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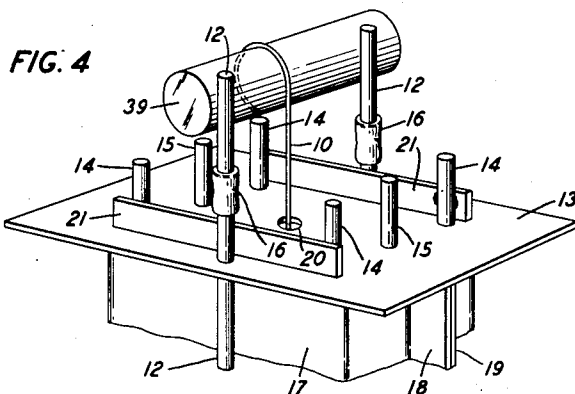
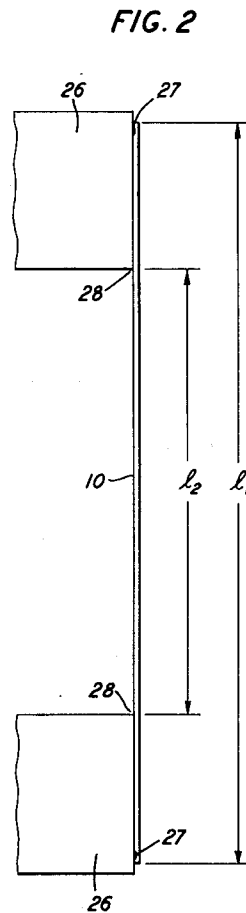
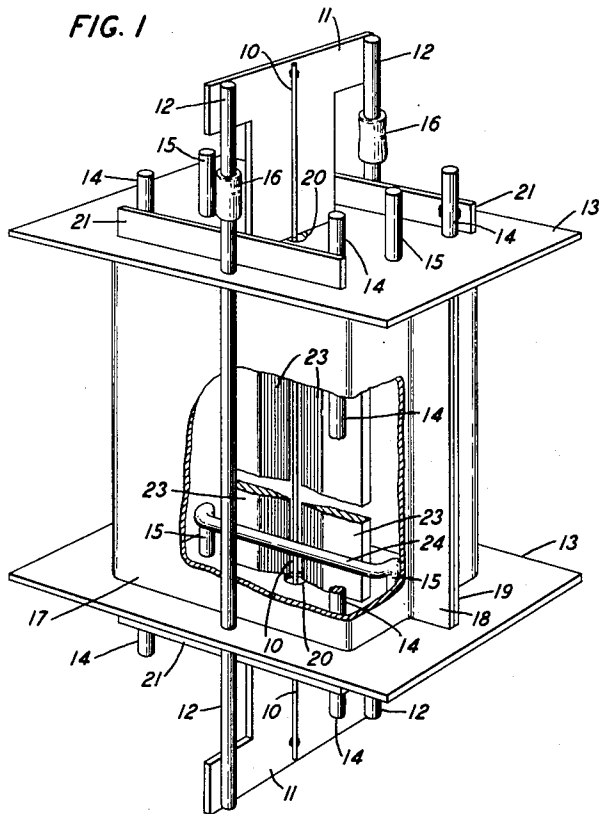
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2,649,553

