July 15, 1958 D. V. EDWARDS 2,843,833

MOUNTING STRUCTURE FOR GAS TUBES

Filed Oct. 6, 1951 2 Sheets-Sheet 1

FIG. 1.

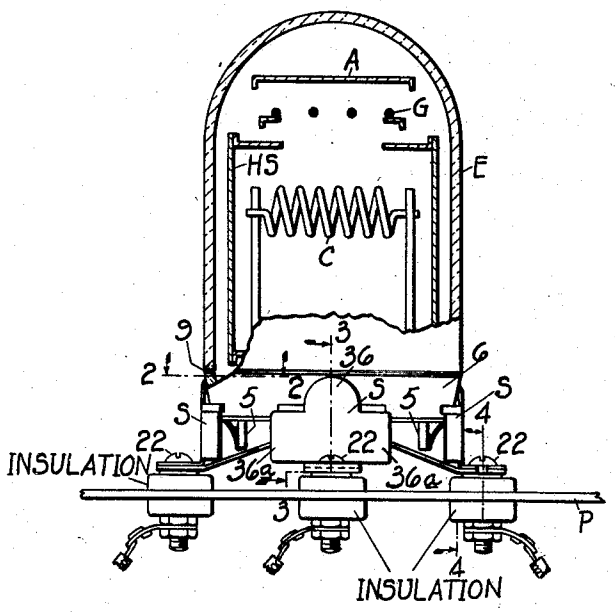


FIG. 2.

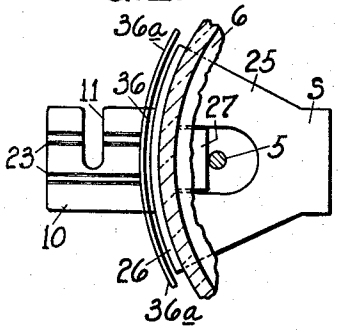


FIG. 4.

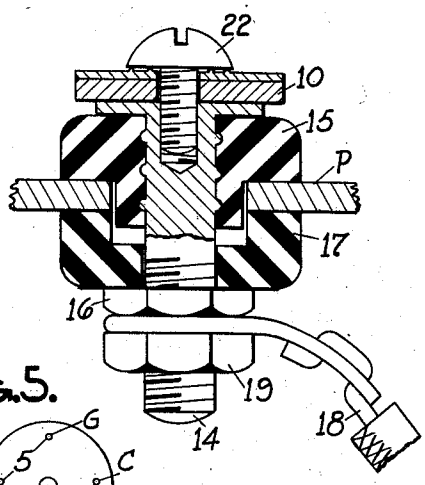


FIG. 3.

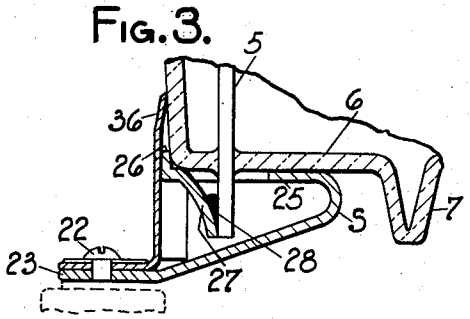
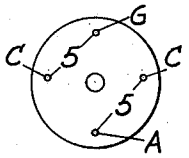


FIG. 5.



Inventor
D. V. Edwards,
By Neil W. Preston,
his Attorney

July 15, 1958 D. V. EDWARDS 2,843,833

MOUNTING STRUCTURE FOR GAS TUBES

Filed Oct. 6, 1951 2 Sheets-Sheet 2

FIG. 6.

