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ELECTRON DISCHARGE DEVICE

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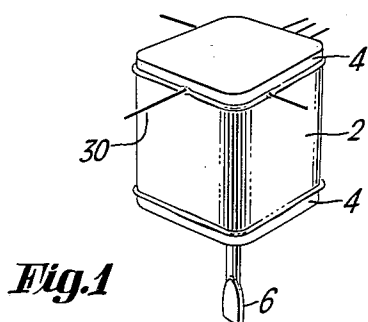


Fig. 1

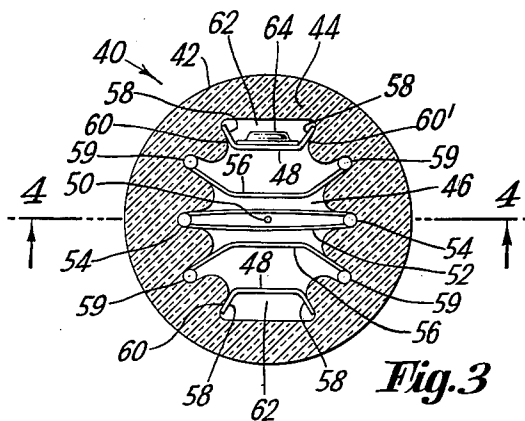


Fig. 3

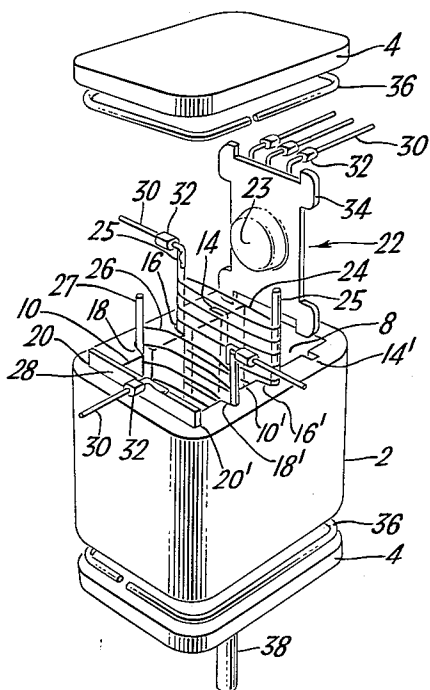


Fig. 2

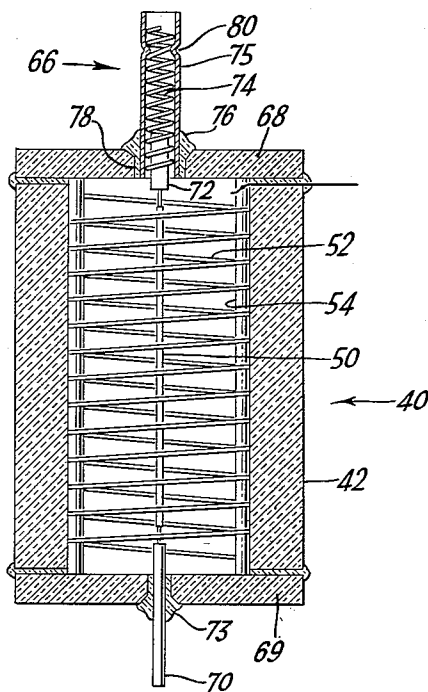


Fig. 4

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ELECTRON DISCHARGE DEVICE

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8 Claims. (Cl. 313—249)

This invention relates to electron discharge devices; more specifically it relates to a new and novel structure for vacuum tubes or the like.

In the early development of vacuum tubes, the principal emphasis was placed on the production of tubes which would have given electrical characteristics. Little attention was paid to the development of improved mechanical supporting structures. The result has been that the supporting structures for vacuum tube electrodes have been mechanically weak, and have not been adapted to automatic assembly techniques. An object of the present invention is, then, to provide a vacuum tube structure which is rugged, and adapted to automatic assembly.

Among the materials which have been continually utilized by the industry in fabricating vacuum tubes has been glass, most commonly utilized for the envelope of the tube. Glass has numerous disadvantages for vacuum tube purposes including a tendency to fracture readily, lack of machinability to close tolerances, etc. Also the industry has relied on the use of mica spacers as a means for supporting and spacing the electrodes in the mount structure of the tube. Such structures are also fragile and do not lend themselves to the maintenance of close tolerances.

It is a further object of the invention to provide a vacuum tube capable of production, in quantity and to close tolerances, by simplifying and improving the mount structure, and utilizing more suitable materials in the vacuum tube envelope.