FILAMENTARY CATHODE SUPPORT STRUCTURE

Filed Sept. 2, 1950

2 Sheets-Sheet 1



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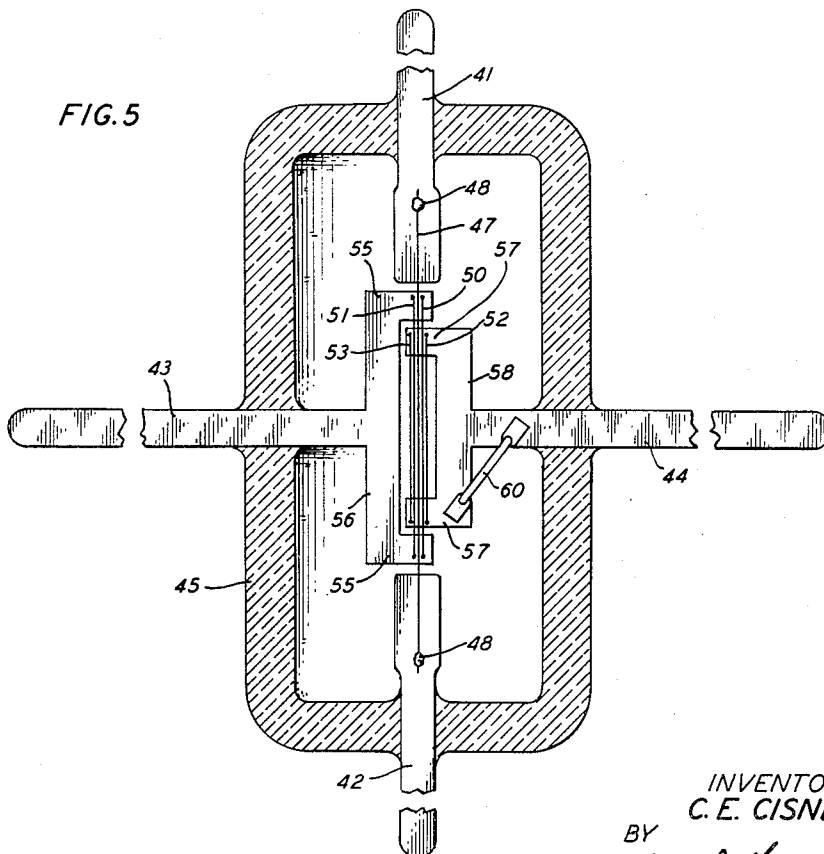
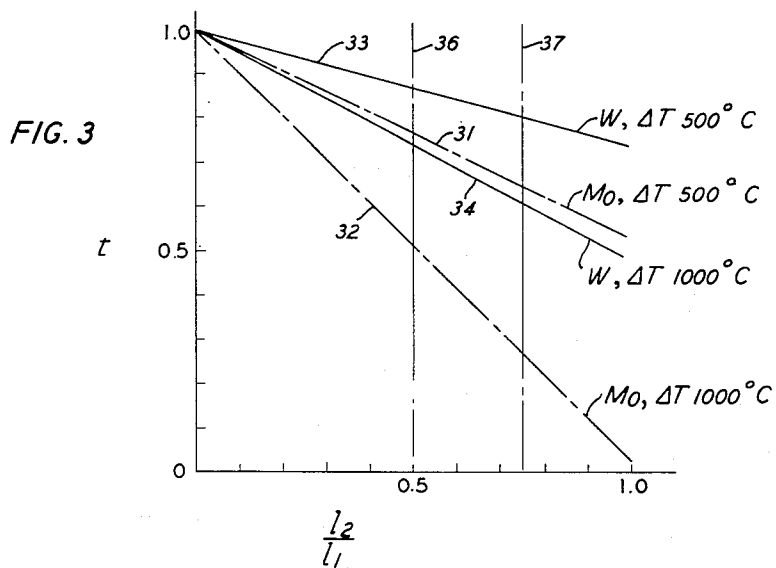
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FILAMENTARY CATHODE SUPPORT STRUCTURE

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2 Sheets-Sheet 2



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FILAMENTARY CATHODE SUPPORT
STRUCTURE

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Application September 2, 1950, Serial No. 183,005

14 Claims. (Cl. 313—37)

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This invention relates to electron discharge devices and more particularly to electrode assemblies for such devices.

It is well known that any movement of an electrode or a part thereof in an electron discharge device is undesirable, particularly when the movement is in the form of a periodic departure from the normal position of the electrode. Such a periodic departure causes an undesired modulation of the electron stream and this deleterious phenomenon has become known as microphonism. The forced vibrations can be imparted to the electrode in various electrical or mechanical ways. Thus an oscillation can be set up due to the frequency of operation or due to a shock induced displacement in any member. But microphonism particularly occurs when there is any modification of the control electrode to emitter or cathode spacing by a forced vibration in one or both of these two electrodes or by variations in interlateral spacing of a single control electrode induced by the same means.

Where the longitudinal dimension to transverse dimension ratio of the electrode is not particularly high, these oscillations which give rise to microphonics are not prevalent. It has therefore been found advantageous in such cases where the desired electrical characteristics permit of it either to employ electrodes having a low ratio of longitudinal to transverse dimensions or to employ with the electrodes cooperating member's rigidly connected to the electrodes and which provide a single oscillating system which can be considered as having a low ratio. However, in certain cases it is not possible to maintain this ratio within a maximum value below which microphonic effects are not prevalent. As this ratio increases the problem becomes more acute, becoming of great importance in cases of single strand electrodes. Such electrodes have been increasingly used in recent years, particularly as single strand emitters in subminiature and close spaced electron discharge devices. The problem is also of importance with other electrodes, such as, among others, control electrodes comprising a plurality of very fine taut wires or laterals.

