March 12, 1935. S. J. POWERS 1,993,804

THERMIONIC POWER DEVICE

Filed April 27, 1927 3 Sheets-Sheet 1

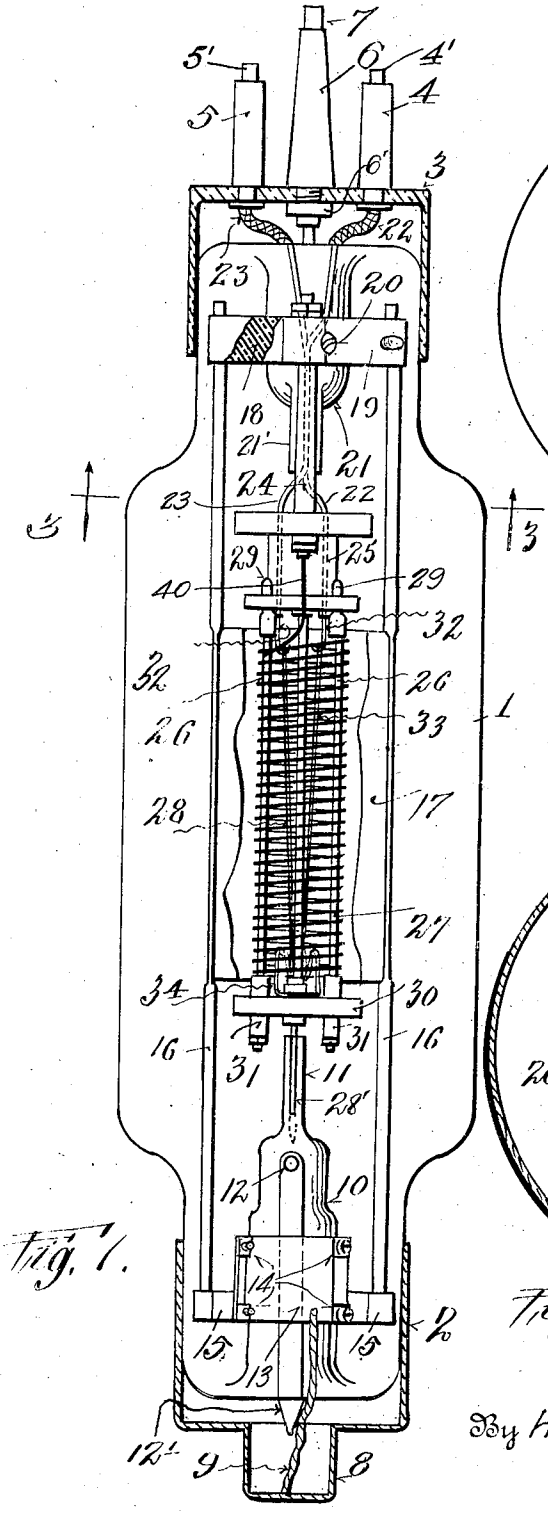


Fig. 1.

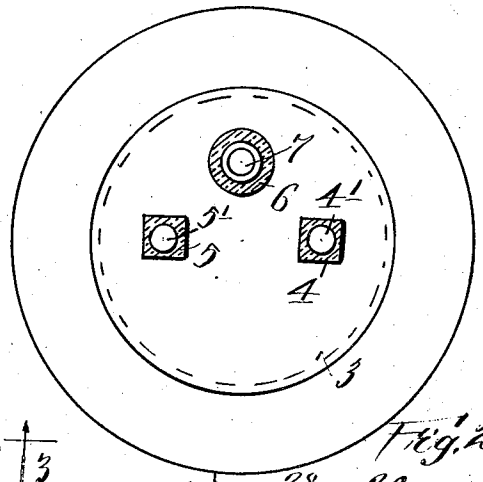


Fig. 2.

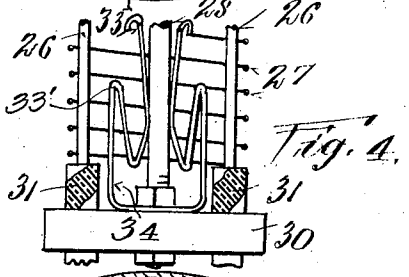


Fig. 4.

