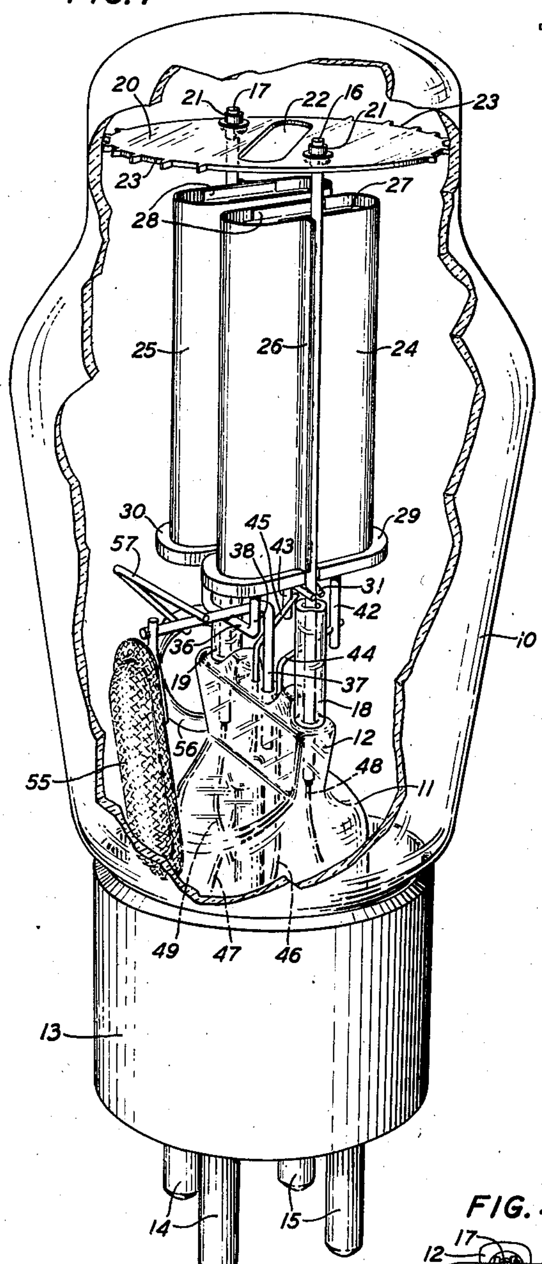
June 8, 1937. V. L. HOLDAWAY 2,083,330

ELECTRONIC DISCHARGE DEVICE

Filed May 2, 1935 2 Sheets-Sheet 1

FIG. 1



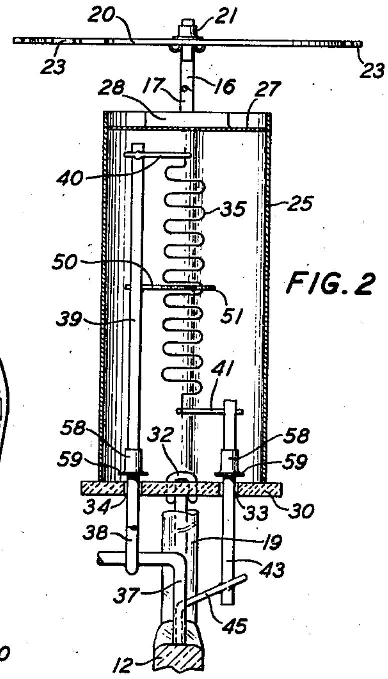




FIG. 2

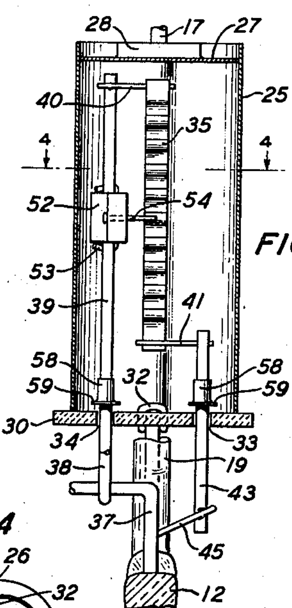



FIG. 3

FIG. 4

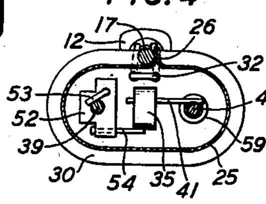



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FIG. 5

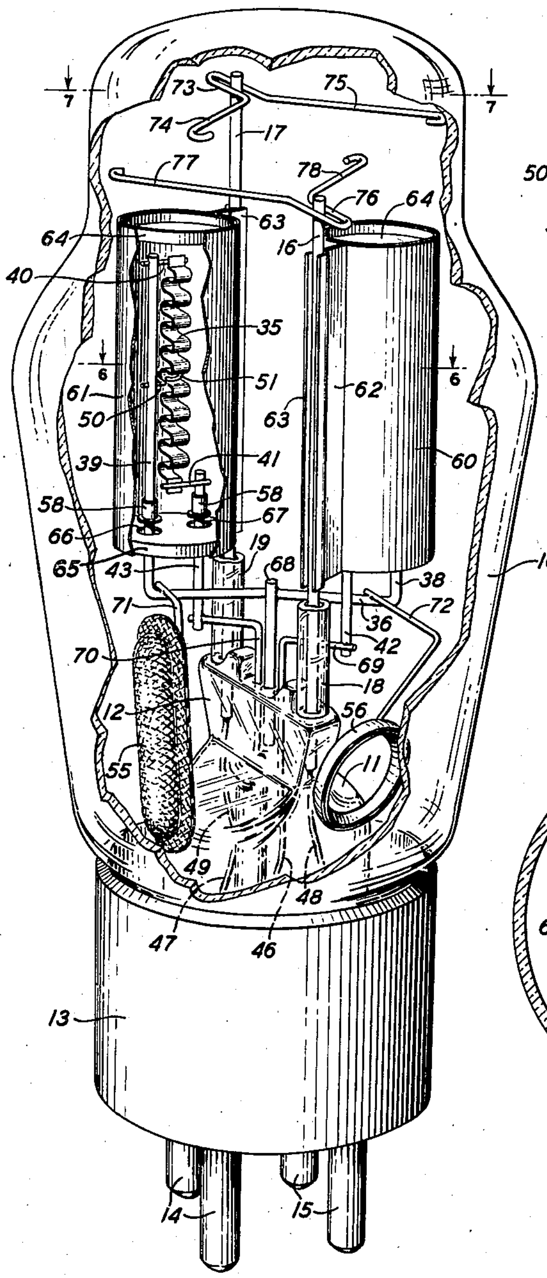


FIG. 6

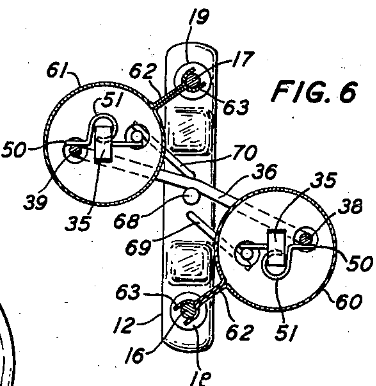
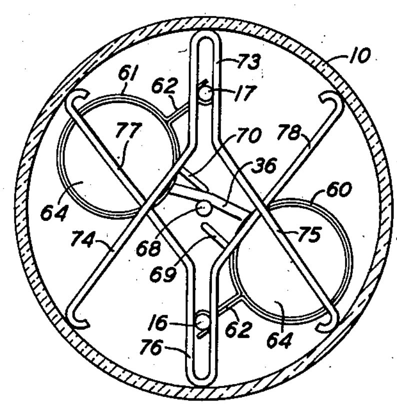


FIG. 7



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# UNITED STATES PATENT OFFICE

2,083,330

## ELECTRONIC DISCHARGE DEVICE

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Application May 2, 1935, Serial No. 19,380

8 Claims. (Cl. 250—27.5)

This invention relates to electronic discharge devices for rectifying alternating current and particularly for rectifying the complete cycle of the alternating current wave.

An object of the invention is to confine the ionization paths to a limited space between the electrodes and to prevent arcing and breakdown in the device.

Another object of the invention is to assemble the electrode units in devices so that the internal impedance is relatively low to obtain efficient operation.

In accordance with this invention, a full wave rectifier comprises an assembly in which two symmetrical hollow anodes are mounted on a stem of a vessel and form complete enclosures for the cathodes or electron emitters which are supported laterally within the anodes by vertical supports extending into the anodes from one end. The configuration of the emitters insures large emitting surfaces to obtain a high efficiency in operation and also to reduce the internal impedance between the respective electrodes.

A feature of the invention is to prevent direct passage of electrons out of the anode spaces by forming baffle shields adjacent the apertures through which the supports extend.