In such devices where single strand electrodes, which have a very high ratio of longitudinal to transverse dimensions, have been employed, the electrodes are initially stressed, usually to a substantial percentage of the breaking strength of the electrode. Priorly various suggestions have been made for high pretensioning of grid laterals or for constant tensioning of filamentary emitters in attempts to prevent the disappearance of this initial tension and to produce a mechanical system having a high resonant frequency so that a given energy will produce the minimum displacement.

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But there are inherent limitations in the stressing of the electrode elements imposed by the low breaking strength of the very fine wires employed and further by the decrease in the tension of the elements, such as grid wires, during processing when they are brazed or otherwise secured to the side laterals or supporting members, the wires being secured to the side laterals over the entire length of contact with the side laterals.

There are also limitations and disadvantages in attempting to employ cantilever spring members at one end of a hot filamentary emitter to maintain a substantially constant force on the filament as it elongates from its cold to hot condition and thus prevent the appearance of slack in the filament which would increase the amplitude of any oscillation or vibration with a resultant increase in the microphonism of the device. Spring systems constrain the filament only along the axis of the filament and allow a relatively high degree of freedom for transverse motion; this may be partially corrected by drawing the filament over a grooved member, but this introduces another member into the spring mechanism. The size of the spring mechanism has been found to be disproportionately large in comparison to the essential electrode structure in very minute vacuum tubes, in which the operative emitting surface of the filamentary cathode may be only one-quarter inch long. Another disadvantage of spring tensioning methods for these filaments is that vibrations in the spring system, from whatever reason they may arise, tend to exist in the naturally resonant spring structure and are translated into vibrations in the filament tension. These and the other disadvantages of the use of spring tensioning mechanisms to tension single strand electrodes are particularly important when exceedingly fine wires, such as of the order of 0.0003 inch diameter are employed, as the breaking strengths of such wires are on the order of a few grams. When such very small tensions are employed, there are additional difficulties due to the large mass of the spring as compared to the small mass and tension of the filament.

While these problems are present in all electrodes or filamentary laterals thereof in which there is a very high longitudinal dimension to transverse dimension ratio, and electron discharge devices including such electrodes thus present a mechanical system favorable to the presence of oscillations, they are particularly acute with respect to single strand emitters because of the higher temperature to which such emitters are raised. This rise in temperature increases the length of the filament and thereby causes a reduction in the tension of the filament.

One object of this invention is to maintain ten-

sion in electrode wires having a high longitudinal dimension to transverse dimension ratio, thereby preventing slackness in the wire and resulting microphonics in the electron discharge device.

Another object of this invention is to tension such electrodes by means of the initial tension of the electrodes themselves thereby obviating the necessity for cumbersome spring mechanisms.

A further object of this invention is to improve electron discharge devices.

A still further object of this invention is to mount a plurality of single strand electrodes so that the electrodes are located in a single plane and each electrode is tensioned by the initial tension within itself alone.

A still further object of this invention is to facilitate the fabrication of electron discharge devices and more specifically to allow the fabrication of the supports for all the electrodes of an electron discharge device in a single operation.

These and other objects of this invention are accomplished, in accordance with this invention by mounting the electrode, or filamentary portion thereof, to be maintained under tension between two rigid supporting members, a heat sink being provided intimately adjacent one or both ends of the electrode and extending for a substantial portion of the total length of the electrode. A heat sink may be considered in this specification as descriptive of a member of some mass possessing good thermal and electrical conductivity which may be placed in free and continuous contact with the electrode between the end of the electrode, which is the point of mechanical attachment of the electrode, and the heated length of the electrode, and which experiences substantially no change in temperature with changes in temperature of the heated length of the electrode. In such cases where the electrode is the emitter of the device the heated length of the electrode is that portion heated by the current passing therethrough.

Thus in accordance with one feature of this invention, the electrode, which may be a single wire, is tensioned between two points, this initial tension being a certain percentage of the breaking strength of the wire. By providing a heat sink in intimate contact with one or both of the ends of the wire only the portion of the wire not in contact with the heat sink will experience any rise in temperature whether the wire is employed in the device as a control electrode, emitter, or other electrode. When this portion of the wire expands and thus tends to become slack, the remainder of the wire communicates some of its original tension to the portion of the wire not in contact with the heat sink and thus acts as a spring to pull the wire taut, thereby removing the slack introduced by the expansion of the portion not in contact with the heat sink. By thus maintaining a certain length of the filament at its original temperature with no decrease of its original tension or stored energy due to temperature changes, this length which is in thermal contact with the heat sink serves as a spring which absorbs a large portion of the elongation occurring in the heated length of the wire with only a moderate decrease in the filament tension from the cold to hot condition.

