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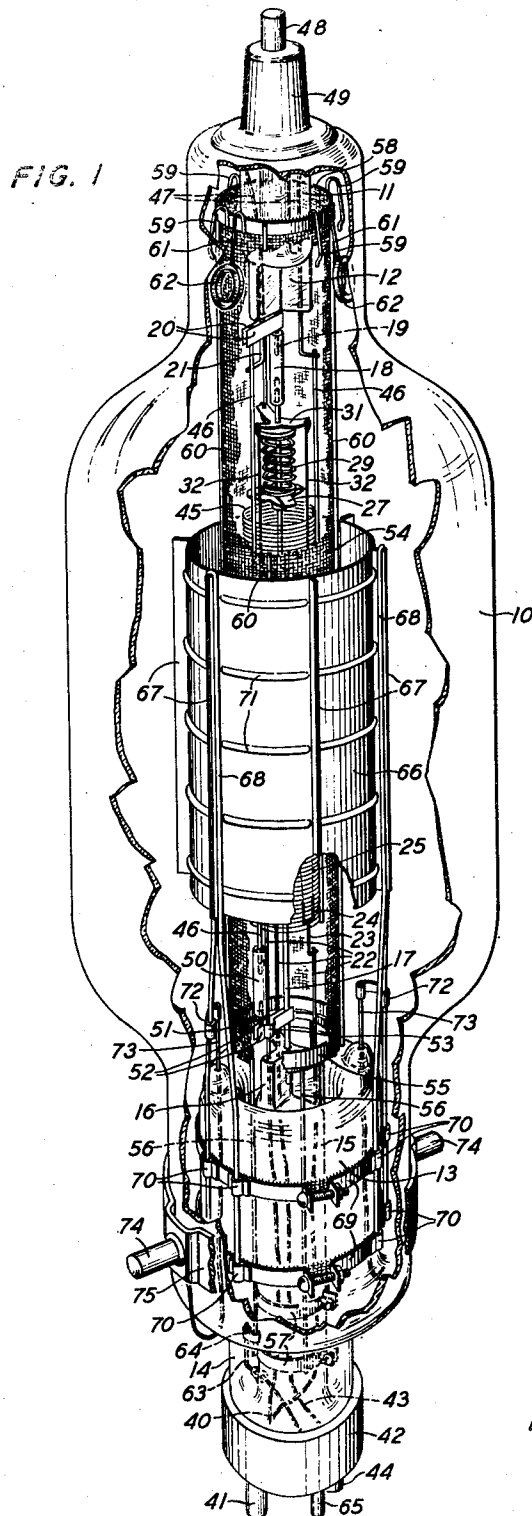
V. L. RONCI

