Jan. 7, 1947. J. W. WEST 2,413,738

ELECTRON DISCHARGE DEVICE

Filed Nov. 17, 1942

FIG. 1

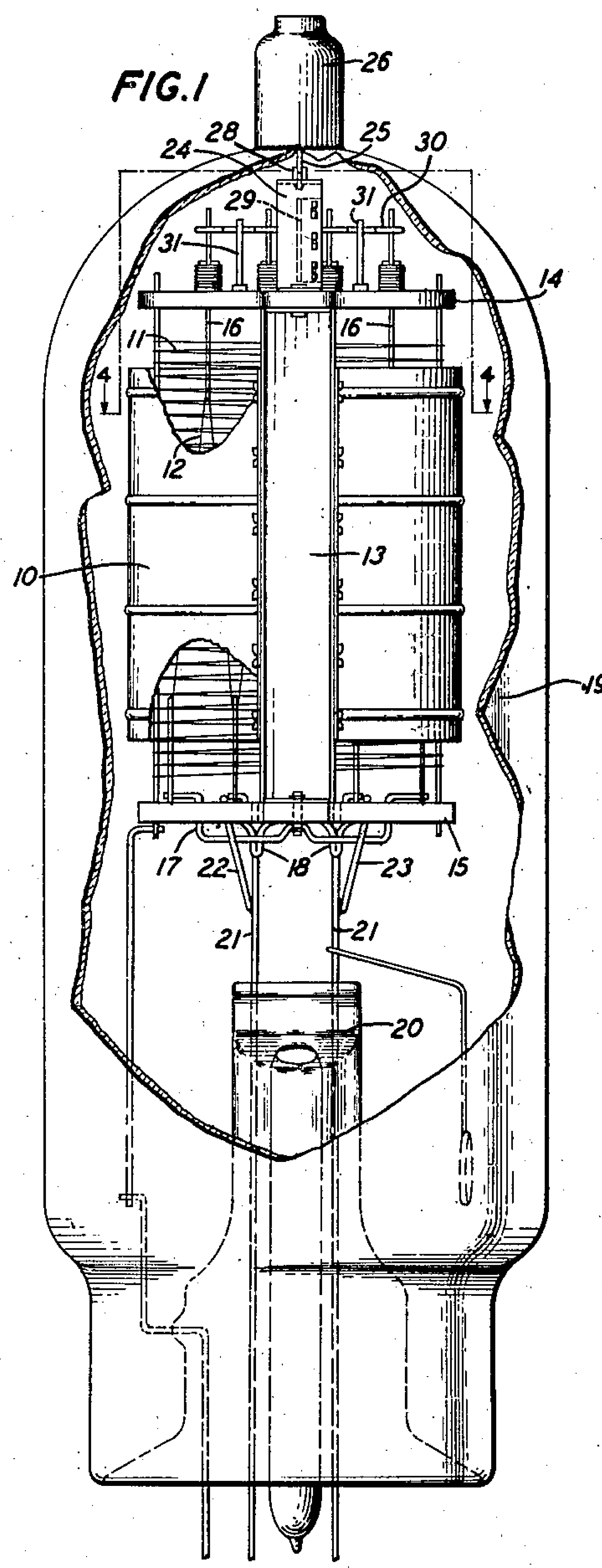


FIG. 2

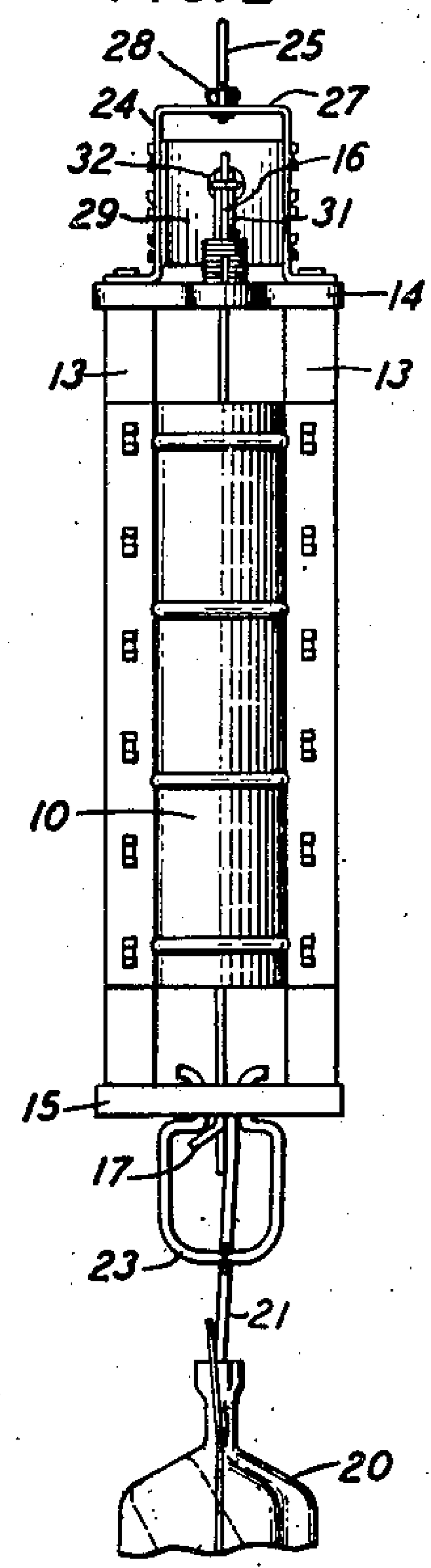


FIG. 4

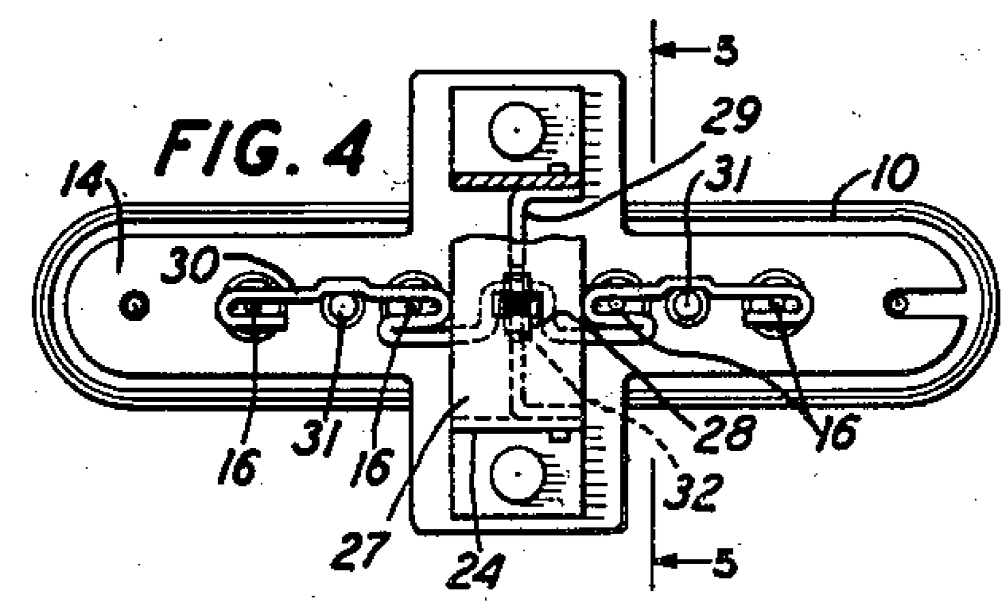


FIG. 3

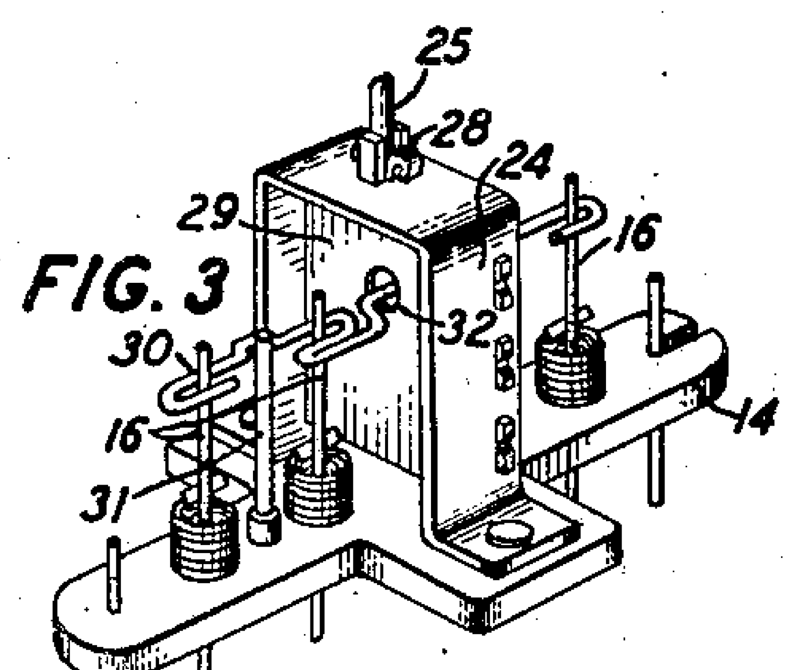


FIG. 6

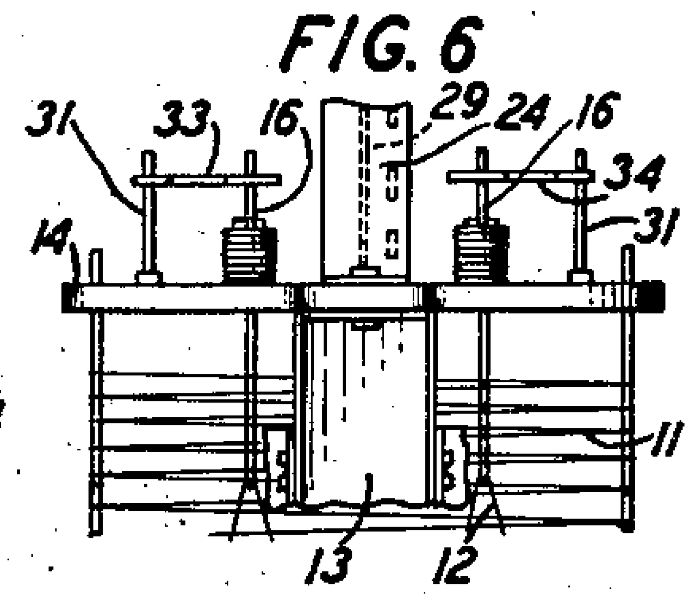
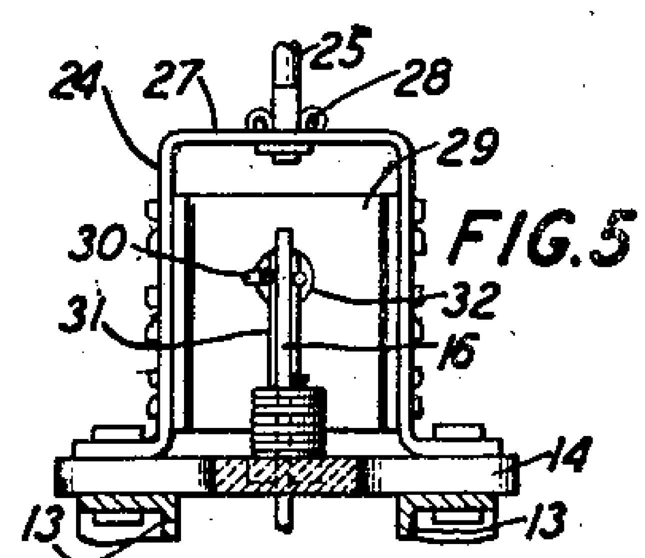


FIG. 5



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ELECTRON DISCHARGE DEVICE

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15 Claims. (Cl. 250—27.5)

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This invention relates to electron discharge devices and more particularly to high power devices having electrode units of extensive area.

As electrode surfaces increase in area in discharge devices to produce greater power output the problem of supporting the electrode assembly in an evacuated enclosing vessel to resist transverse shock, which would distort the electrodes or cause breakage of the fragile filamentary cathode or the enclosing vessel, also increases. Heretofore it has been the usual practice to maintain rigidity in the electrode assembly unit or mount by providing a reinforced truss-like substructure affixed to the supporting stem of the vessel by a metallic collar surrounding the stem. This expedient has increased the cost and manufacturing processes without materially safeguarding the unit in the vessel, particularly the end of the unit furthest from the stem which is subjected to the greatest stress and strain when lateral impact forces imperil the device.

The primary object of this invention is to reinforce the electrode unit in the device to withstand severe shock and vibrations.

Another object of the invention is to fabricate the assembly with a minimum of extraneous superstructure thereby decreasing the cost of production and assembly.

A further object of the invention is to increase the efficiency of operation by the omission of large metallic masses in the vicinity of the stem which increase tension strain in the glass supporting conductors for the electrode supplying various potentials thereto.