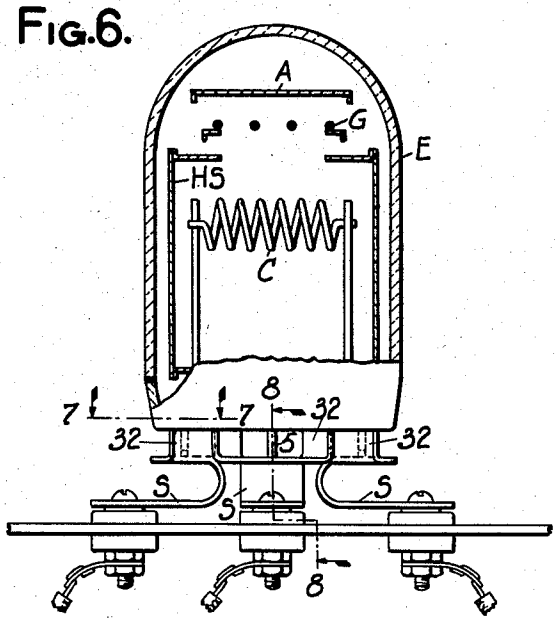


FIG. 7.

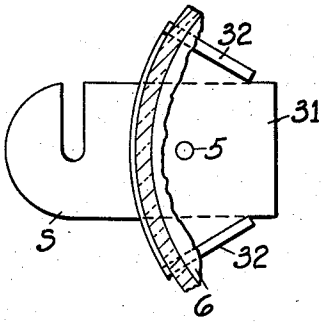
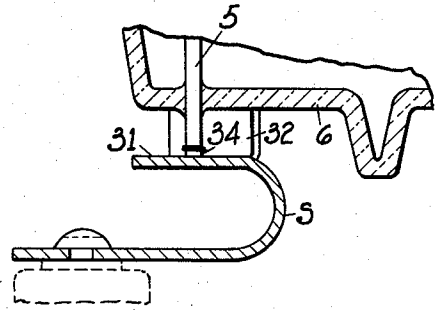


FIG. 8.



INVENTOR.
D. V. Edwards,
BY Neil W. Preston,
his ATTORNEY

United States Patent Office 2,843,833 Patented July 15, 1958

2,843,833

MOUNTING STRUCTURE FOR GAS TUBES

Donald V. Edwards, Montclair, N. J., assignor to Electrons, Incorporated, Newark, N. J.

Application October 6, 1951, Serial No. 250,095

3 Claims. (Cl. 339—93)

This invention relates to structures for mounting and supporting electron discharge tubes on the chassis or supporting body of equipment units using such tubes, and more particularly to a mounting structure for individual power and gaseous discharge tubes of the higher current ratings, which permits ready application and removal of the tube, and provides the desired current conductivity, heat radiating, and shock-proof characteristics in a compact arrangement requiring little space outside of the tube envelope.

In the various applications and uses of certain types of electron discharge tubes, such as hot cathode gaseous discharge tube conducting amperes of current, the conventional pin base and socket mounting structure has certain limitations and disadvantages. Among other things, the amount of current to be conducted by the external connections through the base and socket to the electrodes in the tube envelope of such tubes, more particularly the cathode and anode, together with the relatively high temperature which such electrodes assume in normal operation, calls for a consistently low contact resistance between separable parts and an amount of heat dissipation difficult to obtain satisfactorily in the conventional base and socket type of tube mounting structure. For example, heat due to the current conducted and high electrode temperatures is dissipated largely by conduction through the pins of the base into the socket; and unless these parts are properly designed and the socket appropriately supported for the appropriate amount of heat dissipation, there is likely to be objectionable overheating of certain parts and a tube failure, due to softening of the basing cement, charring of insulation materials, or the like. Also, the contact resistance between the disengageable parts of the conventional base and socket tube mount may become high, due to inadequate spring pressure, corrosion, or the like; and this not only affects the proper operation of the tube, but also tends to produce injurious overheating. Further, the conventional base and socket type of tube mount occupies considerable space between the tube envelope and its basic support, and tends to transmit shock and vibration from such basic support directly to the tube in a degree which in many instances requires special shock mounting in the equipment using the tubes to avoid tube damage.

With these and other considerations in mind, the principal object of this invention is to provide a form of mounting structure for gaseous discharge tubes and the like, which will provide the appropriate detachable connections for the application and removal of tubes, and yet will afford the desired current conductivity, appropriate heat dissipation by radiation as well as conduction, and inherent shock-proof characteristics, all in a compact assembly occupying much less space outside the tube envelope than the conventional base and socket form of tube mounting structure.