2,082,120

ELECTRON DISCHARGE DEVICE

Filed May 3, 1934

2 Sheets--Sheet 1



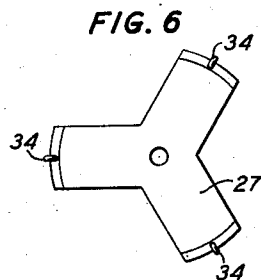
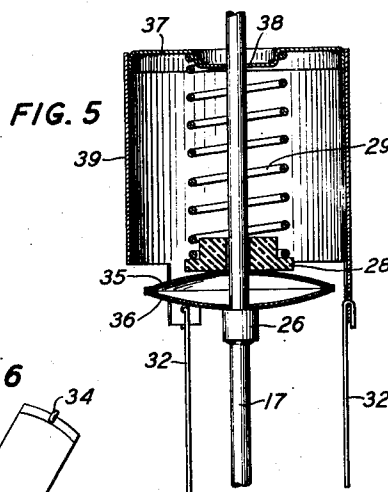
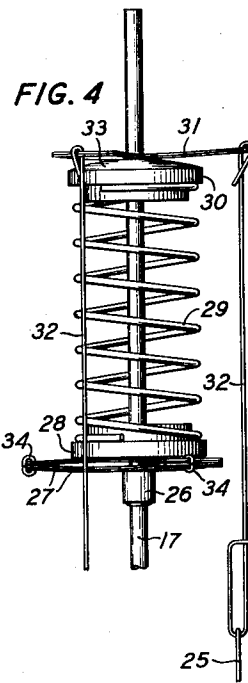
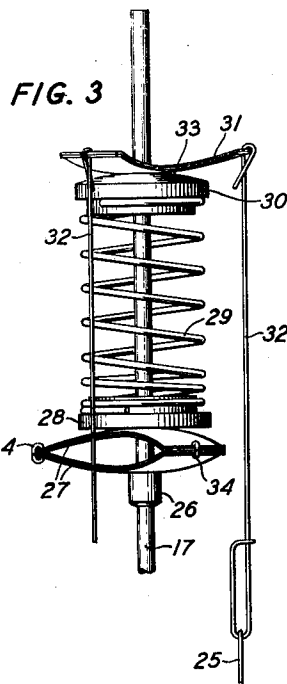
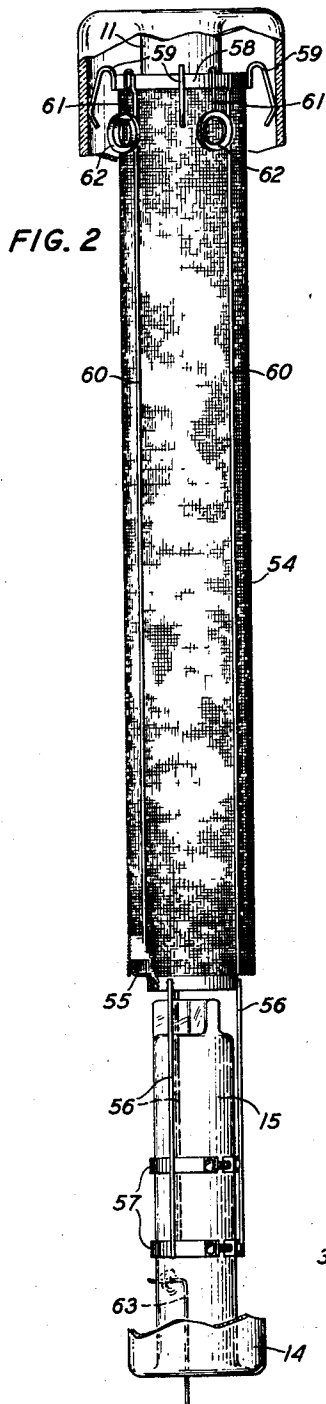
INVENTOR
V. L. RONCI
BY
Walter C. Kiesel
ATTORNEY

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V. L. RONCI
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ATTORNEY

UNITED STATES PATENT OFFICE

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ELECTRON DISCHARGE DEVICE

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

Application May 3, 1934, Serial No. 723,685

20 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to the supporting structures for the electrodes to be employed in high power discharge devices.

5 In discharge devices having a power output of the order of five hundred watts or more, the electronic source is usually in the form of a plurality of filament sections or strands of tungsten which are mounted on a standard and may be tensioned to maintain the strand in uniform spaced relationship with respect to the other electrodes in the device, such as the grid, or grids, and the anode. The tensioning is generally accomplished by helical springs and in order to preserve the tensioning characteristics they are also formed of tungsten. However, it has been found that the tungsten spring is deleteriously affected by intense heating during the manufacturing processes while under stress and obviously fails to perform its tensioning function.

20 An object of this invention is to insure the maintenance of a predetermined tension in one electrode of a discharge device and the proper spacing thereof with respect to the other electrodes.

25 In accordance with one aspect of this invention, the filament supporting structure includes a standard having a spreader or spacer member at one end for spacing several sections of filament in a suitable configuration. The spreader member is superimposed on a tension spring which in turn is adjacent a tension relieving structure which functions when excessive heating occurs in the vicinity of the tension spring to remove stress in the tension spring. Under normal conditions the tension relieving structure maintains the desired stress in the tension spring to obtain the required tension in the filament sections.

40 In a more specific aspect of the invention, the filament sections are held in spaced relation by a universally movable platform which is supported on a standard which also supports a tension mounting including spaced insulating members between which is the helical tension spring. The lower insulating member engages an auxiliary compensating element or tension relieving structure consisting of two opposed cupped bimetallic members which are arranged on the standard adjacent a stop member. A single bimetallic element is also provided on the opposite end of the tension spring and serves as a spreader for the hook members attached to the filament sections.

55 In another embodiment of the invention the filament sections are suspended from a shield

structure supported on the tension spring which in turn is superimposed on the compensating element consisting of two complementary bowed bimetallic discs which are seated on the central standard.

