member into spacing and baffle portions and the relative size of the apertures in the spacing and baffle portions of the bridging member;

Fig. 5A is a cross-sectional view of Fig. 5 on the line 5A—5A showing the positions of the cathode and grid supports extending through the unitary baffle and spacing insulating member;

Fig. 6 is a plan view of the magnetic shield surrounding the terminations of the cathode and heater element; and

Fig. 6A is a cross-sectional view of Fig. 6 on the line 6A—6A showing the feature of the slidable insert in the shield member.

Referring to the drawing, the complete assembly of the electron discharge device made in accordance with this invention is shown in Fig. 1 and comprises an enclosing vessel 10 having an inwardly projecting stem press 11 which also includes an outwardly extending thin glass tubulation 12 communicating with the interior of the vessel for evacuating the space in which a plurality of electrodes are mounted. The portion of the vessel adjacent the stem is affixed, preferably by cement, to a cup-shaped insulating base 13 carrying a plurality of terminals 14 to which the leading-in wires from the electrodes are attached for external connection in an electrical circuit. A pair of relatively heavy parallel supporting members or rods 15 and 16 are sealed in the press and extend toward the opposite end of the vessel 10. These rods are held in rigid spaced relation by an integral bridging member or block 17, preferably of insulating material such as porcelain or "isolantite", and by tie wires 18 which are welded to the upright rods 15 and 16 on opposite sides of the insulating member 17 to insure a positive and rigid connection so that external vibrations or shocks will not cause slippage or chatter of the bridging insulating member on the supports. The upright rods 15 and 16 and the bridging insulating member form a main supporting frame for the electrodes. A metallic wire mesh anode 19 is rigidly supported on the upright members 15 and 16 and consists of two strips of wire mesh formed into a configuration of a cylinder with flanged portions embracing and welded to the upright support members, the cylindrical portion of the anode being located between the upright members. A lead wire 20 sealed in the stem 11 is connected to the support member 16 and one of the external terminals 14, to impress a suitable potential on the anode of the device.

A relatively long tubular metallic cathode 21 is supported in the axis of the cylindrical anode 19 and provided with the usual coating of thermionically active material, such as oxide of alkaline earth metal, to serve as a source of emission of electrons. The tubular cathode is supported in the main supporting frame by a central wire extension 22 which projects through apertures in the bridging member 17, the extension wire being attached to the tubular cathode by pinching the cathode as shown at 23 to the wire extension. In order to insure a tight fit of the wire extension 22 in the bridging member 17, an insulating sleeve 24 embraces the wire extension and fits snugly in the aperture in the bridging member 17. The free end of the wire extension 22 is flattened to insure a tight fit for the insulating sleeve 24 to prevent "sputter" noise between the various elements in the event the device is subjected to shocks or vibrations.

The metallic tubular cathode encloses a twin-bore insulator 26, of quartz or magnesite, known as magnesium carbonate, which serves as a spacer and heat conductor between the cathode 21 and a spirally wound hairpin heater element

27. The terminations of the hairpin heater element are connected to lead wires 28 and 29 which are sealed in the press of the glass stem 11, the lead wires being connected to two of the terminals 14 on the base. A helical wire grid 30 coaxially surrounds the cathode 21 and is held in relative position by two supporting wires 31 and 32 which extend through the bridging member 17 and are rigidly fastened therein. A flexible wire 33 sealed through the end of the vessel 10 is attached to an external cap terminal 34 and the grid supporting wire at 35, to apply a suitable biasing potential on the grid or control electrode of the device.

Since the main frame support of the device solely supports the anode and partially supports the cathode and grid at one end, it is essential, in order to reduce microphonic noises, to support the cathode and grid adjacent the stem so that these electrodes will be held in positive coaxial relation to the anode and still be free from loose connections which may set up sputtering noise.