Another object of the invention is improvement in rigidity of the electrode structure with a view to reducing microphonism due to variations in interelectrode dimensions, without, at the same time, regaining the fabrication of electrode structures differing from those commonly employed.

A further object of the invention is the elimination of stresses heretofore imposed on internal vacuum tube connecting leads by the practice of utilizing the same leads as electrode mount supports.

The above objects and others which may occur to the reader during consideration of the below appended specification and drawings are attained in the invention described below and illustrated in the drawings in which a vacuum tube envelope is formed of a hollow insulating body having slots disposed on its inner wall to receive portions of the elements comprising the electrode structure, the apertures through which insertion of the electrodes is accomplished being closed by insulating members.

In the drawings:

Fig. 1 is a perspective view of a discharge device embodying the invention;

Fig. 2 is an exploded view of the embodiment of the invention disclosed in Fig. 1;

Fig. 3 is a view in cross-section of an alternative embodiment of the invention shown in Fig. 2;

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Fig. 4 is a view in vertical cross-section of a tube utilizing the embodiment shown in Fig. 3;

Referring now to Fig. 1, it will be seen that the invention in one embodiment may comprise a hermetically sealed envelope of generally rectangular configuration having central body 2 of ceramic or other insulating material which is closed at either end by cover members 4, preferably also of an insulating material, and hermetically sealed to the body 2. The device is exhausted and sealed off through tip-off tubulation 6 projecting downward from bottom cover plate 4.

Referring now to Fig. 2 in which an exploded view of a partially assembled tube embodying the invention illustrated in Fig. 1 is shown, it will be seen that the body 2 is of a generally rectangular hollow configuration having central electrode receiving space 8. Provided in opposite faces 10, 10' of space 8 are longitudinal slots or grooves 14, 14', 16, 16', 18, 18' and 20, 20' which are disposed generally parallel to the central longitudinal axis of member 2. Vacuum tube electrodes, such as cathode 22, first grid 24, second grid 26 and anode 28 are fitted in and supported by the pairs of grooves or recesses 14, 14', 16, 16', 18, 18' and 20, 20' respectively. These electrodes are adapted to fit tightly within their corresponding receiving slots and ordinarily extend the entire length of body 2 so that their ends terminate flush with the open end surfaces of body 2 and so that the lateral portions are thus fully supported. Connections to the various electrodes are made by means of connecting leads 30 which are provided with glass beads 32 the purpose of which will be explained below. The cathode 22 has a convex face 23 which bears an electron emissive coating and contains a heater coil of conventional type. Cathode 22 is also provided with laterally projecting lugs 34 which are adapted to fit tightly into cathode receiving slots 14, 14' and are kept as small as possible in order to minimize heat conduction from the cathode body proper to the body 2 thereby maximizing cathode efficiency in terms of power input per unit area. Grid 24 has side rods 25 and is formed of a continuous wire wound around the laterals 25 and is generally of a conventional type. The second grid 26, as shown, is of the type having lateral conductors in only one plane and attached to only one side of the side rods 27 and is also of a type conventional in the vacuum tube art. Anode 28 is a simple metallic plate, rectangular in configuration, which is fitted into receiving slots 20, 20'. In other respects the specific design of the tube is conventional, insofar as its electrical characteristics are determined by electrode spacing, grid winding size and spacing, etc.

Assembly of the tube is accomplished by inserting the various electrodes into their proper slots with conducting leads projecting outwardly from the center of the tube so as to locate the glass beads 32 over the wall portion of body 2. The tube envelope may then be completed by laying glass sealing rings 36 between the surfaces of the walls of body 2 and end plates 4, the entire assembly being sealed together by heating so as to cause the glass of sealing rings 36 to flow between the meeting surfaces of cover members 4 with body 2 and to cause the glass beads 32 to melt and merge into the seal. Upon completion of the body sealing operation, the tube may be evacuated through tubulation 38; the final hermetic seal being produced by pinching off tubulation 38 in the conventional manner.

Microphonism of the tube is considerably reduced by selecting the width of the grid, anode and cathode structures so that they must be placed under a slight amount of compression during the process of insertion into body 2 and will therefore, upon release of the pressure, expand and press tightly against the bottom portions of the

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slots 14, 14', 16, 16', etc. when in place in body 2. It is preferable, too, in designing these structures to make them of extra width so that they remain under some compression stress after insertion in the tube body. The presence of such stress in the various elements reduces a tendency of the elements to vibrate and assures that they remain in position, thereby stabilizing interelectrode distances.