The primary function of the compensating element is to relieve stress in the highly refractory tungsten tension spring in order to avoid "setting" of the spring and thereby preserve the elastic and resilient characteristics of the spring. Of course, the bimetallic element also protects the tensioning spring during operation when excessive temperatures may endanger the characteristics of the spring. An advantage is also secured by employing the modified form of the invention since this structure completely shields the tension spring from the excessive heat generated in the device.

A feature of the invention relates to a mounting of the shield or screen electrode or grid and consists in rigidly securing one end thereof to a collar attached to a stem at one end of the vessel and forming a metallic rim around the other end which extends into an annular portion of the vessel between the stem and the wall of the vessel at the other end. A plurality of expanding fingers attached to the metallic rim engage the wall of the vessel to maintain the screen grid in uniform spaced relation with the control grid and anode. This structure facilitates the assembly of the electrode in the vessel and insures proper spacing of the electrodes and freedom from vibration, while permitting the screen grid to expand and contract due to temperature changes.

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

Fig. 1 is a perspective view of an electron discharge device illustrating one embodiment of the invention and the device is shown with portions of the enclosing vessel and the electrodes broken away to present details of the structure more clearly;

Fig. 2 is an enlarged view in elevation of the screen electrode or grid of the device shown in Fig. 1, illustrating the construction and mounting of the grid from opposite ends of the vessel which are only partly shown;

Fig. 3 is an enlarged view of the filament tensioning structure, in accordance with this invention, illustrating the position of the element on the standard and showing the auxiliary compensating element in normal position;

Fig. 4 illustrates the filament tensioning structure of Fig. 3 with the compensating element in

abnormal position to relieve stress in the tensioning spring;

Fig. 5 shows a modification of a feature of the invention, in cross-section, in which the compensating elements are opposed discs and the filament suspension element forms a shield around the tensioning structure; and

Fig. 6 is a plan view of the form of the compensating element shown in Figs. 3 and 4.

Referring now to the drawings, an electron discharge device illustrative of the various embodiments of this invention comprises a double-ended enclosing vessel 10 having a reentrant stem 11 at one end thereof terminating in a press 12 having a plurality of radiating arms. The other end of the enclosing vessel 10 is provided with a plurality of cylindrical stems 13, 14 and 15 which are joined at contiguous edges and are coaxially disposed with respect to each other and the enclosing vessel 10. The innermost stem 15 which is reentrant with respect to the other stems and the enclosing vessel terminates in a press 16 similar to the press 12 and is disposed in axial alignment therewith.

A filamentary cathode assembly, a portion of which is shown in detail in Figs. 3 and 4, is supported from the press 16 and comprises a central standard 17, which has one end embedded in the press 16 at the center thereof and extends lengthwise and axially of the vessel 10. The other end of the standard 17 is slidably disposed in an insulating sleeve 18 which is supported from the stem 11 by a short stub wire 19 embedded in the sleeve 18 and carried by a pair of metallic strips 20 which are in turn welded to a bent wire 21 embedded in one of the arms of the press 12.

A plurality of rigid wires 22 are embedded in the arm of the press 16 and extend parallel to the standard 17. Each of the wires 22 carries a bent connector wire 23 which in turn is secured to a U-shaped member 24. These wires are secured to and form the rigid connections for supplying heating current for a filamentary cathode formed of three V-shaped sections 25, of tungsten, arranged in a cylindrical boundary around the standard 17 and maintained in definite spaced relation with respect to the other electrodes in the device and held under a suitable tension by a universally flexible superstructure shown in Fig. 3. The superstructure is loosely held on the standard 17 and limited in its movement in a downward direction by an enlargement or stop collar 26. The successive elements of the superstructure above the stop collar 26 are the auxiliary compensating elements 27, flanged insulating disc 28, helical tension spring or compression spring 29, flanged insulating disc 30, and spreader compensating element 31. The spreader member 31 carries a plurality of suspension hooks 32 which engage the bights of the filament sections.

The helical tension spring 29 of tungsten is seated between the flanged insulating discs 28 and 30 and this assembly slides on the standard 17 until it rests against the auxiliary compensating elements 27. The spreader member 31 is provided with an aperture to slip over the standard 17 and rests on the conical surface 33 of the insulating disc 30. This construction allows substantially unrestrained expansion and contraction in all directions of the sections of the filament 25 with temperature variations, and thereby prevents the setting up of deleterious stresses

within the cathode sections. The variations occasioned by longitudinal or rotative movement of the sections of the cathode are compensated for by the compression spring 29 so that a substantially constant tension is maintained in the sections of the cathode 25 and the proper form of the cathode is preserved. The arrangement of the spreader arms together with its position with respect to the conical surface of the top insulator, compensates for unequal expansion of the several sections of the cathode and thereby further prevents excessive strains in the cathode and preserves the proper form of the cathode.