In order to reduce the noise or microphonics of a discharge device in accordance with this invention, the cathode and grid are supported adjacent the press by an auxiliary frame support comprising short rigid wires 36 and 37 which are sealed in the press intermediate the heater lead wires 28 and 29 and the main frame supports 15 and 16. The auxiliary frame wires 36 and 37 extend into a rectangular insulating block 38, situated between the main frame supports 15 and 16, which is provided with a central aperture, to serve as a guide for the cylindrical cathode 21. The block 38 is further attached to the auxiliary frame wires 36 and 37 by angular links 39 which extend through the block and are welded to the auxiliary frame wires. The auxiliary frame insulating block 38 also receives the supports 31 and 32 of the grid 30 to coaxially align the grid with the cathode and the anode, the grid supports having free longitudinal movement in the insulating block 38, to allow for expansion.

The auxiliary frame support also carries an inverted cup-shaped metallic shield 40 which surrounds the auxiliary frame wires 36 and 37 and is attached thereto by upturned ears 41 punched out of the closed end of the shield and welded to the support wires. This shield is spaced a slight distance from the top of the stem press and substantially encloses the terminations of the heater element, to serve as a magnetic and electrostatic shield between the heater element and the control grid. The closed end of the cup-shaped shield is provided with an elongated slot 42 through which extends a tubular collar insert 43 having a flange portion 44 which closes the elongated slot. The tubular collar 43 surrounds the end of the cathode and is attached thereto, preferably by welding, the collar insert being slidable in the slot to align the cylindrical cathode in the axis of the vessel. After alignment of the cathode, the insert is rigidly fixed with respect to the cup-shaped shield to prevent displacement of the cathode. The cylindrical cathode 21 is further affixed to the auxiliary frame members by a tie wire 45 which is centrally attached to the cathode and the ends thereof welded to the support wires 36 and 37 adjacent the block 38. Since the cathode is in mechanical and electrical contact with the shield and the auxiliary frame wires 36 and 37, one of these wires may serve as a

conductor to connect the cathode to an external circuit. As shown in Fig. 2 a lead wire 46 sealed in the stem 11 is attached at one end to the auxiliary frame wire 36 and at the other end to one of the terminals 14 on the base 13. The cup-shaped shield 40 supported above the stem also serves to support strap shields 47 and 48 on opposite sides thereof intermediate the cup-shaped shield and the main supporting frame wires 15 and 16. The purpose of these strap shields is to prevent the deposit of conducting material on the glass stem which would be detrimental to the proper operation of the device.

The rigid structure of the main frame support and the cathode connection with the support reduces to a substantial extent the noise level characteristic of the electrode assembly. The rigidity of the auxiliary frame support engaging the cathode and grid adjacent the stem also contributes to the low noise level of the discharge device of this invention.

When the grid is closely spaced with respect to the cathode to obtain high voltage amplification and these electrodes are held in insulating members extending across the ends of the electrodes, and, furthermore, when a cathode of large surface area is used to insure a copious emission of electrons to the anode, the active material from the cathode is liable to be projected to the surface of the insulating members and form thereon conductive paths which short-circuit the electrodes and impair the performance of the discharge device. In order to overcome the detrimental effect of conductive material depositing on the spacing insulating members in which the cathode and grid are relatively fixed, the parallel insulating members on opposite ends of the electrodes are provided with shield or baffle portions which intercept the active material from the cathode on the spacing portion of the insulating members.

In accordance with this invention, the insulating members 17 and 38 are formed of integral blocks of insulating material having a spacing portion removed from the immediate proximity of the electrodes in which the supports of the electrodes are relatively fixed and shield or baffle portions 49 and 50 respectively, which are positioned closely adjacent the ends of the electrodes. The spacing portion or layer and the baffle portion or layer are formed in a single block of insulating material by cutting converging slots in the longitudinal edges as shown clearly in Fig. 5. These slots may be cut with a circular saw, the slots on opposed edges converging at the center to form a clear passageway which insures a definite space between the separate spacing and baffle layers in the vicinity of the cathode and grid supports. Fig. 5 illustrates the construction of the auxiliary insulating member 38 with a section broken away to show the configuration of the slot 51 and the relative sizes of the apertures in the baffle portion 50 and the spacing portion 38 for the reception of the cathode cylinder and the grid supports. In Fig. 5A it will be noticed that the cathode extends through a slightly larger central aperture in the baffle portion 50 and projects through a smaller diameter aperture in the spacing portion 38. The grid supports 31 and 32 extend through slightly larger apertures in the baffle portion 50 while they slide through apertures in the spacing member 38 substantially the same size as the diameter of the wire supports 31