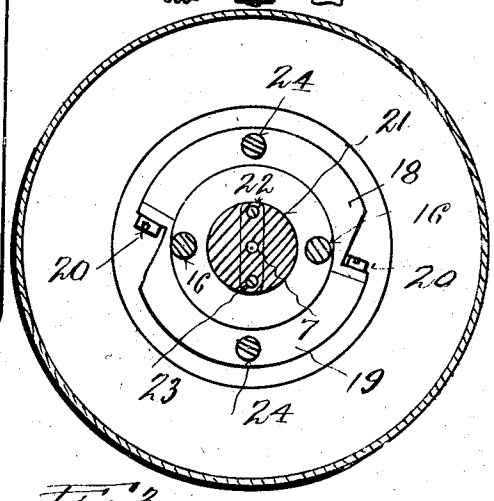


Fig. 3.

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March 12, 1935. S. J. POWERS 1,993,804

THERMIONIC POWER DEVICE

Filed April 27, 1927 3 Sheets-Sheet 2

Fig. 5.

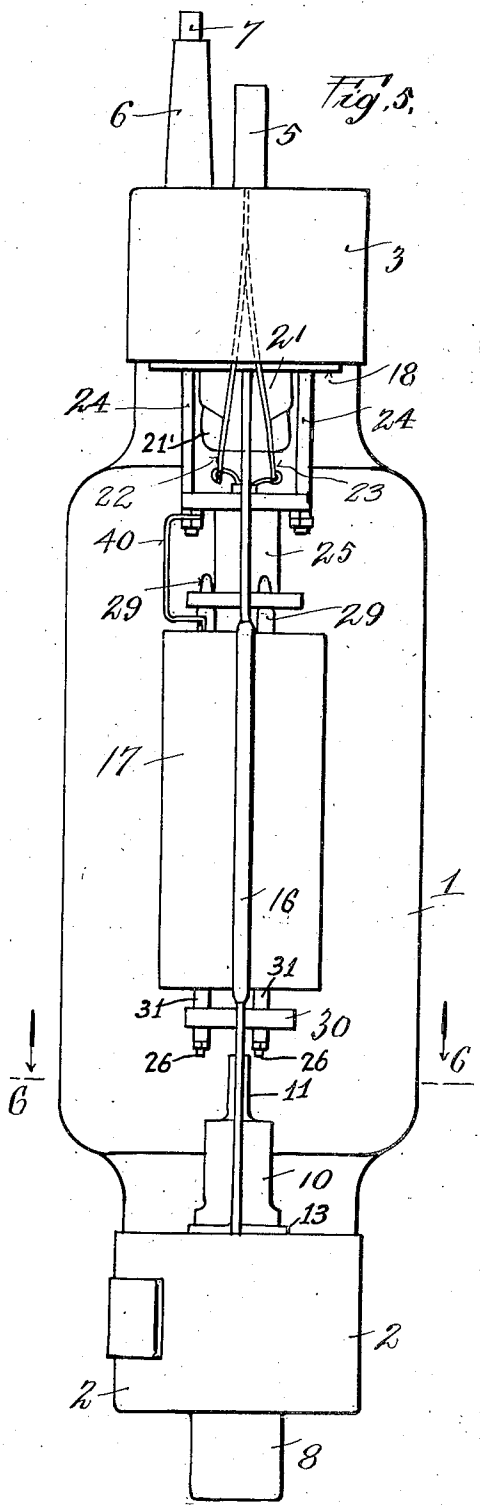
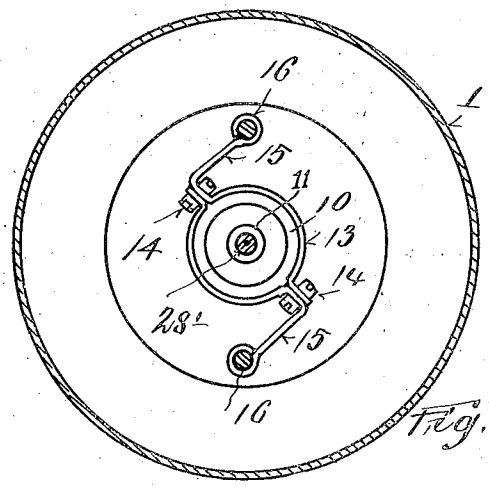


Fig. 6.