The tungsten tension spring 29 is a highly refractory metal which can withstand high temperatures without endangering the resiliency of the spring. However, above a certain safe temperature region, tungsten, because of its peculiar characteristics, becomes soft and plastic, which condition is only temporary, for when the tungsten is cooled to a temperature within the safe region it assumes its original condition without crystallization and is not materially modified like other metals. This transformation occurs in tungsten when in a normal unconstrained state. However, the transformation is not completed if the tungsten is maintained under stress during the excessive heating period. Under these conditions the tungsten becomes plastic and after cooling, "setting" occurs with the result that it does not revert to its original condition. Consequently the tungsten spring loses its resilient characteristic and fails to function as a tensioning member.

Such deleterious overheating is likely to occur during the manufacture of the tube when the elements of the device are heated to high temperatures to remove occluded gases. An efficient method of heating the elements to remove occluded gases is the high frequency induction method in which a high frequency coil surrounds the exterior of the vessel and induces an electric field in the metallic parts of the device to heat them to a high temperature. Due to the location of the filament supporting structure in the axis of the vessel, it is obvious that the tensioning superstructure of the filament cannot escape the radiant heat directed from the adjacent large surface electrodes. Furthermore the screen electrode substantially encloses the tensioning structure so that when this electrode is heated to a high temperature, the tension spring is in the center of an intense heat area.

In order to counteract the effect of this excessive heating of the tension spring in accordance with this invention, the compensating elements 27 and 31 serve as stress relieving members by permitting the tension spring to expand, thereby permitting the spring to pass through the transformation phase during the heating and cooling of the spring. Therefore, the spring does not attain a set condition in which resiliency is lost or impaired. The effect of relieving the stress in the tensioning spring 29 is obtained from the shape and properties of the compensating elements which are formed of bimetallic members having an outer layer of commercial iron, known as "invar" and an inner layer of nickel or a nickel alloy, the two layers being welded together in face to face relation and the layers being formed into concave configurations. These layers have different coefficients of expansion and contraction and the "invar" layer has a lower

expansion than the nickel layer. Consequently it is preferable to form the element with the "invar" layer on the outer surface of the concavity. The form of the compensating element is clearly shown in Fig. 6 in which the element is provided with a plurality of radial arms which form a spider and by referring to Fig. 3 it will be noted that the lower element 27 is concave while the upper element 27 is convex and the complementary arms of the elements are joined together by links 34.

The spreader compensating element 31, which is made of the same material and given the same shape and configuration as the lower compensating element 27, performs the same function as the lower compensating element at the opposite end of the tensioning superstructure. The transitional effect of the compensating elements will be better understood from a comparison of the filament tensioning structures shown in Figs. 3 and 4 in which Fig. 3 shows the normal position of these elements, while Fig. 4 shows the changes occurring in the structure under a condition, for instance, when a high heating temperature is present. The characteristics of the bimetallic elements cause these elements to change their shape due to expansion within a range of temperatures safely below the temperatures at which the tungsten spring is affected adversely. Within this range of temperatures, the bimetallic elements flatten out thereby permitting the tension spring to expand to such a degree that the lower turns are separated and do not form a complete circuit for the initiation of the heating effect of the spring. The bimetallic elements also tend to remove the stress in the spring so that it is not in a strained condition.

Upon the removal of the heating source the bimetallic elements slowly resume their normal positions as shown in Fig. 3, thereby returning the tension spring to its stressed condition for applying tension to the filament strand gradually so that there is no undue stress set up in the strand during the transition period.

While the structure described in Fig. 3 forms one embodiment of the invention as applied to the filament supporting structure, a modification of the invention may be practiced as shown in Fig. 5, in which the auxiliary compensating element at the lower end of the tension spring 29 is formed of two opposed cupped discs 35 and 36 which have the same kind of bimetallic layers as described in connection with the compensating elements 27 and 31. In place of the spreader member 31, a flanged metallic disc 37 having a central depressed portion 38 is seated upon the tension spring 29 and slides on the standard 17. The flanged disc carries a downwardly extending metallic skirt 39 in the form of a cylindrical shield which encloses the tension spring assembly and the skirt or shield is provided with depending integral projections having apertures to receive the filament hooks 32. This arrangement together with the compensating discs forms a substantially complete enclosure around the tension spring and consequently tends to deflect the heat generated in the device from the tension spring 29.