These and other objects and advantages are attained in accordance with this invention by supporting a multielectrode unit assembly from a stem of an enclosing vessel by a pair of rigid conductors sealed in the stem for conveying current to the incandescent filamentary cathode of the electrode mount. These conductors are rigidly secured to the mount and are reinforced by transverse braces having the ends locked in the spacing insulator support of the electrodes and the mid-portions fastened to the conductors intermediate the unit and the stem. This arrangement eliminates costly stem construction and the large mass of metallic supporting structure adjacent the stem. Furthermore, it materially reduces the manufacturing processes of fabrication and lowers the cost of assembly.

The opposite end of the electrode mount is rigidly anchored to the top of the enclosing vessel by a U-shaped yoke member which is secured to the top insulating spacer block and having its

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mid-portion fastened to a conductor sealed through the top of the vessel to supply a high operating voltage to the anode or output electrode of the device. The yoke member is reinforced by a central rib or partition plate member to offset angular stress in the yoke member and to impart substantial rigidity to the yoke member to any transverse shocks or other detrimental forces which would alter or damage the electrode elements of the unit or impair the uniform space relation between them.

A feature of this construction is the provision of a yieldable coupling in the yoke member to prevent endangering the hermetic sealed joint of the anode lead-in conductor in the device. This coupling permits slight expansion of the unit during high temperature operation and contraction thereof after expansion without placing undue strain on the lead-in seal.

Another feature of this assembly relates to the alignment of the supporting tensioned hooks of the filamentary cathode in the electrode mount. This involves a metallic guide member having multiple formed slots to guide the tensioned hooks of the filament supporting structure so that unequal expansion in the various filament sections will not displace the tensioned hooks from their medial plane and thereby vary the space relation of the filament sections with respect to the other cooperating electrodes.

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

Fig. 1 is a view in elevation of an electron discharge device constructed in accordance with this invention, the device being shown with portions of the vessel and the electrodes broken away to illustrate the general assembly of the electrode unit in the vessel;

Fig. 2 is a side view of the electrode unit of Fig. 1 showing the details of the supporting assembly on opposite ends of the unit;

Fig. 3 shows the top portion of the unit in perspective to illustrate the relation of the supporting elements of the unit at the upper end of the device;

Fig. 4 is a plan view of the upper supporting assembly taken on the line 4—4 of Fig. 1 showing the details of the yoke member and the filament hook guiding element;

Fig. 5 is a side view of Fig. 4 taken on the line 5—5 to show the strengthening rib of the yoke member; and

Fig. 6 is a modified arrangement of the guiding element for the filament hooks, the other elements of the assembly being shown partly broken away to clearly illustrate the changes involved.

Referring to the drawing and particularly to Figs. 1 and 2, the electrode unit embodied in the device and used as an illustrative example of the application of the features of this invention to the improvements of the construction of such devices, is substantially disclosed in United States Patent 2,019,492, issued November 5, 1935, to D. A. S. Hale and V. L. Ronci. This unitary assembly or mount includes a hollow metallic anode 10 of large surface area enclosing a flat cylindrical grid 11 and a multisection filamentary cathode 12, the anode being provided with a pair of channel posts 13 which extend beyond the ends of the anode and provide spacing supports for cross-shaped insulating spacer members 14 and 15 at opposite ends of the unit which maintain the grid and filamentary cathode in uniform spacial relation with respect to the anode surface. The filamentary cathode 12 comprises a plurality of inverted V-shaped portions or sections connected in series and forming a single filament having the configuration of a double M and is supported in a medial plane at the top of the unit by a plurality of tensioned hooks 16 and at the lower end is secured to the spacer 15 by a tie wire 17 having multiple arms and a pair of rigid U-shaped anchor wires 18.

The unitary mount is enclosed within a highly evacuated vessel 19, of vitreous material, such as glass, and being of large area and sufficient mass constitutes a hazard to the enclosing vessel which might be fractured by severe shocks imposed on the device by forces directed towards the vessel in a direction transverse to the axis thereof. Such forces are extremely detrimental to the proper functioning of the device when the unit is supported only from the stem 20 of the enclosing vessel, due to the large mass of the unit which concentrates the effect in a large deflection of the upper end of the unit and quite often these forces are sufficient to cause the upper spacer member 14 to strike the glass wall of the vessel with sufficient force to fracture the glass and thereby impair the usefulness of the device. If the forces are not sufficient to cause the above damage, they are nevertheless great enough to distort the electrodes and thereby cause unstable operation due to variations in the characteristics of the device.