Generally speaking, and without attempting to define the nature and scope of the invention, it is proposed to

attach a plurality of supporting elements directly to the respective electrode lead-in rods sealed in the base of the tube envelope, and employ screw-threaded elements to provide a detachable conection of uniform low contact resistance between the outer ends of such supporting elements and the insulated terminals of the chassis plate or the like for the equipment unit in a manner permitting ready application and removal of the tube, said supporting elements being shaped and proportioned to afford in a compact arrangement the necessary electrical conductivity, heat dissipation by both radiation and conduction, and resilient damped shock and vibration absorbing support appropriate for the particular type of tube.

Various other objects of the invention, and the structural features, attributes, and advantages of the tube mounting structure of this invention will be in part apparent, and in part pointed out, in the subsequent discussion of certain physical embodiments of the invention.

Although the characteristic features of this invention may be embodied in various specific forms and applied to various types of tube structures, it is convenient in explaining the nature of the invention to refer to the specific structures illustrated in the accompanying drawings, in which:

Fig. 1 is a general assembly illustrating one form of the mounting structure of this invention applied to one typical type of tube having its electrodes illustrated diagrammatically;

Figs. 2, 3 and 4 are enlarged sectional views of parts of the general organization taken on the lines 2—2, 3—3 and 4—4 indicated in Fig. 1;

Fig. 5 is a diagrammatic view illustrating the preferred disposition of the electrode lead-in rods in the base of the tube envelope;

Fig. 6 is a general view similar to Fig. 1, illustrating a modified form of a tube mounting structure of this invention; and

Figs. 7 and 8 are enlarged sectional views of this modified structure taken on the lines 7—7 and 8—8 indicated in Fig. 6.

While the tube mounting structure of this invention may be used in connection with various types of tubes as a substitute for the conventional forms of tube mounting structures, the mounting structure of this invention is primarily adapted for power tubes and gaseous tubes of the higher current ratings, where current conductivity and substantial heat dissipation from the external connections to the tube electrodes are significant factors in a satisfactory tube mounting arrangement. For purposes of illustration and explanation, it is assumed that a hot cathode grid control gas tube in a glass envelope is representative or typical of the type of tube for which the mounting structure of this invention is especially adapted. As diagrammatically represented in Fig. 1, the electrodes for a tube of this type comprise in general an oxide coated heated cathode C with a heat shield HS, a control grid G and an anode A. These electrodes are mounted in a suitable manner inside a glass tube envelope E with the appropriate lead-in connections to the respective electrodes. It is assumed that the electrode assembly will be supported in a suitable manner (not specifically shown) to provide electrode lead-in connections in the form of relatively stiff leads or rods 5 in the lower end or base of the tube envelope E to project from the bottom of said base at spaced locations for attachment of the supporting elements of the tube mounting structure of this invention.

In the particular construction illustrated, it is assumed that the lead-in connections for the various electrodes will all be sealed in a circular stem mount 6 at the lower end of the tube envelope, in a manner disclosed, for

example, in the prior application of E. K. Smith, Ser. No. 182,678, filed September 1, 1950, now U. S. Patent No. 2,654,850 dated October 6, 1953. In this type of structure, the circular stem mount **6** is provided with the usual exhaust tubulation **7** near its center (see Fig. 3), and is formed with a circular row of bosses or beads to anchor the ends of supporting rods for the electrode assembly and also provide a seal for the through electrode lead-in rods **5**. The portion of the lead-in rods **5** where they pass through the glass are made of tungsten, or other metal or alloy, suitable for forming with the kind of glass used in a gas-tight seal in accordance with usual practice.