The filamentary electrode is secured to the rigid mounting supports at only two points, i. e., at its ends, and is not brazed or otherwise secured to the support or heat sink means at any other point or points. Thus, while the filamen-

tary electrode is contiguous to the heat sink for a substantial portion of its length, the portion adjacent or contiguous to the heat sink is a free length, free to expand or contract along the axis of the filamentary electrode as its initial tension acts as an integral spring to tension the heated portion of the electrode. The percentage of the total length of the electrode that is maintained as a free length adjacent the heat sink and thus at its initial tension will depend on the employment of the electrode in the device and the percentage of the original tension it is desired to maintain. For example, control electrodes may only suffer an increase in temperature of from 100° to 700° C. whereas emitter electrodes will increase in the range of 800° C.

In one specific embodiment of this invention, a single strand filamentary cathode is positioned between knife-edge control electrodes and adjacent an anode, the filamentary cathode being mechanically attached at both ends to flat tabs which serve as supports and which are in intimate contact with the filamentary cathode over a portion of the length of the cathode, the tabs thus serving as heat sinks. The length of the filament between the points of mechanical attachment and the points of last contact with the heat sinks may advantageously be from one-quarter to one-half of the total length of the filament.

In another specific embodiment of this invention, the heat sink may be rods around which each end of the filament is turned, the filament being attached to the rods only at the ends of the filament and being in contact with the rods over the larger portion of the circumferences thereof, whereby the ratio of the length of the wire in contact with the heat sinks to the total length is sufficiently high to allow proper self-tensioning of the heated filament.

In still another specific embodiment of this invention, the electrodes of an electron discharge device are a plurality of coplanar single strand wires, each of the wires being secured to a heat sink at its both ends for a sufficient length of the wire to provide self-tensioning of the wire when heated during operation of the device. Specifically the center fine wire may be the emitter and be secured to heat sinks comprising flat portions extending along the axis of the emitter and through the envelope of the device, the next outer two fine wires may be the control electrode, and the two outermost fine wires the anode of the device. The control electrode wires and the anode wires may be each supported by U-shaped flat members having portions extending through the envelope of the device transverse to the alignment of the wires, the arms of the U's defining heat sinks whereby the tension in the wire electrodes is maintained solely by means of the initial tension therein.

Advantageously in this last embodiment the various flat support members for the electrodes are fabricated at the same time as by being stamped out of a single piece of metal in a single operation. Further advantageously the terminals of these support members are left integral with the matrix sheet until after the electrode wires have been secured to the support members and assembly enclosed in bulb or envelope, the terminals then being punched or sheared out of the matrix sheet of metal before the device is evacuated and sealed off.

It is one feature of this invention that electrodes or laterals thereof having a high longi-

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tudinal dimension to transverse dimension ratio are tensioned by the initial tension within the electrode by attaching at least one end of the electrode to heat sink means which is contiguous with the electrode over a sufficient fraction of the total length to allow the retention of the initial temperature and thus no decrease in stress due to temperature changes in that contiguous portion of the electrode to maintain the electrode under sufficient tension.

It is a further feature of this invention that where such electrodes are fine wire emitter filaments the portion of the filament not contiguous to the heat sink means be less than approximately 75 per cent of the total filament length. More specifically it is a feature of this invention that such portion of the filament advantageously be from approximately 50 to 75 per cent of the total length.

It is a further feature of this invention that the heat sink means may be flat tabs at each end of the filament, the tabs being supported by side rods. More specifically it is a feature of this invention that such tabs and side rods be employed in an electron discharge device comprising knife-edge electrodes positioned in the device by U-shaped support rods at each end thereof.

It is a still further feature of this invention that the heat sink means may be a smooth rod of larger diameter than the side rods and secured thereto, the filament being bent around the circumference of the rod and attached to one side, the length of the filament contiguous to the rod being sufficient to allow proper tensioning of the filament. More specifically it is a feature of this invention that the filament advantageously be contiguous to the circumference of the rod or rods for at least approximately 25 per cent of the filament's total length, there being insufficient frictional force between the filament and the rod to impede the motion of the filament on the rod.

It is a still further feature of this invention that each of the electrodes in an electron discharge device be a fine wire tensioned by heat sink means extending sufficiently along the length of each wire to maintain proper tension therein. Specifically the supports and heat sink means secured to each of the electrodes may be coplanar members punched or otherwise fabricated from the same matrix piece of metal, the supports for the emitter electrode extending along the axis of the electrodes and the supports for the anode and control electrodes having U-shaped portions and extending transverse to the axis of the electrodes.