These difficulties are overcome and the large mass of the electrode mount is rigidly supported from opposite ends of the vessel, in accordance with this invention, by providing rigid anchoring supports at opposite ends of the unit to fixedly couple the unit to the vessel and to strengthen or reinforce the supporting structure of the unit, whereby lateral impact forces are resisted to alter the axial position of the unitary mount in the vessel. This result is accomplished, however, with the added requirement that the unit can expand and contract due to temperature variations in the operation of the device. To simplify the supporting structure at the base of the unitary mount, two rigid conductors or supports 21 are sealed in the stem 20 and extend outwardly from the stem to form external connections for supplying energizing current for the filamentary cathode 12 of the mount. These supports are rigidly affixed to the bent anchor wires 18 connected to the cathode. The rigid supports in the stem are reinforced by diagonally mounted braces 22 and 23 which are

formed into downwardly extending wire loops having their ends extending through the lower insulator 15 and interlocked therein and the mid-portions of the loops are welded to the rigid supports 21 intermediate the stem 20 and the electrode mount. The braces and rigid supports adequately sustain the lower end of the unit from the stem 20 of the vessel and provide a supporting structure for the unit or mount which substantially resists deformation by severe shocks imparted to the device in the vicinity of the stem. This resistance is increased by the transverse braces which are mounted at an inward angle from the spacing insulator 15 to the conductors. Furthermore, this construction greatly simplifies assembly methods and materially reduces cost of production. It also removes large masses of metal from the glass stem 20 thereby relieving the stem from mechanical strain which might endanger the hermetic joints of the conductors sealed therein.

The upper supporting structure of the unitary mount is shown more clearly in Figs. 3, 4 and 5 and should be considered in connection with Fig. 1 which shows the complete assembly in the device. The upper end of the unitary mount is rigidly affixed to the vessel wall by connecting a metallic yoke member 24 between the insulating spacer 14 and a rigid leading-in conductor 25, hermetically sealed in the top of the vessel and connected to an external terminal cap 26. The yoke member is formed of relatively wide metallic strap material, such a molybdenum, and bent into a rectangular U-shaped element which is mounted in inverted position across the short arms of the cross-shaped insulator 14 so that the longitudinal legs of the yoke member extend toward the mount and the ends thereof are bent outwardly to be attached to the insulator 14 by the rivets which secure the anode channel posts 13 to the insulator. The intermediate or connecting section 27 of the yoke member carries a central eyelet 28 which receives the conductor 25 and is rigidly affixed thereto. The connecting section of the yoke member forms a resilient or yielding portion between the rigid conductor 25 and the rigid mass of the unit or mount to compensate for expansion and contraction of the unit under varying heating conditions without endangering the seal of the rigid conductor 25 with respect to the glass vessel and without distorting the electrodes in the mount under the varying conditions.

The yoke member is reinforced by a central strengthening rib, strap or plate 29, which spans the space between the longitudinal legs, the plate being provided with side flange portions mechanically locked to the legs of the yoke member, the upper and lower edges of the plate being free from the yoke member and the insulator 14. It will be seen from Fig. 1 that the yoke member is mounted in a plane substantially parallel to the braces 22 and 23 at the lower end of the mount so that forces directed toward the vessel perpendicular to the plane of the drawing will be resisted by the reinforcing rib 29 and the braces 22 and 23 and forces directed toward the vessel in the plane of the drawing will be opposed by the wide legs of the yoke member and the sides of the braces. Any impact or shock force imparted laterally between these boundaries will be equally assimilated without endangering the axial position of the mount in the device. Electron discharge devices, made in accordance with this invention, have been subjected to a standard pendulum impact gravity test in which a hammer on a pendulum travels at a given acceleration and amplitude to strike the vessel to determine the degree of shock which can be assimilated by the unit supported in the vessel. Devices of this invention have withstood such a test to a high degree, namely, a value of 10*g*, *g* being the acceleration of gravity which is thirty-two feet per second and the degree of shock being ten times the acceleration. This force represents a unit of resistance to shock which is extremely severe, being a value just below the force necessary to fracture the glass by the impact hammer.