In the type of grid control gas tube illustrated, there are four of these electrode lead-in rods **5** for connection to the cathode C, control grid G, and anode A. These rods are preferably spaced at different intervals, such as indicated in Fig. 5, so that the supporting elements attached to these rods as later described and the terminals of the chassis plate will line up only when the tube is in its proper position for the external connections to its electrodes. The circular stem mount 6, after the assembly and moutning of the electrodes is completed ready to be enclosed in a tube envelope, is fused to the tubular body of the glass envelope E, as indicated at **9** in Fig. 1. For the purposes of discussion, it is assumed that this circular stem mount has an essentially flat bottom, and constitutes what may be conveniently termed a sealing base **6** for the tube envelope E.

In accordance with this invention, the mounting structure comprises a plurality of like supporting elements, one for each electrode lead-in rod **5**, and designated S as a whole. Each supporting element S is attached at its inner or upper end to its respective lead-in rod **5**, and has a body portion in the form of a loop extending radially to a point beyond the periphery of the base **6** of the tube envelope to a flattened end portion **10**, with an opening **11** therein to receive a screw-threaded element for a detachable connection with a matching insulated terminal in a chassis plate or like basic supporting body for the tube.

In the specific arrangement illustrated, it is assumed that the tube is to be mounted on a chassis plate P, which is provided with any one of the well known forms of insulated terminals, properly spaced and located in the chassis plate P to cooperate with the outer ends of the supporting elements S of the tube mounting structure. For purposes of illustration, it is assumed that the insulated terminals in the chassis plate will take the form shown in Fig. 4. In this typical structure, the terminal **14** has a flat head and threaded bore in the upper end, and a threaded portion at the lower end. This terminal **14** is molded in a block **15** of suitable insulating material having an extension loosely fitting in a hole in the chassis plate P. This terminal **14** is clamped to the chassis plate P by a nut **16** and a collar **17**, also of suitable insulating material. The end of a wire **18**, preferably with an eyelet terminal, is fastened to the terminal **14** by a nut **19**, all in the manner readily understood from the drawings without detail explanation.

The detachable connection between the supporting elements of the mounting structure of this invention and the insulated terminals in the chassis plate, such as illustrated in Fig. 4, is arranged to afford the desired detachable connections for the ready application and removal of a tube, even though a plurality of tubes are supported close together on the same chassis plate of an equipment unit, as is often the case, and yet obtain consistently low contact resistance between the separable parts not always true of the conventional pin base and socket type of tube mount. The outer flattened end portion **10** of each supporting element is formed with an opening, preferably in the form of a slot **11**, best shown in Fig. 2, to receive the screw **22** of the chassis terminal **14** to clamp such end portion to the flat head of this terminal, as shown in Fig. 4. The upper surface of such end portion **10** of

the suporting element adjacent the slot **11** is preferably made rough by ridges, crimps, or the like, as indicated at **23** in Fig. 2, to have the effect of a lock washer to prevent the screw **22** from becoming loose; but any suitable form of a locking washer or equivalent device (not shown) may be used for this purpose, preferably one fixed to the screw **22**. The screws **22** are located outside of the periphery of the tube base far enough for the insertion of a screw-driver or other actuating tool. In spite of the proximity of an adjacent tube. The tube may be turned to engage, or disengage, the slotted ends of its supporting elements S with the shanks of the screws **22**, as the tube is to be applied or removed, and the tube may be moved endwise into and out of position in a manner that can be readily appreciated without further discussion.

As previously noted, electrical conductivity, heat dissipation, and resiliency and damping for absorbing shock and vibration are attributes of the suporting elements S of the mounting structure of this invention. To provide the shape and porportions to meet these requirements, the supporting elements S are preferably formed out of sheet metal stock of a suitable metal, which has the appropriate electrical conductivity, will retain its resiliency at an elevated temperature suitable for efficient heat dissipation, and is inherently non-corrosive and otherwise capable of forming a stable low resistance contact with the insulated terminals of the chassis plate. While various metals and alloys possess these attributes in a variable degree, it is proposed to use an alloy of nickel, copper, iron and manganese, commonly known as perma-nickel, which in addition to the desirable characteristics of electrical conductivity and the like, may also have its resiliency and inherent damping modified somewhat by heat treatment, thereby facilitating its application to the variable operating conditions encountered in practice.