and 32. The baffle portion 49 of the insulating member 17 is also provided with slightly larger diameter apertures than the apertures in the spacing portion of the block 17 through which the supporting wires of the grid and the cathode extension project. The insulating member 17 is formed substantially the same as the insulating member 38 shown in Fig. 5 except for the large central opening for receiving the cathodes.

Since the baffle or shield portions of the parallel insulating members are interposed between the spacing portions of the insulating members and the electrodes and, furthermore, since the cathode and grid are physically out of contact with the baffle portions, due to the slightly larger diameter of the apertures through which the supports for the cathode and grid extend, any diffusible conductive material, such as the thermionically active coating on the cathode, which is projected toward the insulating members will not deposit on the spacing portions of the insulating members in which the cathode and grid supports are relatively fixed but will deposit on the baffle portion. However, the deposition of conductive material on the baffle portion will not form continuous paths between the associated electrodes due to the slight clearance between the baffle portions of the insulating members and the supports for the cathode and grid extending therethrough. Therefore, a material advantage in prolonging the operating life of the discharge device employing the combined spacing and baffle insulating members of this invention will be obtained. Another advantage of this construction is the reduction in the number of parts for the assembly of the spacing and baffle portions of the insulating members which facilitates assembly of the electrode structure and materially reduces the cost of manufacture. Furthermore, the integral baffle and spacing insulating member obviates the necessity of aligning the cooperating apertures in the separate layers and insures accurate centering of the cathode and grid supports with respect to the baffle and spacing portions of the insulating member. Finally, the integral structure of the baffle and spacing insulating members aids in the reduction of microphonic noises in the device since these units are rigid and compact and do not employ separate connecting members to maintain the layers in spaced relation.

A getter is employed to fix residual gases in the final evacuation of the device. This getter may consist of a vaporizable material, such as magnesium, which is supported in an inverted cup receptacle 52 extending toward the wall of the vessel 10 and attached to a wire support 53 carried by the supporting rod 16 adjacent the glass stem.

While the invention has been disclosed in a specific embodiment of a substantially non-microphonic three-electrode discharge device, it is, of course, understood that various modifications may be made in the structural assembly and its application without departing from the scope of the invention as defined in the claims.

What is claimed is:

1. A discharge device comprising an enclosing vessel, a plurality of cooperating electrodes, a main frame including a bridging insulating member engaging one end of each of said electrodes, and an auxiliary frame including an insulating member parallel to said bridging

member and positioned within the boundary of said main frame, said auxiliary insulating member being in contact with the opposite end of at least one of said electrodes.