A complete understanding of this invention and of the various features thereof may be gained from consideration of the following detailed description and the accompanying drawings, in which:

Fig. 1 is a perspective view of an electrode mount for an electron discharge device illustrative of one embodiment of this invention, certain members being partially broken away to show the elements more clearly;

Fig. 2 is an enlarged representation of the mounting of the filamentary cathode in the device of Fig. 1;

Fig. 3 is a graph of the ratio of final to initial tension in a filamentary electrode against the ratio of the length between the heat sinks to the total length of the electrode for various materials and temperatures, demonstrating the in-

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creased tension during the operation of a device such as illustrated in Fig. 1 constructed in accordance with this invention;

Fig. 4 is a perspective view of a portion of another electrode mount illustrative of another heat sink that may be employed in accordance with this invention; and

Fig. 5 is a sectional view of an electron discharge device illustrative of another embodiment of this invention in which each of the electrodes is either a pair of filaments or a single strand filament each of which is tensioned in accordance with this invention.

Referring now to Fig. 1, there is shown an electrode mount for an electron discharge device including a fine wire single strand emitter **10** tensioned in accordance with the principles of this invention and advantageously having an electron emitting coating thereon. The emitter **10** is secured under a high initial tension at both its ends to flat tabs **11**, the tabs being mounted by side rods **12** extending the length of the electrode mount, an insulator **16** of glass being provided in each rod **12**. The emitter **10** is contiguous to the tabs **11** from the point of mechanical attachment at the ends of the emitter to the ends of the tabs adjacent planar insulating spacer members **13**, the emitter being thus in thermal and electrical contact with the support tabs.

The insulating spacers **13**, which may advantageously be of mica or of fused glass fibres, as disclosed in my copending application Serial No. 171,112, filed June 22, 1950, each have an aperture **20** through which the emitter **10** extends and a plurality of other apertures therein through which extend, beside the tab support rods **12**, anode support rods **14** and U-shaped control electrode supports **15**. A two-part anode **17** having flange sections **18** and **19** welded together encompasses the other electrodes and is in turn positioned between the spacers **13** by the anode support rods **14** which are welded to the anode **17**. Anode support rod retaining tabs **21** may be secured to the support rods **14** on the outer sides of the spacers **13**, as by being welded thereto, to lock the unit together.

The control electrodes may be knife-edge electrodes **23** supported at each end adjacent the spacers **13** by the base portion **24** of the U-shaped supports **15**, the base portion **24** being bent slightly so that the control electrodes **23** are coplanar with the ends of the supports **15**. By employing such knife-edge electrodes within a few emitter filament diameters of the springless tensioned filament and on either side of the filament so mounted in accordance with this invention, satisfactory space currents with very low anode voltages are realizable. Further, low interelectrode capacity and negligible control electrode current or emission are attainable with this arrangement. Additionally the knife-edge control electrodes may be supported individually, as by formed fused glass fibre insulators, fabricated as disclosed in my above-mentioned copending application, encompassing and positioning the electrodes. With such an arrangement the device may be considered as a double electron beam type device when different voltages are applied to the two opposing knife edges.

As shown in the illustrative embodiment disclosed in Fig. 1, the emitter filament **10** is in contact with the tabs **11** for approximately one-third of its total length. The tabs **11** thus serve as heat sink means to maintain a portion of the

filament 10 at its original temperature, and thus at its original tension, whereby that portion of the filament serves itself as tensioned or spring means to maintain proper tension in the remainder or heated portion of the filament not in contact with the supporting tabs 11. This portion adjacent the heat sink is not brazed or otherwise secured to the heat sink except at the single point of rigid attachment at each end of the filament 10 so that the portion adjacent the heat sink is a free length capable of expanding and contracting in order to tension the heated portion of the filament. The initial or original tension of the wire 10 is applied by stressing the wire in its cold condition and then securing its ends to the tabs 11 while it is thus stressed.

Referring now to Fig. 2, there is shown an enlarged representation of the mounting of the filamentary cathode in a device such as that illustrated in Fig. 1, in which heat sinks 26 correspond to the filament support members 11, the filament 10 being mechanically attached to the heat sinks at the points 27. The filament, whose total length is l_1 , makes electrical and thermal contact with the heat sinks 26 from the points 27 to the points 28, which are the points of last contact between the filament 10 and the heat sinks 26. These points 28 therefore define the length l_2 , which is the length of the filament 10 that is heated from the initial temperature T_1 to the operating temperature T_2 . The filament portions contiguous to the heat sinks 26, i. e., between the points 27 and 28, remain at the initial temperature T_1 and are not secured to the heat sinks 26 except at the points 27, thus being free to move slightly along the heat sink.