It is important that each supporting element S is conductively attached to its lead-in rod **5** in such a way that the seal between this rod and the base of the tube envelope will not be mechanically damaged by the forces likely to be applied to said supporting element in the ordinary handling and use of the tube, which the supporting element itself will not absorb by its own distortion. Generally speaking, a typical seal between a lead-in rod and the glass base of the tube envelope can stand substantial forces applied axially of the rod, but is relatively weak and susceptible to cracking the glass seal for tilting forces applied to the rod. Accordingly, in accordance with this invention, the end portion of the supporting element S attached to the lead-in rod **5** is shaped to make contact with the tube base at a plurality of separated points, so as to avoid the application of a tilting stress to the lead-in rod and damage to the seal as the supporting element is subjected to the bending or twisting forces likely to be encountered in practice.

In the type of mounting structure illustrated in Figs. 2 and 3, the inner end portion of the supporting element S is shaped somewhat like a sector **25** (see Fig. 2) which is adapted to fit against the bottom of the base **6**, and is also preferably provided with a curved ridge **26** (see Fig. 3) to engage the periphery of the base. An integral flange or lip **27** is cut out of this sector shaped portion, and is bent down for soldering to the lead-in rod **5**, as indicated at **28** in Fig. 3. Since this attached end portion of the supporting element S is in contact with the glass base of the tube at a plurality of separated points at the time the soldered connection is made to the lead-in rod **5**, forces applied to the supporting element S, that would otherwise tend to tilt the rod are transmitted directly to the tube base, and there is no tilting stress on the rod to damage the seal.

In the type of mounting illustrated in Figs. 7 and 8, the inner end portion of the supporting element S comprises an arcuate part designated **31**, to which the end of the lead-in rod **5** is attached, preferably by a welding

operation as later discussed. This part **31** is formed with two up-standing flanges or legs **32** which are brought into contact with the bottom surface of the tube base **6** at the time this part is attached to the lead-in rod **5**. These legs or flanges **32** bear against the base of the tube envelope at a plurality of separated points; and the application of displacement forces to the supporting element S produces a component of axial thrust on the lead-in rod **5** it can readily stand, rather than a tilting stress likely to damage the glass seal for this rod.

It is preferred in this case to connect the lead-in rod **5** to the supporting element by a butt weld, since a connection of the desired conductivity, mechanical strength and heat resistance properties can be obtained more consistently from a welded connection than a conventional soldered connection, and with less chance of over-heating and damaging the glass seal.

Considering the heat dissipation characteristics of the mounting structure of this invention, in the case of gas tubes and the like, the anode and cathode, and sometimes other tube electrodes, assume relatively high temperatures in normal operation, and also the current to be conducted to these electrodes is relatively large in the order of amperes. Under such conditions, the electrode lead-in rods tend to assume high temperatures, and in order to avoid overheating and damaging the seals for such rods, heat should be effectively dissipated from the lower ends of these lead-in rods. In addition to heat dissipation by conduction through the external electrode connections, which exists in the case of the conventional base and socket type of tube mount, the supporting elements of the mounting structure of this invention are shaped and proportioned to provide exposed surfaces of an area sufficient for extensive heat dissipation by radiation to the chassis or other bodies, and by convection due to air currents naturally circulating under and around the base of the tube, thereby enabling the lead-in rods adjacent the seals to be maintained at an acceptable temperature level. Such heat dissipation from the supporting elements S also serves to maintain a relatively low temperature at the contacting surfaces between said supporting elements and their insulated terminals of the chassis plate, in spite of the amount of current being conducted. In this connection, a low and stable contact resistance between the disengageable parts of such a tube mount is important, otherwise excessive heat may be generated locally due to a high contact resistance and the currents being conducted. Also, it is desirable to avoid high temperatures at contacting surfaces, because temperature accentuates oxidation, corrosion and the development of other deleterious surface conditions producing high contact resistance. In the interests of obtaining an initial low contact resistance, the contact surfaces of the supporting elements, and also if desired the insulated terminal, may be plated with silver or a similar metal providing a low surface contact resistance.

