

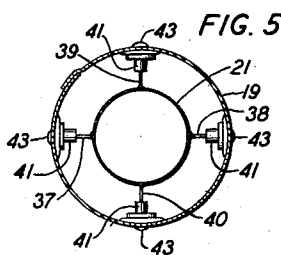
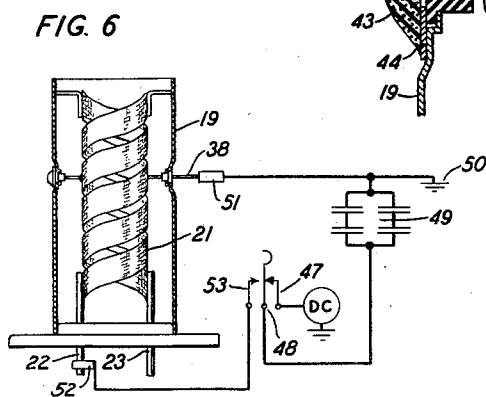
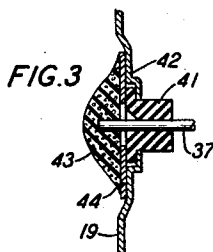
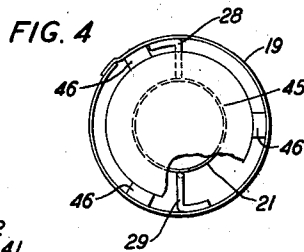
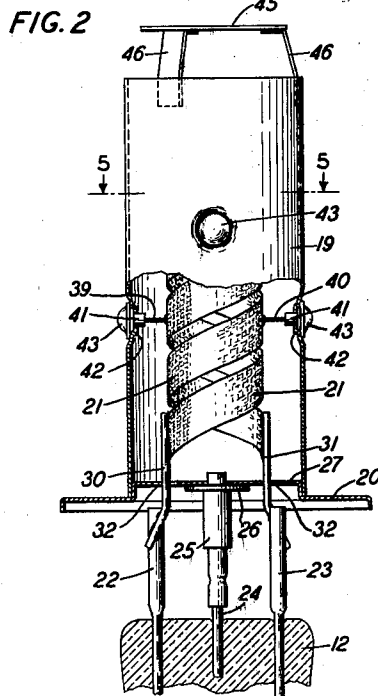
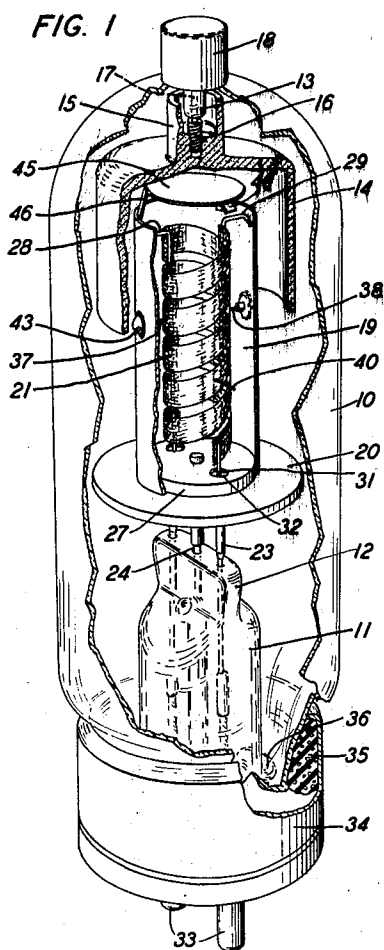
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V. L. RONCI

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ELECTRONIC DISCHARGE DEVICE

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INVENTOR
V. L. RONCI

BY

Walter C. Kiesel
ATTORNEY

UNITED STATES PATENT OFFICE

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ELECTRONIC DISCHARGE DEVICE

Victor L. Ronci, Brooklyn, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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10 Claims. (Cl. 250—27.5)

This invention relates to electronic discharge devices and more particularly to vapor discharge devices employing electron emissive cathodes.

An object of the invention is to conserve heat energy usually dissipated by radiation and convection in a glowing cathode structure.

Another object of the invention is to obtain stability in the cathode assembly and increase the operating efficiency of the discharge device.

In accordance with one aspect of this invention the improved structure may be embodied in a mercury vapor type rectifier comprising a vessel enclosing the cathode and anode. The anode is supported from one end of the vessel and the cathode, which is mounted coaxial with the axis of the vessel, is supported from the other end and extends into the cavity of the anode. In order to conserve the heat radiation of the cathode, a heat shield or casing is provided about the cathode.

A feature of the invention relates to the assembly of a ribbon cathode in which the relative position of the cathode, with respect to the anode and shield, is maintained constant by a plurality of radial arms extending from insulated sockets in the shield to rigidly space the ribbon cathode with respect to the shield. This arrangement insures stable operation of the rectifier due to the rigidity of the cathode assembly and its constant uniform relation to the anode of the rectifier device.