Referring again to Fig. 1, a plurality of leading-in conductors are sealed in the stem 15 and are connected to the wires 22. Two of the conductors 40 are connected to a terminal 41 on a base 42 attached to the stem 14, while the other conductor 43 is attached to the terminal 44 on the base.

The sectional filament 25 is surrounded by a

helical control grid 45 which is supported on three equidistant parallel rods 46, each rod being supported by a bent wire extending from the press 12, similar to the wire 21 described heretofore. These wires are secured to leading-in conductors 47 which extend to a terminal 48 located on the end of an insulating bushing 49 secured to the end of the vessel 10. The length of the control grid 45 and its close spacing with respect to the filamentary cathode 25, requires a sustaining member at the free end in order to prevent the grid from vibrating and also to maintain the special relation with the other electrodes in the device. The grid electrode 45 is sustained in accurate position and at the same time permitted to expand and contract freely in a longitudinal direction by a guiding arrangement which includes one of the grid supporting rods 46 which is lengthened whereby it enters a quartz sleeve 50, the rod 46 being permitted to slidably move in the sleeve 50, but prevented from moving in a transverse direction. The sleeve 50 is rigidly held in a vertical position by a stub wire 51 sealed in the lower end and the stub wire being held between two metallic straps 52 which extend inwardly in a radial direction and are secured to the standard 17. It will be noted that the straps 52 extend in a direction occupied by one of the filament supporting wires 22 and in order to preserve the insulation of this wire, the straps 52 are provided with complementary nodes 53 which form a sufficient insulating space around the filament supporting wire 22.

The control grid is surrounded by a cylindrical screen or shield electrode or grid 54 which extends a considerable distance beyond the ends of the cathode and control grid toward the stem 13 and also extends in the opposite direction toward the stem 11 to reduce the capacity between the electrodes.

A further feature of the shield grid assembly in accordance with this invention is the slidable support of the shield grid on the internal wall of the end of the vessel 10 so that the shield grid does not vibrate and may expand and contract thereby avoiding distortion of the grid and the alteration of the characteristics of the device. While Fig. 1 shows the arrangement of the screen grid 54 with respect to the other electrodes in the device, it is believed a clearer understanding of the construction and assembly of this electrode may be obtained from Fig. 2 which shows the grid segregated from the other electrodes and the cooperating parts of the enclosing vessel with which it makes contact. The screen electrode 54 consists of a long cylinder of wire mesh which is provided with metallic reinforcing ends, one of the ends being a cup-shaped annular metallic collar 55 having flanges of two different diameters, the flange of larger diameter being welded to the interior surface of the wire mesh cylinder while the flange of smaller diameter, which incidentally corresponds to the diameter of the stem 15, forms a rim to which the vertical support rods 56 are attached and these rods are secured to metallic collars 57 which are clamped in spaced relation on the stem 15.

The other end of the mesh cylinder 54 is provided with a metallic collar 58 which carries a plurality of bent resilient fingers 59 which are spaced at equidistant positions and slidably engage the interior wall of the end of the vessel 10 adjacent the stem 11. In order to increase the rigidity of the screen electrode 54, a plurality of strengthening rods 60 are welded to the ex-

terior surface of the cylinder and are attached at opposite ends to the collars 55 and 58.

Another feature of the grid structure of this invention is the provision of the collar 58 of a low expansion metal such as "invar" to preserve the configuration of the grid and thereby protect the resilient fingers 59 from undue stress which might interfere with the proper functioning of the sliding support of the fingers. This improved grid structure also serves as a support for the "getter" receptacles. The collar 58 is provided with two bent wires 61 which carry grooved rings 62 in which is held an easily vaporized metal, such as magnesium, which is heated to a vaporizing temperature in the final stages of the evacuation process to deposit a film of magnesium on the adjacent wall of the tube to trap residual gases which cannot be removed by the ordinary pumping method. A leading-in conductor 63 for the screen electrode 54 is provided in the side wall of the stem 15 and is joined to one of the support rods 56 by a strap 64 while the external end is secured to the terminal 65 on the base 42.