A further feature pertains to the alignment of the cathode sections within the anodes to insure stability in the characteristics of the device. This is accomplished by maintaining the relation of the cathode sections to the anodes substantially constant by a restraining member which engages an intermediate portion of the cathode and is secured to one of the cathode supports, the member being coated with an insulating ceramic to avoid conduction to a support held at a different potential.

A further feature of the invention relates to the support of the electrode units in an enclosing vessel and the maintenance of uniform space relationship of the anodes without the use of spacers of insulating material. This arrangement comprises two anode casings supported from the stem of the vessel with the cathode supports entering twin apertures in the lower closure members of the anodes and spacing the two units in the vessel by similarly shaped tripodal members which are individually attached to the supports of the anodes. The spaced arms of the spacer members resiliently engage the wall of the vessel to prevent shocks or vibrations affecting the relationship of the electrodes.

These and other features of the invention will be described in the following detailed specification and in connection with the accompanying drawings set forth various embodiments of the invention.

Fig. 1 is a perspective view of one embodiment of a full wave rectifier device in accordance with this invention with a portion of the enclosing vessel broken away to show the electrode unit assembly;

Fig. 2 illustrates a side view in elevation of one of the electrode units with the anode casing in cross-section to show the cathode assembly mounted therein;

Fig. 3 is similar to Fig. 2, but illustrates a modified arrangement of the cathode structure;

Fig. 4 shows a cross-sectional view of the unit taken on the line 4—4 of Fig. 3;

Fig. 5 is a perspective view of another embodiment of the invention with a portion of the enclosing vessel and one of the anodes broken away to show the detail assembly of one of the dual units.

Fig. 6 shows a cross-sectional view of the electrode units on the stem taken on the line 6—6 of Fig. 5; and

Fig. 7 is a cross-sectional view of Fig. 5 on the line 7—7 showing the relation of the anodes and spacer members with respect to the wall of the enclosing vessel.

Referring to the drawings, one aspect of the invention, as shown in Fig. 1, is a complete double half-wave rectifier device employing mercury vapor or other vapor as the ionizing medium, although a suitable inert gas or a gaseous mixture may be used, and comprising an enclosing vessel 10 having an inwardly projecting stem 11 terminating in a flat press 12, the stem-end of the vessel being affixed to an insulating base 13 having a plurality of terminal pins or prongs 14 and 15 projecting from the lower surface to which the separate electrodes are connected so to be coupled to an operating circuit.

The stem 12 is provided with two upright supports or rods 16 and 17 having short portions thereof adjacent the press surrounded by glass insulating sleeves 18 and 19 respectively. The glass sleeves may be secured to the stem by fusing the ends thereof into the press 12 during the sealing of the support rods 16 and 17. In order to maintain the support rods 16 and 17 in uniform parallel relation, a spacer member or disc 20, of mica or a suitable ceramic material, is secured to the extreme ends of the support rods in a conventional manner, such as by metallic eyelets 21. The disc 20 is provided with a central elongated slot 22, to increase the surface insulation path between the support rods 16 and 17. The disc 20 is also provided with serrated edges 23 which engage the inner wall of the reduced end of the vessel 10 to maintain the electrode unit accurately in position with respect to the axis of the vessel. Two flattened cylindrical anodes 24 and 25 are arranged in parallel relation between the upright supports 16 and 17. Each anode is formed of sheet metal, such as nickel, and may be provided with a roughened or darkened surface, such as a carbonized coating, to dissipate the heat more readily and to decrease the possibility of a disturbing electron emission from the anode. The longitudinal edges of the anodes are brought together in the form of an outwardly extending flange 26 which is welded to one side of the support rods 16 and 17, respectively. The top of each anode is provided with a metallic insert or closure 27 having an upwardly bent extension 28 which is welded to the inner edge of the anode. The lower ends of the hollow anodes are closed by insulating plates or closure members 29 and 30 having a slightly larger dimension than the cross-section of the anode associated therewith. The insulating plate 29 is held in abutting relation to the anode 24 by a wire connector 31 and a similar connector 32 secures the insulating plate 30 in abutting relation to the anode 25. These connectors consist of a hairpin shaped wire, as shown in Figs. 2, 3 and 4, threaded through tight fitting holes adjacent the outer edge of the insulating plate and having the parallel ends projecting through the plate bent outwardly and welded to the support rods 16 and 17, respectively. Each of the insulating plates is provided with twin apertures 33 and 34 along the long diameter of the plate and substantially at equal distances from the center of the plate. The assembly of the anodes presents a pair of completely enclosed casings, due to the closure members at the top and bottom openings, and the only passageways connecting the space within the anodes to the surrounding media are the twin apertures 33 and 34 in the insulating plates supported between the anodes and the press 12.