Considering now the shock and vibration absorbing characteristics of the mounting structure of this invention, various types of equipment units in which the tubes are to be mounted, such as motor control devices, servomechanisms, and the like, are often subjected to severe shocks and sometimes sustained vibration in practical operation. Consequently, a tube structure mounted directly on the chassis plate or other supporting body of such equipment units is likely to be subject to shock and sustained vibration over a rather wide range of frequencies, which may cause undue displacement of the electrodes, or stress the supporting elements or welded connections of the tube structure beyond their mechanical strength and damage the tube.

It is common practice to take care of these conditions for radio receivers on mobile units and in similar situations, by providing a special shock-proof mounting for the equipment unit as a whole, or for the tube supporting body or chassis. Aside from matters of complication and expense, it is not always feasible to employ such shock-proof mounting for some types of equipment units; and it is proposed in accordance with this invention to provide a mounting structure for the individual tubes which, in addition to the features of electrical conductivity, heat dissipation and detachability above mentioned, will afford the appropriate resilient and damping effects to avoid transmission of damaging shock and vibration to the tube for the amplitudes and frequencies of motion of the chassis plate likely to be encountered in practice.

In the tube mounting structure of this invention, the supporting elements S are constructed to have sufficient flexibility to absorb excessive shocks or accelerating forces that might otherwise be transmitted from the chassis to the tube. In practical operation such shocks may be applied to the tube in various directions relative to its center of gravity, and the tube should be able to tilt by flexure of the supporting elements to accommodate movement of the tube in various directions relative to its supporting chassis. Accordingly, the supporting elements S are preferably shaped with a loop or reverse bend in a plane extending endwise of the tube, as shown in Figs. 3 and 8, to permit free tilting movement of the tube by flexure of the supporting elements, as well as endwise movement of the tube. Also, such loop in the supporting elements permit their linear expansion with changes in temperature, and avoids the application of undue stresses to the lead-in rods or their seals for a change in temperature after the outer ends of these supporting elements S are rigidly secured to the chassis plate.

In addition to transmission of shocks or accelerating forces from the chassis plate to the tube, under some conditions of operation the chassis plate may vibrate from time to time at frequencies, which might cause failure of some part or parts of the tube structure, if directly transmitted to the tube with sufficient amplitude. In general, the supporting elements, welded connections and the like in a typical tube structure may be designed to stand relatively large displacement forces periodically applied at lower frequencies, which for the purposes of discussion may be assumed to be in the range of frequencies of say 30 to 60 cycles per second. Such parts, however, are likely to be damaged by vibration at the higher frequencies of chassis movement that may be expected in practice, particularly if such frequency corresponds with the natural or resonant frequency of some part of the tube structure. In accordance with this invention, it is proposed to shape and proportion the supporting elements S with respect to the mass of the tube, in accordance with familiar principles of transmission of mechanical vibration between bodies, so as to effectively reduce or attenuate transmission of vibration from the chassis plate to the tubes at those frequencies likely to damage the tube. In this connection, the resiliency of the supporting elements S may be said to provide a mechanical tuning, analogous to electrical tuned circuits or filters; and this mechanical tuning effect may be selected to pass vibrations at frequencies the tube can stand, but attenuate and effectively exclude the unwanted frequencies of vibration damaging to the tube, assuming a given amplitude of chassis movement for these frequencies. There are of course considerable variations in the types of tubes, equipment units using such tubes, and the amplitude and frequency of vibration of the chassis plate likely to be encountered in practice; but in general the tube mounting structure of this invention may be designed to obtain effective suppression of deleterious effects of transmitted vibration, as well as a yieldable support to absorb shocks.