The screen electrode and the other enclosed electrodes are surrounded by a cylindrical anode 66, of molybdenum, which is disposed concentrically about the other electrodes and comprises a plurality of arcuate metallic sections having integral flanges 67, the flanges of adjacent sections being positioned in face to face relation and connected by hairpin-shaped supporting rods which extend downwardly to spaced collars 69 clamped about the stem 13. The supporting rods are attached to collars by welded straps 70. The metallic surface of the anode 66 may be roughened, by carborundum blast, or carbonized, to increase the heat radiation from the electrode and the surface may also be provided with corrugations or embossments 71 to prevent distortion of the anode by heat during the operation of the device. The anode 67 is connected to an external circuit through metallic straps 72 which are connected to the support rods 68 and to leading-in conductors 73 which extend from the joined edges of the stems 13 and 14, the external ends of the leading-in wires being connected to terminals 74 mounted on a split metallic collar 75 clamped about the end of the enclosing vessel encircling the stem 13.

Although the invention has been disclosed in detail with reference to a specific embodiment of a complete electron discharge device, it may, of course, be embodied in other devices such as gaseous or vapor discharge devices. Furthermore, various modifications may be made in the specific details shown and described in connection with the disclosure of this invention without departing from the scope and spirit of the invention as defined in the appended claims.

What is claimed is:

1. A supporting assembly in a discharge device comprising an electrode, a supporting member, tensioning means carried by said supporting member and coupled to said electrode, and auxiliary compressible means adapted to cooperate with said tensioning means to regulate the stress in said tensioning means under abnormal heating conditions.

2. A suspension assembly for a cathode comprising a central standard, a tension spring adjacent said standard, spacing means supported by said tension spring, the cathode being suspended therefrom, and yieldable means supporting said spring on said standard.

3. A suspension assembly for a cathode having

a plurality of filamentary strands comprising a central metallic rod, a helical tension member insulatingly spaced from said rod, a spacing member supported on said tension member, said strands being suspended from said spacing member, and yieldable means supporting said tension member on said central rod.

4. A suspension assembly for a cathode having a plurality of filamentary strands comprising a central metallic rod, a helical tension member insulatingly spaced from said rod, a spacing member supported on and extending outwardly from said tension member, said strands being arranged in a boundary around said rod and suspended from said spacing member, and yieldable means on said rod supporting said tension member, said tension member, spacing member and yieldable means being slidably mounted on said rod.

5. A suspension assembly for a cathode having a plurality of filamentary strands comprising a central standard, a tension spring surrounding said standard, said filamentary strands being arranged in a boundary around said standard, means spacing said strands from said tension spring, and a yieldable bimetallic element supporting said tension spring on said standard.

6. An electronic discharge device comprising a vessel containing an anode, a cathode having a plurality of strands surrounded by said anode, a central support for said cathode, a tension member carried by said support for applying a desired stress on said strands to maintain them in uniform spaced relation with respect to said anode, and pressure relieving means on said support in operative relation to said tension member.

7. An electronic discharge device comprising a vessel containing an anode, a cathode having a plurality of strands surrounded by said anode, a central support for said cathode, tension means carried by said support for applying a desired stress on said strands to maintain them in uniform spaced relation to said anode, and bimetallic members on said support adapted to relieve the stress in said tension means when heated to abnormal temperatures.

8. A discharge device comprising a vessel containing an anode, a cathode having a plurality of strands surrounded by said anode, a central support for said cathode, a tension member carried by said support for applying a desired stress on said strands to maintain them in uniform spaced relation with respect to said anode, and yielding members adjacent opposite ends of said tension member, said members being capable of altering the stress in said tension member under abnormal heating conditions, while maintaining said cathode strands in normal relation.

9. A discharge device comprising a vessel containing an anode, a cathode having a plurality of strands surrounded by said anode, a central support for said cathode, a tension member carried by said support for applying a desired stress on said strands to maintain them in uniform spaced relation with respect to said anode, and oppositely disposed concavo-shaped members resiliently supporting said tension member on said support.

10. A discharge device comprising a vessel containing an anode, a cathode having a plurality of strands surrounded by said anode, a central support for said cathode, tensioning means carried by said support for applying a desired stress on said strands to maintain them in uniform

spaced relation with respect to said anode, and oppositely disposed dished members supporting said tensioning means on said standard, said members having layers of different coefficients of expansion and contraction.