The anode casings form enclosures for parallel cathode sections which are arranged in the axis of each anode casing, to serve as a source of electrons between the cathodes and the surrounding surface of the respective anodes. The cathode may be of any suitable configuration, and, as shown in Fig. 2, comprises a preformed folded ribbon 35, preferably of wire mesh which is coated with electron emissive material, such as the oxides of alkaline earth metals, preferably barium and strontium oxides. In order to maintain the cathode sections in proper spacial relation with respect to the surfaces of the anodes, a U-shaped wire support 36 is attached to a bent wire 37 fastened in the press 12 and is provided with long arms 38 and 39 which project through the apertures 34 in the insulating plates 29 and 30. These arms extend almost to the upper closure members 27 of the anodes and carry extension stub wires 40 which are attached to the upper ends of the cathodes 35, to maintain the center or axis of the folded ribbon cathode 35 along the axis of the anode in which it is situated. The lower ends of the cathodes 35 are secured to stub wires 41 which extend from straight supports or conductors 42 and 43 projecting through the apertures 33 in the insulating plates 29 and 30. The conductors 42 and 43 are held in position by bent wires 44 and 45, respectively, sealed in the press 12 and connected to corresponding leading-in conductors or wires 46 and 47, respectively, which are secured to the contact pins 14 on the base 13. The contact pins 15 are attached to leading-in conductors 48 and 49 which are joined to the sealed ends of the upright supports 16 and 17, respectively, to supply suitable potentials to the anodes of the rectifier device.

When a folded form of filament is employed in the rectifier device or any other form of cathode is employed which does not have sufficient rigidity to maintain it in uniform space relation with respect to the wall of the anode casing, it may be desirable to provide an intermediate restraining member for the cathode assembly to insure constant spacing of the cathodes. As shown in Fig. 2, a wire hook 50 projects at right angles from the arm 39 extending into the anode casing and is provided with a loop portion 51 which embraces the intermediate portion of the cathode 35. The loop portion 51 is provided with an insulating coating, such as beryllium oxide, to electrically insulate the hook from the cathode at the point of embrace. The loop portion 51 is so proportioned that a minimum thermal contact is made with the cathode thereby maintaining a uniform temperature in the cathode section. Another form of restraining member is shown in Figs. 3 and 4 and consists of an insulating block 52 which surrounds the arm 39 extending into the anode 25. This block is secured to the arm by a U-shaped wire 53 which extends through the block and is welded to the arm, such as 39, above and below the block. The block carries an offset pin or bar 54 which is welded to the center point of the cathode 35. The bent arm or wire 37, shown in Fig. 1, which carries the U-shaped support 36 for the cathodes also forms a support for a mesh container 55 containing a capsule of mercury which forms the vapor conducting substance in the device. A getter ring 56 is also supported from the bent wire 37 by a connecting wire 57.

The use of mercury vapor in a rectifying device materially decreases the cathode-anode voltage drop whereby a high output current may be obtained with a given electrode assembly. However, the maximum efficiency of such a combination is partially destroyed by arcing and breakdown between the supports of the dual assembly where these supports are joined by materials which may establish conducting paths between them.

In accordance with this invention arcing is materially decreased in the structure previously described by limiting the ionization paths to the spaces between the cathodes and anodes and substantially closing the opposite ends of the anode structures, so that electrons cannot escape to the surrounding media exterior to the anodes to cause ionization of the vapor. It will be noted that the only possible paths for the escape of electrons in the unit structure of this invention is through the twin apertures in the insulating plates at the lower end of the anodes through which the supports of the cathode extend.

In order to provide complete shielding of the cathodes, in accordance with this invention, the twin apertures are masked by baffle shields 58 which are in the form of tubular metallic eyelets secured to the individual arms 38 and 39 and the short supports 42 and 43 which carry the cathode sections. These shields are provided with flared portions 59 which are spaced slightly above the apertures in the insulating plates 29 and 30 and the diameter of the flared portion is larger than the apertures in the plates so that any electrons projected from the cathodes cannot pass through the apertures into the surrounding vapor by a direct path. In view of the fact that any electrons striking the flared portion of the shield will be deflected to the anodes, it is obvious that ionization of the vapor exterior to the anode structure is substantially overcome. This arrangement materially increases the efficiency of the full wave rectifier and permits the attainment of a maximum peak inverse voltage without the danger of arcing.