The filamentary cathode 12 must be maintained in a medial plane in order to insure stable characteristics in the operation of the device and to prevent contact of the cathode with the closely spaced laterals of the grid electrode 11. Conditions of operation may cause different sections of the cathode to expand more than others and this is compensated by the tension springs engaging the filament hooks. However, difficulties may occur due to expansion in some sections which cause the hooks to be displaced from their medial plane, thereby producing contact between the filament and the grid. This difficulty is avoided, in accordance with this invention, by providing a metallic guide element 30, formed of nickel or molybdenum wire, which is bent at a plurality of points to provide parallel sections forming guide slots for the hook extensions 16, to maintain them in a medial plane commensurate with the plane of the filamentary cathode 12. The guide element 30 extends across the top of the mount and is supported by a pair of posts 31 secured in the top insulating spacer 14. The guide element 30 is a continuous wire of circular cross section having distributed portions bent to form the guide slots and extending freely through a circular aperture 32 in the reinforcing plate 29 of the yoke member. This element while formed of metal, preferably nickel, is not subjected to heating by induction during the evacuation process of the device when the electrodes are inductively heated by a high frequency coil mounted in coaxial relation to the device. Therefore, the guide element is not distorted since it forms an open circuit member to heating current induced therein, and accordingly is unaffected by such high temperature heating effects.

The guide element has been shown as extending through an opening in the reinforcing plate of the yoke 24, such an arrangement being practical for a construction in which the cathode has more than two sections. However, it is not necessary that the guide element extend through the yoke member if the cathode is formed of two sections, as shown in Fig. 6. The guide member is subdivided into two sections 33 and 34 which are mounted on the posts 31 and extend toward each other but are separated by the yoke member, the free ends of the guide sections being bent to form the guide slots for the hooks 16.

Although the invention has been described and shown in association with a specific unitary mount of electrodes, it is, of course, understood that various modifications may be made in the details of assembly of the supporting structure of this invention without departing from the scope and spirit thereof as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising an enclosing vessel, an electrode assembly unit within said vessel, means supporting said unit from one end of said vessel, conductive means extending from the opposite end of said vessel, a metallic yoke member intermediate said conductive means and said unit, and a rigid rib spanning the space within said yoke member.

2. An electron discharge device comprising an enclosing vessel, an electrode assembly mount within said vessel, means supporting said mount from one end of said vessel, conductive means extending from the opposite end of said vessel, a metallic yoke member intermediate said conductive means and said mount, said yoke member having longitudinal rigid portions extending from said mount and a connecting resilient portion attached to said conductive means, and a bridging strap attached to said longitudinal portions and substantially extending across the space bounded by said yoke portions.

3. An electron discharge device comprising an enclosing vessel, an electrode assembly mount within said vessel, means supporting said mount from one end of said vessel, a conductor sealed in the other end of said vessel, a resilient metallic yoke member interconnecting said conductor and said mount, and shock-resisting means bridging the space between and attached to longitudinal portions of said yoke member.

4. An electron discharge device comprising an enclosing vessel, an electrode assembly unit within said vessel including a plurality of electrodes and spacing insulators at opposite ends thereof, a pair of conductors supporting said unit from one end of said vessel, a brace member attached to each of said conductors having the ends engaging one of said insulators, a conductor extending from the opposite end of said vessel, a yoke member attached to the other spacing insulator and joined to said latter conductor, and a strengthening insert extending across said yoke member to resist transverse shock to said unit.

5. An electron discharge device comprising an enclosing vessel, an electrode assembly mount within said vessel including a plurality of electrodes and spacing insulators at opposite ends thereof, a pair of conductors supporting said mount from one end of said vessel, a pair of wire loops having their mid-portion attached to said conductors and their end portions interlocked with one of said insulators to reinforce the support of said mount, a central conductor extending within said vessel from the opposite end thereof, a metallic U-shaped strap member having a mid-portion attached to said central conductor and downwardly extending legs secured to said mount, and a strengthening plate extending between said legs.

6. An electron discharge device comprising an enclosing vessel, an electrode assembly mount within said vessel, means supporting said mount from one end of said vessel, a central conductor extending into the opposite end of said vessel, an inverted U-shaped yoke attached to said mount and said central conductor, and a rigid partition having side flanges secured to the side portions of said yoke.

7. An electron discharge device comprising an enclosing vessel, an electrode assembly mount within said vessel, means supporting said mount from one end of said vessel, a central conductor extending into the opposite end of said vessel, an inverted U-shaped metallic yoke intermediate said central conductor and said mount, a strengthening plate secured to the legs of said yoke and extending across the space therebetween, and means connecting said central con-

ductor to a yieldable portion of said yoke to compensate for expansion and contraction of said mount.