For many applications and uses, it is important to provide damping in connection with the resilient supporting elements S to absorb energy and restrict the amplitude of movement of the tube under the influence of shock and vibration that may be transmitted from

the chassis plate. In the mounting structure illustrated in Figs. 1 to 3, a thin strip 36 of resilient metal is welded to the outer slotted end of the supporting element S, and is arranged to bear at its upper end against the tube envelope, as best shown in Fig. 3. This affords friction damping for movement of the tube relative of the chassis, due to the rubbing of the upper end of this strip 36 upon the tube envelope. This strip 36, which may be formed with lateral fins 36*a* as best shown in Fig. 1, also adds additional heat dissipating surface to the supporting elements, which in many situations is desirable to maintain the desired level of temperatures. In many instances, sufficient damping is provided by the frictional losses in the metal itself of the supporting element S as it is stressed by the disturbing forces of shock or vibration. Such form of damping, sometimes termed hysteresis damping, is characteristic of the specific form of supporting elements shown in Figs. 6 to 8. In this arrangement, any deflection of the resilient body portion of the supporting element S is accompanied by energy losses, and a damping effect due to what may be termed molecular friction in the metal itself. The frequency and amplitude of movement of the chassis plates of different types of equipment units vary materially; and in many instances the inherent hysteresis damping of the supporting element itself is sufficient, while in other cases additional friction damping, as illustrated in Figs. 1 to 3, may be desirable.

The specific embodiments of the invention illustrated and described are merely typical or representative; and it should be understood that various adaptations, modifications and additions may be made in such specific structures without departing from the invention.

What I claim is:

1. In a mounting structure of the character described for hot cathode gas tubes, in combination with relatively stiff lead-in rods for all the tube electrodes sealed in a substantially flat sealing base of the tube envelope, a like plurality of supporting elements directly attached respectively to said lead-in rods for bodily supporting said tube and conducting current to its electrodes, each supporting element comprising a strip of relatively thin resilient metal having an end portion attached by fused metal to the corresponding lead-in rod, each supporting element having a curved body portion extending inwardly from the lead-in rod and then outwardly beyond the periphery of the tube envelope for making detachable contact with the terminals of the tube supporting body, said body portions of said supporting elements being disposed flatwise generally parallel with the sealing base of the tube envelope, said supporting elements being exposed to the outside air for dissipation of heat and acting to attenuate transmission of shocks and vibration from the tube supporting body to the tube damaging to its structural elements.

2. In a tube mounting structure of the character described for establishing exposed heat radiating detachable electrical connections with the insulated terminals of a tube supporting body, a tube envelope having a substantially flat circular sealing base, a plurality of electrode lead-in rods sealed in said base at different intervals in a circular row, and a resilient supporting element attached to each lead-in rod and extending radially beyond the periphery of the base for attachment to its insulated terminal of the tube supporting body, each supporting element having an end portion welded to its lead-in rod and being exposed to the outside air for dissipation of heat, and each supporting element being formed with flanges contacting with the base of the tube envelope on opposite sides of the lead-in rod.

3. A tube mounting structure of the character described for detachably mounting electron discharge tubes on a tube supporting assembly and establishing exposed heat dissipating electrical connections between the wire terminals of said assembly and said tubes, a plurality of lead-in rods sealed in the base of said discharge tube at preselected locations, a resilient metal support contacting the underside of the base of said discharge tube and having a curvilinear central portion capable of compression, said resilient metal support having an upright portion engaging the lower periphery adjacent the bottom portion of said tube and at said preselected location, said resilient metal support having its other end detachably connected to a stationary mount, said tube support assembly being free to move in a vertical plane when subjected to external forces whereby the magnitude of the rocking and tilting stresses is reduced.

References Cited in the file of this patent

UNITED STATES PATENTS

1,549,355	Ghegan	Aug. 11, 1925
1,579,156	Siemann	Mar. 30, 1926
2,000,570	Nina	May 7, 1935
2,004,610	Jones	June 11, 1935

FOREIGN PATENTS

274,431	Great Britain	Aug. 25, 1927
284,019	Great Britain	Jan. 23, 1928
319,946	Italy	July 27, 1934