In the embodiment of the invention as shown in Fig. 5, the dual unit assembly of the electrodes is attained without the use of insulation except for the supports extending through the stem of the device. In this arrangement the anodes 60 and 61 are in the form of hollow cylinders of sheet metal, such as nickel, with their edges joined together in a flange 62 and terminating in a U-shaped longitudinal groove or flute 63, which embraces the respective upright supports 16 and 17 extending from the press 12. The parallel anodes extend at acute angles from the press 12 on opposite sides thereof, as shown more clearly in Fig. 6 and are provided with upper metallic disc inserts 64 having a peripheral flange welded to the inner edges of the cylindrical anodes. The lower ends of the anodes are closed by metallic disc inserts 65 having twin apertures 66 and 67 so that each anode structure forms a substantially closed metallic casing. A central support 68 extends from the stem and carries the U-shaped frame 36, similar to the frame described in connection with Fig. 1, but having the long arms 38 and 39 at a greater distance from the center of the frame and supported at a bisecting angle with respect to the press 12 so that the arms 38 and 39 extend through the apertures 66 in both anodes 60 and 61. The folded ribbon cathode 35 is secured to the upper end of the arm by the stub wire 40 and the lower end is connected to the stub wire 41 which extends from the corresponding straight supports 42 and 43 projecting through the remaining apertures 67 in the lower inserts 65. The straight supports 42 and 43 are connected respectively to bent conductors 69 and 70 sealed in the press 12 and connected to the respective leading-in conductors 46 and 47. The twin apertures in the lower inserts of the two anodes are shielded by the tubular shields 58, similar to the structure described in connection with Fig. 2, and the intermediate points of the cathodes are restrained by insulated hooks 50. The mesh container 55 supporting the mercury capsule is supported from the center support 68 by a connecting wire 71 while the getter ring 56 is supported from the U-shaped frame 36 by a connecting wire 72. It will be realized that the electrodes are assembled in proper relation from the stem of the vessel without the aid of any spacing insulating member so that the insulation resistance between the separate units is materially increased and a higher degree of efficiency may be obtained.

In order to properly support the upper ends of the anodes of the rectifier device and also to overcome displacement of the anodes due to shocks or vibrations, another feature of this invention relates to the support of the separate units at the top of the vessel by individual tripodal resilient springs or spacer members which are positioned in superimposed relation transverse to the axis of the vessel and each spring has three points in contact with the wall of the containing vessel 10.

It will be noted that the upright support 17 in Fig. 5 is slightly longer than the support 16 arranged parallel thereto. The upright support 17 has its free end secured between parallel portions of a hairpin-shaped wire section 73 so that the nodal portion is in contact with the cylindrical wall of the dome-shaped portion of the vessel 10. Beyond the parallel portions of the hairpin section of the spring are angular legs 74 and 75 which extend at equal angles from a diametrical point opposite the nodal portion of said spring and the ends of the legs are bent inwardly to present a rounded contact to the wall of the vessel 10 at triangular points with respect to the bend of the hairpin section 73. This spring or spacer positions the support 17 at its upper end and prevents vibrations or shocks altering the position of the support. A similar symmetrical spring or spacer is connected to the upright support 16 and is provided with a hairpin section 76 having the nodal portion in contact with the cylindrical wall of the vessel at a position diametrically opposite the nodal portion of the hairpin section 73. The angular legs 77 and 78 extend at opposed angles with respect to the legs 74 and 75, as shown clearly in Fig. 7, and the ends of these legs are bent inwardly to form a smooth contact with the inner wall of the vessel 10. This arrangement maintains the dual sets of elements in position in the vessel and protects the assembly against shocks. Furthermore, the superimposed relation of the tripodal springs prevents the establishment of conducting paths between the two units and thereby increases the insulation resistance of the device. It will also be noted that the resilient character of the tripodal springs permits the spacer members to compensate for variations in the internal diameter of the vessel due to the yielding contact of the legs of the springs with the wall of the vessel.