- 5 2. An electron discharge device comprising an enclosing vessel having a stem, a cylindrical anode, a main frame supporting said anode from said stem, a cathode and grid within said anode having one end in engagement with said
- 10 frame, an auxiliary frame engaging the opposite end of said cathode and grid to space them with respect to said anode, and a shield member carried by said auxiliary frame surrounding the end of said cathode adjacent said stem.
- 15 3. An electron discharge device comprising an enclosing vessel having a stem, a cylindrical anode, a main frame supporting said anode from said stem, a tubular cathode and a helical grid coaxially positioned within said anode, said
- 20 cathode and grid having one end in engagement with said frame, an auxiliary frame extending from said stem, said cathode and grid extending into said auxiliary frame, a shield member carried by said auxiliary frame and surrounding the end of said cathode adjacent said stem, and
- 25 centering means extending from said shield engaging said cathode.
4. An electron discharge device comprising an enclosing vessel having a stem, a main frame including a bridging insulating member extending
- 30 from said stem, an auxiliary frame adjacent said stem within said main frame, an anode engaging said main frame between said insulating member and auxiliary frame, a cathode within
- 35 said anode and extending through one end of said auxiliary frame, means engaging said cathode and extending through said bridging member, and a sleeve member on said means rigidly fastening said means in said bridging
- 40 member.
5. An electron discharge device comprising an enclosing vessel, a plurality of cooperating electrodes, supports extending from said electrodes, and an integral insulating member extending
- 45 across one end of said electrodes, said insulating member having a portion in which said electrode supports are relatively fixed and a shielding portion having apertures for the free passage of a plurality of said supports, said shielding
- 50 portion preventing continuous conducting paths being formed between said supports by deposited metallic particles.
6. An electron discharge device comprising an enclosing vessel, a plurality of cooperating electrodes, and an integral insulating member extending
- 55 across one end of said electrodes, said insulating member having a spacing portion engaging said electrodes and a parallel baffle portion between said spacing portion and said electrodes, said baffle portion having apertures
- 60 through which certain of said electrodes extend without engaging said baffle portion.
7. An electron discharge device comprising an enclosing vessel having a stem, an electron emitting cathode and an anode beyond said stem,
- 65 supports for said cathode and anode, and an insulating member extending across one end of said cathode and anode, said insulating member having a spacing portion engaging said supports
- 70 and an integral baffle portion provided with apertures through which some of said supports extend without contacting with said baffle portion, said baffle portion being parallel to said

spacing portion and located between said spacing portion and said cathode and anode.

8. An electron discharge device comprising an enclosing vessel having a stem, an electron emitting cathode, a plurality of cooperating electrodes surrounding said cathode and positioned beyond said stem, parallel supporting elements extending from said electrodes in spaced relation, and an integral, multiple layer, insulating member having a layer engaging said electrode supporting elements and another layer surrounding some of said elements but free from engagement therewith at contiguous points.

9. An electron discharge device comprising an enclosing vessel having a stem, an electron emitting cathode, a plurality of cooperating electrodes surrounding said cathode and positioned beyond said stem, parallel supporting elements extending from said electrodes in spaced relation, and an insulating member engaging said supporting elements, said insulating member having opposed slots cut therein to form parallel layers, one of said layers spacing said supporting elements in operative relation, said other layer serving as a baffle between said spacing layer and said electrodes, certain of said elements passing freely through said baffle layer without contacting therewith.

10. An electron discharge device comprising an enclosing vessel having a stem, a pair of rigid parallel supports extending from said stem, a cylindrical anode carried between said supports, an insulating spacing member engaging the free ends of said supports, a pair of auxiliary supports extending from said stem within said parallel supports, a spacing insulating block attached to the free ends of said auxiliary supports and extending across one end of said anode, a tubular cathode positioned in the axis of said anode having a portion extending through said insulating block, an inverted cup-shaped shield surrounding the extending end of said cathode, said shield substantially enclosing said auxiliary supports and attached thereto, and a metallic insert in said shield having a collar portion engaging said tubular cathode.

11. An electron discharge device comprising an enclosing vessel having a stem, a pair of rigid parallel supports extending from said stem, a metallic mesh tubular anode attached to said supports, an insulating spacing member engaging the free ends of said supports, a pair of auxiliary supports extending from said stem within the space between said parallel supports, a spacing insulating block attached to the free ends of said auxiliary supports and extending across one end of said anode, a tubular cathode positioned in the axis of said anode having a portion extending through said insulating block, an inverted cup-shaped shield surrounding the extending end of said cathode, said shield substantially enclosing said auxiliary supports and attached thereto, a metallic insert in said shield having a collar portion engaging said tubular cathode, a helical wire grid coaxially surrounding said cathode within said anode, a pair of supports parallel to said cathode engaging said helical grid, said supports being held in said spacing member and block, and a flexible wire attached to one of said grid supports and sealed in one end of said vessel remote from said stem.

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