8. An electron discharge device comprising an enclosing vessel, an electrode unit therein including an anode, a grid and a multisection filamentary cathode, a pair of insulating spacer members on opposite ends of the electrodes, a plurality of tensioned hook members engaging said multisection cathode, and metallic means supported on one of said spacer members, said means having bent portions forming guiding slots for said hook members to permit sliding movement in a vertical plane but preventing displacement thereof from said plane.

9. An electron discharge device comprising an enclosing vessel, an electrode mount therein including an anode, a grid and a multisection filamentary cathode, a pair of insulating spacer members on opposite ends of the electrodes, a plurality of tensioned hook members engaging said multisection cathode, and a metallic guide supported in spaced relation on the insulating spacer member adjacent said hook members, said guide having spaced parallel sections forming slots for said hook members to maintain said hook members in a normal plane.

10. An electron discharge device comprising an enclosing vessel, an electrode mount therein including an anode, a grid and a multisection filamentary cathode, a pair of insulating spacer members on opposite ends of the electrodes, a plurality of tensioned hook members engaging said multisection cathode, and a continuous wire guide element supported on the insulating spacer member adjacent said hook members, said element having spaced folded portions forming slots for said hook members, said guide element being incapable of distortion by high frequency inductive heating.

11. An electron discharge device comprising an enclosing vessel, an electrode assembly unit therein including an anode, a grid and a multisection filamentary cathode, a pair of insulating spacer members on opposite ends of the electrodes, a plurality of tensioned hook members engaging said multisection cathode, a pair of conductors supporting said unit at one end of said vessel and connected to said cathode, a central conductor extending into the opposite end of said vessel, a metallic yoke at the opposite end of said unit connecting said unit to said central conductor, a partition extending across said yoke member having an opening therein, and a wire guide element for said hook members extending through said partition.

12. An electron discharge device comprising an enclosing vessel, an electrode assembly unit therein including an anode, a grid and a multisection filamentary cathode, a pair of insulating spacer members on opposite ends of the electrodes, a plurality of tensioned hook members engaging said multisection cathode, a pair of conductors supporting said unit at one end of said vessel and connected to said cathode, a central conductor extending into the opposite end of said vessel, a metallic yoke at the opposite end of said unit connecting said unit to said central conductor, a partition extending across said yoke member to reinforce it against lateral shock imparted to said vessel, and a pair of similar metallic guide elements supported on said insulating spacer adjacent said hook members, said elements having bent parallel portions on opposite sides of said hook members to prevent movement thereof parallel to the plane of said partition.

13. An electron discharge device comprising an enclosing vessel containing an electrode unit subject to expansion and contraction as a whole, reinforced conductive means to rigidly support said unit from opposite ends of said vessel to withstand transverse shock capable of displacing said unit from a central position in said vessel, and one of said means having a transverse yielding portion to compensate for expansion and contraction of said unit in an axal direction.

14. An electron discharge device comprising an enclosing vessel containing a unitary electrode assembly of extensive length which is susceptible to lateral shock capable of distorting the electrodes in the unit, and means for rigidly supporting said assembly from opposite ends of the vessel including a pair of conductors at one end connecting said unit to said vessel, a pair of angularly arranged U-shaped braces clamped to said unit and affixed to said conductors, a yoke member connecting the opposite end of the unit to said vessel, said yoke being formed of flat strip metal, and a reinforcing rib extending across the space within said yoke member and attached to longitudinal portions thereof.

15. An electron discharge device comprising an enclosing vessel containing a unitary electrode mount of extensive length which is susceptible to lateral shock capable of distorting the electrodes in the mount, and means for rigidly supporting said mount from opposite ends of the vessel including a pair of conductors at one end connecting said mount to said vessel, a pair of angularly arranged U-shaped braces clamped to said unit and affixed to said conductors, a yoke member connecting the opposite end of said mount to said vessel, said yoke being formed of flat strip metal, and a reinforcing rib extending across the space within said yoke member and attached to longitudinal portions thereof, the planes of said braces being substantially parallel to the planar direction of said reinforcing rib and substantially perpendicular to the direction of extension of said yoke member to provide reinforcement against shocks imparted to said vessel from all directions transverse to the axis thereof.

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