Another feature of the invention relates to the fabrication of the cathode unit to facilitate the assembly. This is accomplished by mounting the cathode ribbon coaxially in the heat shield or casing and welding the radial arms projecting into the casing to the cathode helix by a condenser discharge to rigidly affix the cathode to the casing at a plurality of medial points. This method overcomes distortion of the cathode configuration and avoids strains in the cathode surface. Furthermore, the cathode coating is not deteriorated in view of the localized effect of the weld.

These and other features of the invention will be more clearly understood from the following detail description when considered with the accompanying drawing:

Fig. 1 is a perspective view of the rectifier device embodying this invention in which portions of the vessel and the electrode elements are broken away to illustrate details of the assembly;

Fig. 2 is an enlarged view in elevation of the cathode assembly shown in Fig. 1 with a portion shown in cross-section to illustrate the detail construction;

Fig. 3 illustrates an enlarged view in cross-section of the insulated joint embodied in the cathode assembly of Figs. 1 and 2;

Fig. 4 shows a top plan view of the cathode assembly of Fig. 2 with a portion of the top shield broken away;

Fig. 5 is a cross-sectional view of the cathode assembly taken on the line 5—5 of Fig. 2; and

Fig. 6 illustrates a method of fabrication of the cathode assembly in which the welding equipment is shown schematically.

Referring to the drawing, the electronic discharge device, which in one aspect of this invention is a half wave mercury vapor rectifier, comprises an enclosing vessel 10, having a reentrant stem 11, terminating in a press 12, supporting a cathode assembly, and a reentrant stem or seal 13 at the opposite end of the vessel supporting an enclosing anode 14 which partially surrounds the cathode assembly.

The anode 14 is an inverted cup-shaped cylindrical mass of synthetic graphite molded and machined to the configuration shown and provided with an integral neck portion 15 having a hollow recess and threaded socket to receive the threaded head 16 of a leading-in conductor 17. The neck portion 15 protects the threaded joint and the glass forming the stem 13 around the conductor from bombardment by positive ions. This conductor terminates outside the vessel in a metallic cap or terminal 18.

The cathode assembly of the invention comprises a heat shield or casing formed of a cylindrical body portion 19 and a bottom closure disc portion 20 which substantially encloses an electron emitting cathode formed of two helical ribbons 21—21 arranged in a cylindrical boundary coaxial with the body portion 19 of the heat shield. These ribbons are formed of wire mesh cloth of suitable width and are coated with electron emissive material, such as oxides of alkaline earth metal. The ribbons are wound in the form of a double spiral with the turns of one ribbon alternating with the turns of the other ribbon to form a cylindrical convolute which may be arranged to surround the axis of the vessel 10 and present an emitting surface to the anode 14 for the conduction of large currents.

The details of the supporting structure of the cathode assembly are shown in Fig. 2 in which the shield casing is mounted on a central standard and the cathode ribbons are supported by the casing and the current conductors or leading-in wires sealed in the press. In the formation of the press 12 three parallel wires 22, 23 and 24 are sealed therein, the center wire 24 being terminated within the glass press. The latter wire forms a standard and is provided with a metallic cap 25 having a circular flange 26 which forms a seat for a central circular embossment 27 on the disc shield 20. The flange 26 is welded or soldered to the embossment 27 to provide a rigid connection and the cap is also

welded to the wire 24. The cylindrical shield 19 fits over the embossment 27 and is welded thereto at distributed points to form an enclosing casing or heat conserving shield for the ribbon cathode mounted within it.

The cathode ribbons 21 are arranged coaxially within the casing 19 and are supported at the top by wire straps 28 and 29 which are attached to the surface at the upper ends of the ribbons and extend radially to the adjacent portions of the shield 19. The ends of the wire straps are bent to follow the contour of the shield, as shown in Fig. 4, and are rigidly affixed thereto, as by welding. The lower ends of the ribbons are provided with wire extensions 30 and 31 which project longitudinally through apertures 32 in the embossment 27 and are bent outwardly and welded to the leading-in conductors 22 and 23, respectively. The latter wires extend through the stem 11 and are attached to terminal prongs 33 extending from a base 34 secured to the reduced end of the vessel 10 by cement 35. A filling of mercury 36 is also provided in the vessel to serve as the ionizing medium for the conduction of the discharge.