The initial strain s_i in the filament 10 over its length l_1 under the influence of an initial tension m is

$$s_i = \frac{mgl_1}{M\pi r^2} \quad (1)$$

where M is Young's modulus, g the acceleration due to gravity, and r the radius of the filament 10.

When the portion l_2 of the filament experiences an increase in temperature ΔT from T_1 to T_2 that portion will tend to expand and, if the filament were unstrained, the expansion e would be

$$e = \alpha l_2 \Delta T \quad (2)$$

where α is the temperature coefficient of the filament.

However as the filament is under an initial strain this expansion serves merely to reduce that strain; thus the final strain s_f in the total filament length l_1 at the temperature T_2 is

$$s_f = s_i - e \quad (3)$$

$$= \frac{mgl_1}{M\pi r^2} - \alpha l_2 \Delta T \quad (4)$$

assuming M to be entirely independent of temperature.

Since the ratio of the final to initial strain will be the same as the ratio of the final to initial tensions, this tension ratio t can be determined from Equations 1 and 4 and is

$$t = \frac{s_f}{s_i} = \frac{(mgl_1/M\pi r^2 - \alpha l_2 \Delta T)}{mgl_1/M\pi r^2} \quad (5)$$

or

$$t = 1 - \frac{M\pi r^2 \alpha l_2 \Delta T}{mgl_1} \quad (6)$$

In order to make Equation 6 independent of any particular filament diameter the terms U

and Ψ may be introduced, U being the ultimate tensile strength of the material of the filament per unit area and Ψ being the fraction of U the initial tension m was. ΨU may therefore be substituted in equation (6) as

$$\Psi U = \frac{m}{\pi r^2} \quad (7)$$

and Equation 6 becomes

$$t = 1 - \left(\frac{M\alpha}{\Psi U g} \right) \left(\frac{l_2}{l_1} \right) \Delta T \quad (8)$$

It can thus be seen that the decrease in tension, as represented by the tension ratio t , is a straight line function of the temperature increase ΔT and the ratio of total filament or electrode length to heated length, for any given material and initial tension. While this analysis has been performed with reference to a straight filamentary electrode it is perfectly general and equally applicable to heat sinks having other configurations, as shown in Fig. 4, and to other electrodes such as control electrodes having a plurality of fine wire strands, each of which is self-tensional in accordance with the invention.

In Fig. 3 Equation 8 has been plotted, line 31 being for molybdenum with a ΔT of 500° C. and line 32 with a ΔT of 1000° C. Line 33 is for tungsten with a ΔT of 500° C. and line 34 with a ΔT of 1000° C. Ψ , the fraction of initial tension to breaking strength, was taken as 0.9. A slightly lower value of Ψ might be more generally employed. While only two temperatures have been chosen, the operating temperatures of filamentary emitters would be generally within the range of these two.

The range between the lines 36 and 37 where the ratio of l_2/l_1 is from approximately 0.5 to 0.75 is advantageous for filamentary emitters in electron discharge devices such as illustrated in the drawing. Below 0.5 the increase in t obtained is offset by the additional heat sink and filament length that must be provided for in the miniature tube, though the electrode may be mounted in this range to obtain the benefits of this invention. However, if control or other electrodes are tensioned in accordance with this invention, the ratio may advantageously be higher than .75 because of the lower ΔT , though filamentary emitters may also be mounted in this region in accordance with this invention.

In one specific embodiment of this invention in accordance with Fig. 1, the emitter filament 10 may be of .0003 inch tungsten wire and be operated at an increase of temperature of approximately 800° C. the heated length l_2 being approximately $\frac{3}{8}$ inch.

While the heat sink employed in the illustrative embodiment of Fig. 1 is a flat tab to which the filament 10 is contiguous for a large portion of its entire length, my invention is not to be considered as limited to such heat sink means. Thus the heat sink may be a rod 39 secured to the side rods 12 as shown in Fig. 4, the filament 10 being bent around the circumference of the rod 39. The end of the filament 10 may be secured to the rod 39 at a point at the underside approximately 210 degrees away from the initial point of tangency. This point of mechanical attachment and the diameter of the rod are so chosen that the distance between the point of attachment and the point of initial tangency which distance is the length of the filament 10 contiguous to the rods 39 at each end of the filament, is for both ends at least approximately 25

per cent of the total length of the filament. The point of mechanical attachment would be the point 27 in the representation of Fig. 2 and the point of initial tangency the point 28 of that representation. The rod 39 at the other end of the filament may be positioned on the other side of the filament.