11. A discharge device comprising a vessel containing an anode, a cathode having a plurality of strands surrounded by said anode, a central support for said cathode, tensioning means carried by said support for applying a desired stress on said strands to maintain them in uniform spaced relation with respect to said anode, and oppositely disposed dished metallic members having separate layers of high and low coefficients of expansion and contraction, the layers thereof of high expansion being faced toward each other, said members supporting said tensioning means.

12. A discharge device comprising a vessel containing an anode, a cathode having a plurality of strands surrounded by said anode, a central standard for said cathode, a tensioning member carried by said standard for applying a desired stress on said strands to maintain them in uniform spaced relation with respect to said anode, and oppositely disposed dished members resiliently supporting said tensioning member on said standard, each of said dished members having contiguous layers of "Invar" and nickel.

13. A discharge device comprising a vessel containing an anode, a cathode having a plurality of strands surrounded by said anode, a central standard for said cathode, tensioning means carried by said standard for applying a desired stress to said strands to maintain them in uniform spaced relation with respect to said anode, and oppositely disposed concavo-shaped members having radially extending arms resiliently supporting said tensioning means on said standard.

14. A discharge device comprising a vessel containing an anode, a cathode having a plurality of strands surrounded by said anode, a central support for said cathode, a tension member carried by said support for applying a desired stress on said strands to maintain them in uniform spaced relation with respect to said anode, and oppositely disposed bimetallic members resiliently supporting said tension member on said support, said bimetallic members having outwardly extending arms arranged in uniform pairs with the edges of the arms only in contact.

15. A discharge device according to claim 14, in which links join the ends of the arms together.

16. A discharge device comprising a vessel containing an anode, a cathode having a plurality of strands surrounded by said anode, a central support for said cathode, a helical tension spring carried by said support, yieldable bimetallic members adjacent opposite ends of said tension spring, said members having radially extending arms, the arms of one of said yieldable members at one end of said spring projecting at intermediate angles with respect to the arms of another yieldable member at the other end of said spring, and means connecting said strands to the arms of one of said yieldable members.

17. An electronic discharge device comprising a vessel containing an anode, a cathode having a plurality of strands surrounded by said anode, a control grid between said cathode and anode, a screen grid between said control grid and anode and comprising a wire mesh cylinder, metallic ring members at opposite ends of said wire mesh cylinder, strengthening rods extending between the rings and welded to the exterior surface of said cylinder and said rings, clamping means on one end of said vessel, one of the rings having an integral collar of smaller diameter in alignment with said clamping means, supports secured to said collar and clamping means, and expansion fingers extending from said other ring and engaging a boundary wall of said vessel.

18. A suspension assembly for a cathode having a plurality of filamentary strands, including a supporting member, a tension spring surrounding said member, oppositely disposed dished bimetallic members fitted on said member and resiliently supporting said tension spring, a metallic shield supported by and surrounding said tension spring and forming with said dished members a complete enclosure for said spring, and a plurality of hooks connecting said strands to said shield.

19. An electron discharge device comprising an enclosing vessel having inwardly projecting stems at opposite ends thereof, a central support rigidly held in one of said stems and yieldingly supported from the other stem, a cathode having a plurality of filamentary strands surrounding said support, bimetallic yielding members located on said central support, a helical tension spring superimposed on said bimetallic members, a spreader member on said central support adjacent said tension spring, suspension hooks connected to said spreader member and said filamentary strands, a helical control grid surrounding said filamentary strands, upright supports attached to said control grid and rigidly affixed to one of said stems, a guiding support extending from the other stem and engaging a grid support, a cylindrical wire mesh screen grid surrounding said control grid and filamentary cathode, said screen grid having metallic ring terminations, upright supports connected to one of said ring terminations, clamping means on one of said stems for said upright supports, a plurality of equally spaced expansion fingers on the other of said ring terminations, said fingers engaging a wall of said vessel adjacent the other stem, and a cylindrical anode formed of arcuate sections joined together surrounding said wire mesh screen grid and supported from the end of said vessel adjacent said stem supporting said cathode and screen grid.

20. A suspension assembly for an electrode comprising a supporting member, tensioning means associated with said supporting member, and compressible means subjacent said tensioning means adapted to automatically relieve stress in said tensioning means under abnormal heating conditions.

VICTOR L. RONCI.