The cathode may be subjected to considerable distortion under high temperature operating conditions due to the length and the configuration of the cathode and the instability of the convolute during expansion and contraction. Therefore, in accordance with this invention these difficulties are avoided by anchoring the spiral ribbons at intermediate points so as to preserve their configuration and insure a stable structure of high efficiency. This is accomplished by attaching a plurality of braces or arms 37, 38, 39 and 40 to spaced turns of the ribbon cathodes 21 and connecting the arms to the casing or shield 19. These arms extend radially from the outer surface of the cathode ribbons and are anchored to the shield 19 and insulated therefrom. The anchoring arms are distributed along the length of the cylindrical configuration of the cathode to prevent damage due to mechanical shocks, to equalize the stresses produced in the ribbon by differences in temperature and to maintain the turns in axial symmetry with the heat shield.

The arms are located at points corresponding with each complete convolute of the spiral ribbons with respect to the adjacent terminating end of each ribbon cathode. This arrangement is realized more clearly from the drawing of Figs. 1 and 2 in which the upper end of one of the spiral ribbons is attached to the casing 19 by a strap 28 and the brace or radial arm 37 is located at the point of one complete turn of the ribbon so that the supporting points are in vertical alignment. Similarly, the upper end of the other ribbon is attached to the casing by the strap 29 and at the point of one complete turn the arm 38 is rigidly affixed thereto. The same stabilizing arrangement is present at the lower end of the cathode structure shown more clearly in Fig. 2. The lower end of one ribbon is attached to the wire extension 30 and the arm 39 is affixed at a point which constitutes a complete turn of the helix. The same relationship exists between the wire extension 31 and the arm 40 with respect to the other spirally formed cathode ribbon. The extensions 30 and 31 and the arms 39 and 40 are positioned at right angles with respect to the straps 28 and 29 and the arms 37 and 38 so that the ribbon cathode sections are braced against twisting distortion. Furthermore, not more than a complete turn of each ribbon is left unsup-

ported along the whole length of the cathode structure and therefore progressive distortion cannot endanger the operation of the cathode. It is within the scope of this invention to affix additional braces to the cathode assembly when the diameter thereof is enlarged to the extent where the braces can be spaced apart at points less than a complete turn of each helix.

The braces or radial arms extend through the heat shield casing 19, but are insulated therefrom to maintain a uniform temperature in the cathode and avoid energy loss in the casing. The insulated joint or socket between the arms and the casing is shown more clearly in Fig. 3 and consists of an insulating bushing 41 which extends through an aperture in the casing, the aperture being formed in a dished depression 42. This depression forms a seat for the enlarged portion of the bushing. The brace or arm extending through the bushing 41 is terminated slightly beyond the outer surface of the casing and is restrained from radial movement toward the axis of the casing by an insulating button 43 formed on the end of the arm. This button is produced by forming a plastic mass of a highly refractory cement, such as "alundum" cement, which is a highly fused aluminum oxide. A metallic washer 44 is interposed between the insulating button and the casing 19 to facilitate the assembly.

The configuration of the cathode ribbons insures a copious supply of electrons to enable the device to rectify high voltages at maximum efficiency and the radial truss bracing preserves the symmetry of the spiral ribbons whereby troublesome sagging or misalignment is overcome and consequent transitory operating life is avoided.

In high voltage gaseous rectifiers the active coating on the cathode may be poisoned or rendered inactive by back-emission from the anode and this is particularly to be avoided when the anode is formed of graphite or metals coated with graphite or carbonaceous material. The positive ions bombard the anode during the cycle when the device is not rectifying, and cause carbon particles to be released from the anode. These particles under the influence of the inverse potential attack the cathode coating and reduce the emission property thereof.

In order to overcome this difficulty a protective shield or disc 45 is mounted in the direct path between the anode and the cathode and any ionic bombardment is absorbed and dissipated by this shield. The shield is superimposed on the cylindrical heat shield casing 19 and supported therefrom by a plurality of spaced arms 46. This arrangement permits the egress of electrons from the cathode to the anode through the intervening gaps formed by the two shields, but eliminates contamination of the cathode coating by carbon particles.

The assembly of the cathode structure raises some difficulty due to the limits of the available space within the cathode casing. This difficulty is overcome in accordance with this invention by the use of discharge welding to secure the arms or braces to the cathode ribbons since it is impossible to employ the usual spot welding equipment in the limited space of the casing and other securing media could not withstand the high temperatures and strains or would be detrimental to the cathode by their quick cooling effect.

The method of this invention is shown schematically in Fig. 6 in which a direct current source of 250 volts having a grounded terminal is connected to a closed contact 47 of a switch 48 which

is connected to a multiple bank of electrolytic condensers 49 grounded at 50. The condensers are connected to a clip 51 which is connected to the arm or brace 38 and the leading-in wire 22 is engaged by another clip 52 which is connected to an open contact 53 of switch 48. When the switch is closed the bank of condensers immediately discharges at the point of high resistance produced by the contact of the arm 38 with the oxide coating on the cathode ribbon 21. This discharge produces a momentarily intense sparking effect at the point of contact which is sufficient to weld the arm 48 to the cathode ribbon. After the weld is completed the excess length of the arm is cut off and the insulating button is formed thereon as shown in Fig. 3.