Further, heat sink means may be provided at only one end of the fine wire filament or other electrode strand, the wire being adjacent that one heat sink a sufficient portion of its total length to obtain the certain minimum tension which may be desired. Additionally the fine wire filament or other electrode strand may be stressed in a cold condition between two supports and separate heat sink means positioned adjacent one or both ends of the wire, the heat sink means being of any desired shape or material but being in thermal transfer relation with the wire to maintain that portion adjacent it at a low temperature either through conduction or radiation from the heat sink, when the remainder of the wire assumes a high temperature. With any of these arrangements, however, mounting and tensioning of electrodes in accordance with this invention allows the use of completely rigid mounting members, an economy of space, and the self-tensioning as described above whether for filamentary cathodes, the laterals of control electrodes, or other fine wire electrodes.

Referring now to Fig. 5 there is shown another illustrative embodiment of this invention in which each of the electrodes is either a pair of fine wire filaments or a single fine wire filament tensioned in accordance with this invention. As seen there flat metal terminals 41, 42, 43 and 44 extend through the glass bulb or envelope 45, one terminal through each side thereof. An emitter filament 47 is secured at points 48 to two opposing terminals 41 and 42, the wire being contiguous to the terminals for a portion of its length and not secured thereto except at points 48. The terminals 41 and 42 thus define heat sinks in thermal transfer relation with both ends of the filament 47 so that by initially stressing the filament in the cold condition and securing it at the points 48 the portion of the filament adjacent the heat sinks, or terminals, 41 and 42 will itself act as spring means to keep the heated portion between the terminals taut and prevent the appearance of slack therein.

Coplanar with the filament 47 and on each side thereof are fine wire strand control electrodes 50 and 51. Coplanar with these and outside the control electrodes are two anode wire strands 52 and 53. Thus the electrode assembly comprises five fine wire coplanar strands. The control electrodes 50 and 51 are each rigidly secured at their ends to ends 55 of a U-shaped support member 56 formed integral with the terminal 43 and the anodes 52 and 53 are each rigidly secured at their ends to the ends 57 of a U-shaped support member 58 formed integral with the terminal 44. Each of the electrode wires is thus supported so that a portion of its length is contiguous to heat sink means and free to expand or contract thereon. Thus each is a tensioned springless filament in accordance with this invention. As can be noted in the drawing a smaller free length of the control electrode or anode need be contiguous to the heat sink means than in the case of the emitter filament as these are not subject to the same high temperatures. A getter 60 is advantageously positioned in the

device as between the terminal 44 and U-shaped portion 57 formed integral therewith.

The ends 55 and 57 of the supports 56 and 58 are advantageously slightly curved adjacent the other electrode filaments, but are coplanar therewith at the point of support for the electrode filaments secured thereon.

In the fabrication of the electron discharge device illustrated in Fig. 5 the portions of terminals and support members within the bulb 45 are advantageously punched or otherwise stamped out of a single matrix sheet of metal, the filaments being tensioned by being stressed in their cold condition and secured to the terminals and supports under this initial tension, and the glass bulb then sealed to the terminals. Advantageously the terminals are not initially completely punched from the matrix so that they remain connected together external to the bulb 45 by an outer rim or web until after the device has been sealed in at which time the terminals may be punched or sheared free of the web. Pumping, processing and seal-off are accomplished in the usual manner by means of a tubulation, not shown.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. In an electron discharge device, a springless tensioned electrode comprising a strand of fine diameter wire under an initial tension, means rigidly securing each end of said wire under said tension at a single point, and heat sink means in heat transfer relationship with at least one end of said wire between said one end and the remainder of said wire, said heat sink means being adjacent said wire for a substantial length thereof to maintain said length at its initial temperature, whereby said wire is maintained taut during the operation of said device, said wire being free to move axially adjacent said heat sink means to tension said wire.

2. In an electron discharge device, a springless tensioned electrode comprising a strand of fine diameter wire under an initial tension, means rigidly securing each end of said wire under said tension and heat sink means having a mass appreciably greater than that of said wire in heat transfer relationship with at least one end of said wire and a sufficient portion of said wire to maintain said portion at its original temperature during operation of the device, said portion being free to move axially adjacent said heat sink means, whereby the tension of said portion maintains the electrode taut during the operation of said device.

3. In an electron discharge device, a springless tensioned electrode in accordance with claim 2 wherein said heat sink means is in heat transfer relationship with at least approximately one-quarter of the length of said electrode.

4. In an electron discharge device, a springless tensioned electrode in accordance with claim 2 wherein said heat sink means is in heat transfer relationship with from approximately one-quarter to one-half of the length of said electrode.