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March 12, 1935. S. J. POWERS 1,993,804

THERMIONIC POWER DEVICE

Filed April 27, 1927 3 Sheets-Sheet 3

Fig. 7

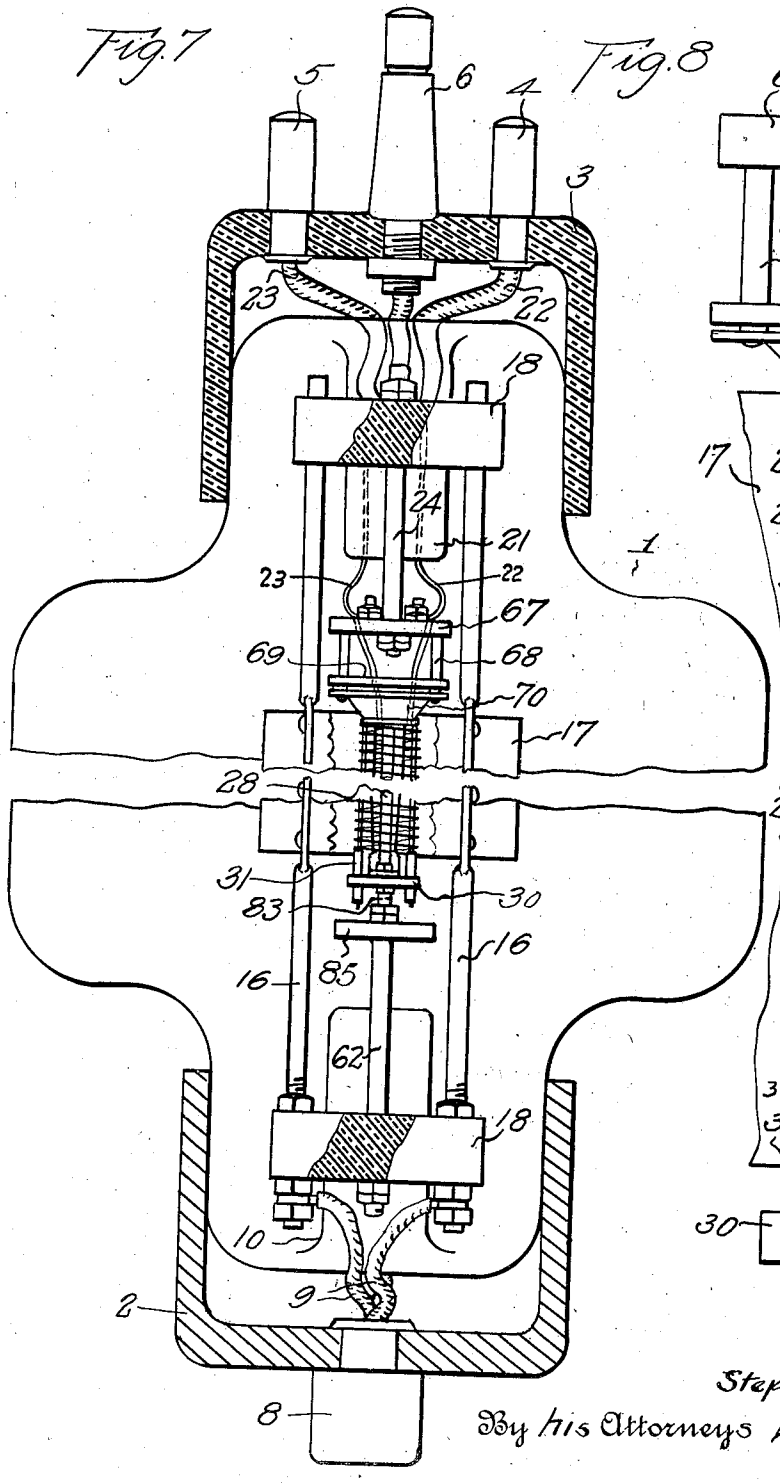
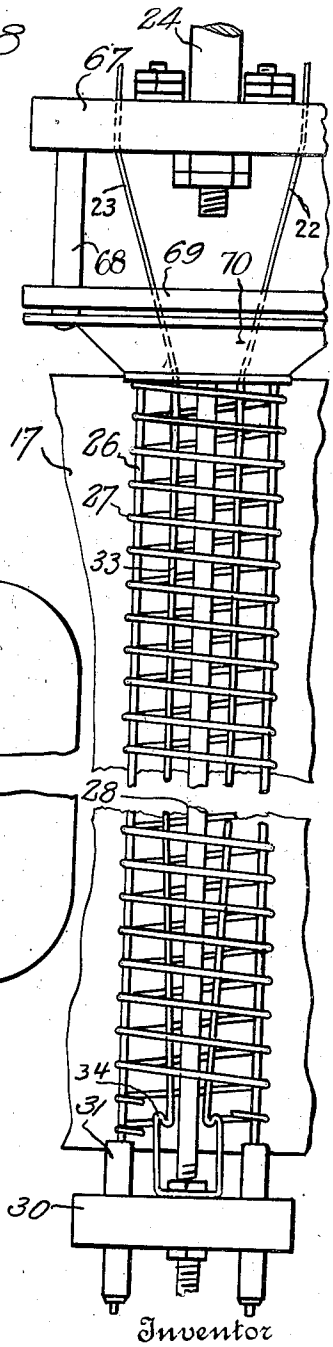