While the invention has been disclosed with respect to a particular embodiment of the invention, it is, of course, understood that the invention is not limited to the structure shown, but may be employed in other devices. Furthermore, various modifications may be made in the arrangement of the related elements embodied in this disclosure without departing from the scope of the invention as defined in the appended claims and such modifications are intended to be included therein.

What is claimed is:

1. An electronic discharge device comprising a vessel having a stem, a cathode assembly supported beyond said stem, an anode in said vessel in spaced relation to said cathode assembly, said cathode assembly including a hollow metallic receptacle, a spiral ribbon cathode coaxially positioned in said receptacle, and outwardly extending supporting members attached to said cathode intermediate its ends and connected to said receptacle.

2. A rectifier device comprising a vessel having a stem at each end, an anode supported from one stem, and a cathode assembly supported from the other stem, said cathode assembly comprising a cylindrical shield, a spirally arranged electron emitting cathode positioned within said shield, supporting members for said cathode connected to said shield at the top thereof, leading-in wires in said stem connected to the ends of said cathode, and intermediate outwardly extending supporting members attached to said cathode and insulatingly connected to said shield.

3. An electrode mount for discharge devices comprising a cup-shaped metallic receptacle, a helical ribbon cathode mounted within said receptacle, said ribbon cathode having its surface equally spaced from the wall of said receptacle, and radial support members extending through the wall of said receptacle and secured to the surface of said cathode.

4. An electronic discharge device comprising a vessel, an anode within said vessel, a cathode unit having a portion extending into said anode, said unit comprising a cylindrical heat shield, a ribbon cathode non-inductively wound in double helical formation and coaxially supported in said shield, and projections extending through said shield and connected to said cathode.

5. An electronic discharge device comprising a vessel having a stem, an anode within said vessel, a cathode unit having a portion extending into said anode, said unit comprising a cylindrical shield, and a pair of ribbon cathode sections spirally wound in alternate relation in a cylindrical configuration coaxial with said shield, extensions on adjacent ends of said sections being connected to said shield, leading-in wires in said

stem, the opposite ends of said cathode sections being connected to said leading-in wires, and intermediate arms insulatingly connecting said sections to said shield.

6. An electronic discharge device, according to the preceding claim, in which said arms are arranged at equal angles with respect to said shield and cathode sections.

7. An electronic discharge device comprising a vessel having a stem, an anode within said vessel, a cathode unit having a portion extending into said anode, said unit comprising a cylindrical heat shield, and a pair of ribbon cathode sections spirally wound in alternate relation in a cylindrical configuration coaxial with said shield, extensions on adjacent ends of said sections being connected to said shield, leading-in wires in said stem, the opposite ends of said cathode being connected to said leading-in wires, and four arms supporting the intermediate portions of said cathode sections from said shield, one pair extending in opposed relation on one diameter of said shield and the other pair extending along a diameter at right angles to the first pair and in a different plane.

8. An electronic discharge device comprising an enclosing vessel having a stem, a standard extending from said stem, a circular shield having an embossed portion supported by said standard, a cylindrical shield portion superimposed on the embossed portion of said circular shield, a double spiraled cathode element coaxially positioned in said cylindrical shield, leading-in wires in said stem connected to the ends of said elements adjacent said circular shield, a cup-shaped anode extending from said vessel toward said cathode element, and arms extending from the surface of said element and connected to said cylindrical shield.

9. An electronic discharge device comprising an enclosing vessel having a stem, a standard extending from said stem, a circular shield having an embossed portion supported by said standard, a cylindrical shield portion superimposed on the embossed portion of said circular shield, a double spiraled cathode element coaxially positioned in said cylindrical shield, leading-in wires in said stem connected to the ends of said element adjacent said circular shield, a cup-shaped anode extending from said vessel toward said cathode element, said shield having spaced indentations on its circumference, insulating bushings seated in said indentations, a plurality of metallic braces extending from the surface of said element and projecting through said insulating bushings, and a plastic mass attached to each of said braces exterior of said shield.

10. An electronic discharge device comprising an enclosing vessel having a stem, a standard extending from said stem, a cup-shaped cylindrical heat shield supported by said standard, a double spiraled cathode element coaxially positioned in said heat shield, leading-in wires in said stem connected to the ends of said element adjacent one end of said heat shield, said heat shield having spaced indentations on its circumference, insulating bushings seated in said indentations, radially extending braces projecting from said cathode element through said bushings, and a dome-shaped mass of insulating material embracing the end of each brace, said mass securing said bushings and braces to said shield.

VICTOR L. RONCI.