Referring now to Fig. 3 which shows a plan view of a body member suitable for use in an alternative embodiment of the invention, it will be seen that the body 40 has a generally cylindrical outer wall 42 and is provided with plane surface 44 at the near end of the body and a similar plane surface (not visible in the drawing) at the far end of the body, both being generally parallel to each other and generally perpendicular to the central axis of the body. Such surfaces are adapted, as in the case of the embodiment of Fig. 2, to receive end closure members in a manner similar to that already taught. The central portion of block 40 is hollowed out and provided with peripheral recesses in a configuration which may perhaps be best characterized as pinnate and thereby is adapted to receive the extremities of electrodes to be assembled and held within the block. The body 40 in this embodiment of the invention is adapted to receive the elements of a double tetrode having symmetrical, oppositely disposed sections and a common cathode. Accordingly, the general configuration of the hollowed out portion 46 is symmetrical about the center of the two tube sections, the axis bisecting the anodes 48 and being coaxial with filament 50 in the center of the tube body. The body 40 may be readily formed by moulding, casting or extruding a suitable insulating material such as a ceramic, for example. Materials which can be worked to close tolerances are preferred.

The electrodes utilized in the body of Fig. 3 comprise centrally located filament 50, double sided grid 52 which is formed on side rods 54 and which surrounds filament 50, a pair of single sided grids 56 each of which is provided with supporting side rods 59 and are located on opposite sides of filament 50, and sheet metal anodes 48 which are provided with wing portions 58. Each of the electrodes is adapted to fit into recesses in the wall of body 40, being supported thereby in place and retained under a slight degree of compression stress to increase their stability and minimize microphonism. The individual recesses and the intervening ridges or protrusions into the central space 46 of body 40 have been rounded in this instance to facilitate extrusion and to minimize any localized stresses that would be established by the presence of sharp corners. While the rounded form is preferable, it is obvious that other types of surfaces might be employed. The grid 52 may be formed in a conventional manner as was grid 24 of Fig. 2, while the standard single sided grid 26 of Fig. 2 has been modified by bending at points centrally spaced from its outer edges to provide the winged grid structure 56. The anodes 48 are also provided with wings 58 which cooperate with lateral walls 60 of anode recesses 62 to retain anode 48 in place. A certain amount of outward pressure by wings 58 on wall 60 is desirable in order to minimize motion of the anode within the recess. A getter capsule 64 may be attached to the surface of one of the anodes 48 and should be located on the side of the anode away from the electron stream. Connections to the electrodes are made in the manner disclosed in connection with Fig. 2.

The filament structure utilized in a tube embodying the body of Fig. 3 is illustrated in the cross-sectional view of Fig. 4. The tube has the body 40 of Fig. 3 sealed by end closures 68, 69 in a manner similar to that described for the tube of Fig. 2. Centrally disposed within upper ceramic closure disc 68 is a spring tensioner 66 which supports one end of the filament 50 and maintains it centered within the central space 46 of body 40. The filament 50 is of the conventional type having a metallic central core and suitable emissive coating. It is anchored

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at the end away from the spring tensioner in the ceramic base closure member 69 by affixing it to a bottom filament lead 70. The bottom filament lead 70 is inserted through a suitable aperture in the ceramic base cap 69 and is maintained therein by means of hermetic seal 73, which may be made of glass frit, and which thus serves to rigidly maintain lead 70 in a central position in the cap.

The upper end of filament 50 is anchored to filament spring tab 72 which is in turn firmly affixed to the lower end of filament spring 74. Filament tension spring 74 is retained in axial alignment with the filament assembly by metal exhaust tube 75, which is in turn retained in rigid position in cylindrical aperture 78 provided in upper ceramic cap 68 by hermetic seal 76. The upper end of filament tension spring 74 is anchored, in order to maintain tension on the assembled filament structure, by the bead or crimp 80 in the wall of the exhaust tube, the crimped portion being of sufficient inward extension to engage a turn of the spring coil. The upper end of tube 75 is pinched off in the conventional manner at the end of the evacuation process (not shown). For a better understanding of the filament structure employed herein, the reader is referred to a copending application Ser. No. 328,701 filed on December 30, 1952, by Mortimer Weiss, entitled "Electron Discharge Device" and assigned to the same assignee.