Fig. 8



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UNITED STATES PATENT OFFICE

1,993,804

THERMIONIC POWER DEVICE

Stephen J. Powers, Hoboken, N. J., assignor, by mesne assignments, to Radio Corporation of America, a corporation of Delaware

Application April 27, 1927, Serial No. 187,049

13 Claims. (Cl. 250—27.5)

This invention relates broadly to thermionic power devices.

One of the objects of this invention is the improvement of high power vacuum devices.

Another object of this invention is the provision of a novel means of supporting the plate of high power vacuum devices, which is adapted to prevent the puncture of the glass by reason of the high voltages employed on the plate of said tubes. A still further object of this invention is the provision of a novel means of support for the plate.

A still further object of this invention is the novel construction employed in supporting the grid and filament assembly whereby the assembly may undergo longitudinal movement by reason of the expansion due to heat without permitting lateral movement.

A still further object of this invention is the provision of a new and novel means of supporting the filament whereby it is maintained taut regardless of its temperature.

A still further object of this invention is the novel construction of the grid lead.

Another object of this invention is the employment of a synthetic ceramic product made of refined clay for the insulating supports for the various elements of the tube.

A further object of this invention contemplates the employment of quartz bushings between the metallic grid supports and the ceramic supports with a view to preventing electrolysis and cracking of the ceramic supports under the action of a very high frequency electrical currents encountered in the operation of a device of this type.

A still further object of this invention is to employ molybdenum for supporting some of the elements of the tube.

These and many other objects which will become apparent upon further disclosure are sought by means of this invention.

This invention resides substantially in the combination, construction, arrangement and relative location of parts, all as will be more fully hereinafter described.

Wherever possible the same reference numerals will be used in the various figures to indicate the same or similar parts.

Referring to the drawings,—

Fig. 1 represents a side elevational view with some parts in cross section and some parts broken away disclosing a power tube employing the principles of my invention.

Fig. 2 is an end view of the tube showing the relative disposition of the grid and filament terminals.

Fig. 3 represents a cross sectional view taken on the line 3—3 of Fig. 1 looking in the direction of the arrows.

Fig. 4 is an enlarged side elevational view of a detail showing the method of supporting the filament and the grid at their lower ends.

Fig. 5 is a side elevational view of this tube taken at right angles to the view in Fig. 1.

Fig. 6 is a cross-sectional view taken on the line 6—6 of Fig. 5 looking in the direction of the arrows, and

Fig. 7 is a side elevational view with some parts in cross section and some parts broken away showing a somewhat modified form of the invention.

It has always been one of the problems in the construction of high power vacuum tubes which employ very high plate voltages to provide suitable means for supporting the various elements of the tube so as to reduce to a minimum the possibility of destruction of the tube by reason of the puncture of the glass envelope. The problem has been to arrange and support the various elements of the tube, so that the tendency to arc over and the consequent destruction of the tube is eliminated. It has also been somewhat of a problem to support the grid and filament elements, so as to permit of expansion of the parts due to the high temperature employed without destroying the relative arrangement of the parts. Also due to the high electrostatic fields incident to the operation of said tubes, it has been difficult to support the parts, so that they will not be thrown out of alignment. I have provided a device by means of which these difficulties are readily overcome.

By my construction, I have also discovered that the parts may be advantageously supported by means of a synthetic ceramic product such as a refined clay, compressed, dried and fired at high temperature. I have also discovered the molybdenum is a suitable material for supporting the elements even at the high temperatures employed. By means of my construction, I have also provided a novel method of bringing the terminals of the various elements to the bases of the tube.