While the invention has been described with respect to a dual rectifier device, it is, of course, understood that the invention is not limited to such a specific application since other uses may be advantageously realized from the disclosure and concept of the invention. Furthermore, it is understood that the invention is not limited to a structure having a combination of the features disclosed since under certain conditions the operating characteristics of the device may be sufficiently improved by employing only one or more of the various features and therefore the invention should be defined within the scope of the appended claims.

What is claimed is:

1. A full wave rectifier comprising a vessel having a stem, a pair of parallel uprights extending from said stem, a spacer member attached to said uprights, a pair of hollow metallic anodes attached to and extending between said uprights in parallel relation, each of said anodes having closure members at opposite ends thereof, the closure member adjacent said stem having apertures, a plurality of supports extending into said anodes through said apertures, a pair of cathodes extending between pairs of said supports within said anodes, and flared members surrounding said supports adjacent said apertures.

2. A full wave rectifier comprising a vessel having a stem, a pair of parallel uprights extending from said stem, a spacer member attached to said uprights, a pair of hollow metallic anodes at-

tached to and extending between said uprights in parallel relation, each of said anodes having closure members at opposite ends thereof, the closure member adjacent said stem having apertures, a plurality of supports extending into said anodes through said apertures, a pair of cathodes extending between pairs of said supports within said anodes, and tubular eyelets secured to said supports within said anodes having flared portions facing the apertures in said closure member adjacent said stem.

3. A full wave rectifier comprising a vessel having a stem, a pair of parallel uprights extending from said stem, a spacer member attached to said uprights, a pair of hollow metallic anodes attached to said uprights in parallel relation, each of said anodes having a metallic closure over one of the corresponding ends thereof, a pair of apertured insulating plates abutting against the opposite ends of said anodes, a pair of supports extending freely through each of said apertured insulating plates, a cathode extending lengthwise between each pair of said supports within each anode, and metallic eyelets secured to said supports closely adjacent the inner surfaces of said insulating plates.

4. A full wave rectifier comprising a vessel having a stem, a pair of parallel uprights extending from said stem, a spacer member attached to said uprights, a pair of hollow metallic anodes attached to and extending between said uprights in parallel relation, each of said anodes having a metallic closure in each of the corresponding ends thereof, a pair of apertured insulating plates abutting against the opposite ends of said anodes, a pair of supports extending freely through each of said apertured insulating plates, a cathode extending lengthwise between each pair of said supports within each anode, metallic eyelets secured to said supports having portions shielding the apertures in said insulating plates, and means connecting the outer portion of each of said insulating plates to the corresponding uprights.

5. A dual electrode assembly comprising a vessel having a stem, two similar cathode and anode units supported from said stem, and a tripod spacer member connected to each of said units and engaging the wall of said vessel.

6. A dual electrode assembly comprising a vessel having a stem, two similar cathode and anode units supported from said stem, and a separate metallic spring spacer element engaging each unit and the adjacent wall of the vessel and having symmetrical outwardly extending leg portions engaging other portions of the wall of said vessel at substantially equal angles from a diametrical point opposite the engagement of said spacer element with the wall of said vessel.

7. A full wave rectifier comprising an enclosing vessel having a stem, a pair of uprights projecting from said stem, a pair of hollow anodes secured to said uprights, metallic inserts closing the open ends of said anodes, the insert adjacent said stem having twin apertures, supports extending from said stem and passing freely through the twin apertures, an electron emitting cathode within each of said anodes and supported by the respective supports passing through the twin apertures, and flared shielding members individually secured to said supports adjacent said apertures.

8. A full wave rectifier comprising an enclosing vessel having a stem, a pair of uprights projecting from said stem, a pair of cylindrical anodes secured to said uprights, said anodes having upper and lower closure portions, said lower closure portion having twin apertures, a U-shaped support extending from said stem and having an arm projecting into each of said anodes through one of each of said twin apertues, a folded ribbon cathode within each anode having one end adjacent the upper closure portion connected to the corresponding arm of said U-shaped support, a pair of short supports extending from said stem and projecting through the remaining apertures in said lower closure portions and connected to the other ends of the respective cathodes within said anodes, a pair of metallic spring spacers having triple arms mounted transversely beyond said anodes, each spacer having the similar arm slidably contacting with spaced portions of the wall of said vessel and the intermediate arm secured to one of said uprights and also contacting with a portion of the wall of said vessel, and metallic shields secured to said support arms and short supports and having flared portions substantially closing said apertures to deflect electrons emanating from said cathodes away from said apertures.

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