Vacuum tubes constructed according to the invention are particularly adapted to facilitate assembly and permit assembly by automatic machinery techniques. The insertion of the electrodes into either of the bodies disclosed above may be conveniently performed by simple mechanical devices already known in the art, sequentially arranged to insert a given electrode as the body passes under the dispenser. Subsequent assembly of the end cover plates is simplified and is also adaptable to performance by machinery. It should be noted, too, that the structures facilitate the assembly of vacuum tubes having different characteristics by simple, direct substitution of electrodes of the desired type, and, that variations in spacing may be readily accomplished by providing differently formed body parts. Similarly, beam forming elements may be provided which fit the slots, in order to provide tubes having beam type characteristics. Added advantages will be found in the ability of the body wall to conduct heat away from the individual electrodes through the intimate contact provided, thereby producing cooler running electrode structures. Considerable modification of the body structures is, of course, possible. For example, in some types of construction, it may be found desirable to eliminate one of the cover plates by providing either an integral substitute envelope portion, or by further changing the configuration of the body portion to receive electrodes of a configuration other than rectangular. For example, the surfaces containing the oppositely facing recesses may be caused to slope towards each other, so as to provide a triangular shaped body section; alternatively, a rounded integral bottom portion may be utilized. Where it is desirable to increase the restraint applied to the electrodes, suitably recessed or ridged closure member portions may be employed, as well. Similarly, variations in the type of recess or groove utilized may be found useful. For example, a series of small protrusions which are arranged in a line, may be substituted for a ridge, and the number of protrusions may be as small as two (per ridge) although the support supplied to an electrode would then be considerably reduced. Similarly, a number of small recesses could be aligned to provide support for mating projecting portions of an electrode. Here the electrodes would be considerably compressed during insertion, and then released, allowing the mating projecting portions to lock in the recesses.

What I claim is:

1. An electron discharge device having a hermetically sealed envelope, a number of electrodes having oppositely

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extending lateral supporting portions contained within said envelope, and said envelope having recesses oppositely disposed along substantially straight lines on its inner surface, said recesses each being adapted to engage said electrode supporting portions at a plurality of points, whereby said electrodes are maintained in predetermined, spaced relationship.

2. An electron discharge device having a hermetically sealed envelope, a number of substantially rectangular electrodes contained within said envelope, said envelope having lateral walls containing recesses oppositely disposed along substantially straight lines on the inner surfaces of said walls and said electrodes having oppositely extending lateral supporting portions inserted in said recesses and engaging said recesses at a plurality of points, whereby said electrodes are maintained in predetermined, spaced relationship.

3. An electron discharge device including a hermetically sealed envelope, a number of electrodes within said envelope, said envelope having a generally tubular body portion, the inner surface of said body portion being defined by the motion of a directrix substantially parallel to the axis of said tubular portion along a pinnate locus, and said electrodes having oppositely disposed lateral supporting portions adapted to engage said inner surface, whereby said electrodes are supported and maintained in predetermined, spaced relationship.

4. An electron discharge device having a hermetically sealed envelope, a number of electrodes contained within said envelope, and a number of connecting leads connected to said electrodes and passing through the wall of said envelope, said envelope including a hollow body having generally parallel, oppositely facing recesses on the inner surface, there being an aperture for the insertion of said electrodes and a closure member for said aperture, said electrodes having laterally projecting portions adapted to be received by said recesses and to contact said closure member, whereby said electrodes are maintained in a predetermined, spaced relationship.

5. An electron discharge device having a hermetically sealed envelope, a number of substantially planar electrodes having oppositely extending lateral supporting por-

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tions contained within said envelope, and said envelope having recesses oppositely disposed along substantially straight lines on its inner surface, said recesses being adapted to engage said electrode supporting portions and to subject a number of said electrodes to lateral compressive stress, whereby said electrodes are maintained in predetermined, spaced relationship.

6. An electron discharge device including a hermetically sealed envelope, a number of electrodes sealed within said envelope, said envelope having a tubular body portion containing a number of longitudinal grooves on its inner surface, a number of said electrodes being received and maintained under lateral compression in predetermined, spaced relationship by said grooves.

7. An electron discharge device including a number of electrodes, a hermetically sealed envelope for said electrodes, said envelope having a tubular body portion, and the inner surface of said body portion having a number of longitudinal recesses, a number of said electrodes being slidably engaged under lateral compressive stress by said longitudinal recesses and maintained in a predetermined, spaced relationship thereby.

8. An electron discharge device including a hermetically sealed envelope, a number of electrodes within said envelope, said envelope having a generally tubular portion, the inner surface of said body portion having oppositely disposed recesses being defined by the motion of a directrix substantially parallel to the axis of said tubular portion along a pinnate locus to provide oppositely disposed recesses, each of said electrodes having oppositely disposed lateral supporting portions conformably extending into a pair of said recesses and pressing against the surface thereof, whereby said electrodes are supported in predetermined, spaced relationship and maintained under compressive stress.

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