5. In an electron discharge device, an electrode comprising a strand of fine diameter wire under an initial tension and heat sink means comprising a thermal and electrical conducting support member of substantially greater mass than said

wire contiguous to a portion of said wire at one end thereof to maintain said portion at its initial temperature, said end being attached to said heat sink means at only one point, and said portion being free to move axially along said heat sink means as the initial tension of said portion causes said portion to contract to maintain said wire taut during operation of said device.

6. In an electron discharge device a springless tensioned cathode comprising a strand of fine diameter wire under an initial tension, means rigidly securing the ends of said wire under said tension, means in electrical contact with said wire between said ends allowing ingress of current into only an intermediate portion of said wire to heat it, and means in heat transfer relationship between said ends and said intermediate portion to maintain the remainder of said wire at its initial temperature, said remainder being free to move axially along said last-mentioned means, whereby the initial tension of the remainder of said wire causes said remainder to contract and maintains the wire taut.

7. In an electron discharge device, a springless tensioned cathode comprising a strand of fine diameter wire under an initial tension, means rigidly securing the ends of said wire under said tension, means providing electrical contact to only a portion of said wire to allow ingress of current to said portion to heat said portion, heat sink means between at least one end of said wire and said portion in heat transfer relationship for at least approximately one-quarter the length of said wire to maintain the initial temperature in the wire adjacent said heat sink means, whereby said wire is maintained taut during operation of said device by the initial tension in the wire adjacent said heat sink means.

8. In an electron discharge device, an electrode comprising a springless tensioned fine diameter wire under an initial tension and heat sink means contiguous to each end of said wire, said heat sink means comprising a thermal and electrical conducting rod in transverse relation to the axis of said wire, said wire being rigidly secured to said heat sink means at each end at a single point and having a free length contiguous to the circumference of said heat sink means for a sufficient length to maintain said length at its initial temperature, whereby it may contract due to its initial tension to maintain the wire taut during operation of the device.

9. In an electron discharge device, a springless tensioned filamentary cathode comprising a fine diameter wire under an initial tension and heat sink means contiguous to each end of said wire, said wire being rigidly secured to said heat sink means at a single point at each end of said wire and having a free length contiguous to said heat sink means for at least approximately one-quarter of the total length of said wire between said points to maintain said free length at its initial temperature, whereby it may contract due to its initial tension to maintain said wire taut during passage of current through said wire.

10. An electron discharge device comprising a fine diameter wire cathode, knife-edge control electrodes adjacent said cathode, an anode encompassing said control electrodes and said cathode, a pair of flat support tabs, each end of said cathode being secured to one of said tabs at a single point, and means mounting said tabs in said device, said tabs defining heat sink means

being in electrical and thermal contact with a substantial portion of said cathode to maintain said portion at its initial temperature during operation of said device whereby said portion is free to contract to keep said wire taut.

11. An electron discharge device in accordance with claim 10 wherein said flat tabs are in electrical and thermal contact with the ends of said wire for at least approximately one-quarter of the length of said wire.

12. An electron discharge device comprising a fine diameter wire cathode, knife-edge control electrodes adjacent said cathode, an anode encompassing said control electrodes and said cathode, a pair of large diameter rods in said device, means rigidly mounting said rods transverse to the axis of said cathode, the ends of said cathode being bent over said rods and secured thereto under an initial tension, said rods being in electrical and thermal contact with said ends for at least one-quarter of the length of said wire to maintain said ends at their initial temperature during the operation of said device to keep the cathode taut.

13. An electron discharge device comprising a plurality of coplanar fine diameter wire electrodes, means mounting each of said wire electrodes under an initial tension, said means each comprising heat sink means extending adjacent to and in thermal transfer relationship with a portion of each of said wires for a substantial distance thereof, whereby said portions are maintained at their initial temperatures during operation of said device, each end of said wires being rigidly secured to said heat sink means at only a single point.

14. An electron discharge device comprising a bulb, a fine diameter wire cathode within said bulb, terminals extending along the axis of said cathode and extending through said bulb, the ends of said wire cathode being rigidly secured to each of said terminals at one point, said terminals extending contiguous to said wires in heat transfer relation with a portion thereof, a pair of fine diameter wire control electrodes adjacent said cathode and coplanar therewith, a pair of fine diameter wire anodes adjacent said control electrodes and coplanar therewith and with said cathode, a pair of terminals extending through said bulb transverse to the axis of said wires, and a U-shaped support member integral with each of said terminals, each end of said control electrodes being secured to an arm of one of said U-shaped members at a single point and each end of said anode being secured to an arm of the other of said U-shaped members at a single point, each of said control electrode and cathode wires having a free length in heat transfer relationship with said arms of said U-shaped members and each of said cathode, control electrode and anode wires being secured under an initial tension.

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