Referring to the drawings, in which I have disclosed an apparatus embodying these features, in Fig. 1, at 1 is shown a glass envelope of suitable shape provided at one end with the metallic cap base 2 and at the other end with a suitable insulating base constructed of a synthetic ceramic and the like. It is, of course, evident that a metallic base might be employed if desired. The base or cap 3 is provided with two prongs 4 and 5 of rectangular cross section which may be made of suitable insulating material. The current carrying terminals extend centrally therethrough as shown at 4′ and 5′. It is, of course, evident that if the cap 3 is of insulating material, the prongs 4 and 5 may be made of metal. Also mounted on the cap 3 is a synthetic ceramic post 6 with a reduced threaded portion which extends

through the hole in the cap cooperating with a synthetic ceramic nut 6' to securely attach the post to the cap. The post 6 has an axial bore through which the metallic terminal 7 for attachment to the grid extends.

It will be noted that the metallic cap 2 is provided with an integral lug 8, to which the current conductor 9 is soldered. This conductor is connected at its other end to the plate of the tube. Extending internally of the glass envelope 1 is a glass stem tube 10 having a reduced cylindrical portion 11, which is hollow. The stem tube 10 is hollow and is provided with a small hole 12 through which the envelope is exhausted and then sealed off at 12' in the usual manner. Encircling the stem tube 10 and clamped thereto by means of the bolts 14 is a two part metallic collar 13 having the integral extending arms 15 provided at their ends with loops. The molybdenum plate supports 16 are mounted in these loops at one end so as to be free for longitudinal movement in the disk 18 due to expansion. A plate 17 is shown riveted or otherwise secured to the supports 16 which are flattened at their point of contact with the plate. The plate may be constructed of tungsten, molybdenum and the like. A reentrant glass stem portion 21 extends internally of the envelope at its other end and terminates in the usual press portion 21' through which pass the filament and grid lead-in wires. Stem 21 has encircling it a synthetic ceramic disk composed of two parts 18 and 19, which are secured together by means of machine screws 20.

Extending through the press 21' in the usual manner are two current leads 22 and 23 which connect to the filament terminals 4 and 5. It will also be noted that the other ends of the plate supporting rod 16 are mounted in this ceramic disk or collar. Supported on the ceramic collar are the two rods 24 which may be made of metal or even of insulating material. Secured in any suitable manner to the rods 24 is a synthetic ceramic spool 25. Within the holes in one of the spool flanges are mounted the quartz members 29, which are hollow to receive the grid supporting rods 26. The grid rods 26 which support the grid 27 are secured to the disk 30 and are free to slide longitudinally in their supports in spool 25 to allow for expansion and contraction effects.

Supported centrally on the spool 25 is a suitable support of either insulating or metallic material 28 which is threaded for a considerable length of its outer end and has mounted therein an insulating disk 30. The grid supports 26 are mounted in the quartz bushings 31 as clearly shown in Fig. 1. A filament 33 is shown mounted on the hooks 32 which are themselves supported on the spool 25. The filament leads extend through the spool and through the press 21' and appear as mentioned above at 22 and 23. Supported on the rod 28 and the disk 30 is a wire member 34 which has its ends looped over to form hooks at 33', to which the filament is attached. If desired the filament and member 34 may be of one piece and fashioned to the shape shown in Fig. 4.

It will be noted that the end 28' of rod 28 extends into the hollow extension 11, and is not secured thereto, so that it may move longitudinally thereof, as the filament or grid assembly expands or contracts.

The relative disposition of the various supports is clearly shown in Figs. 3, 5, and 6. It will be noted that in Figure 5 the grid lead is shown at 40 and the filament leads which extend through the member 21 are shown at 22 and 23. As shown in Fig. 3, the grid lead 7, which connects to the member 40 extends centrally of the member 21', which is solid and the filament leads 22 and 23 so extend therethrough. The method of supporting the ends of the rod 28, which permits longitudinal movement thereof at the same time does not permit lateral movement.

A slightly modified form of construction is shown in Figs. 7 and 8, where as before the glass envelope 1 is provided at one end with a metal cap 2 and at the other end with a cap 3, which may be insulating material, such as synthetic ceramic. The cap 2 has the plate terminal 8 to which the plate leads 9 are connected. The internal glass stem 10 supports a synthetic ceramic collar 18', in which the plate supports 16 are mounted. At the other end of the envelope the internal member 21 supports a ceramic collar 18', which receives the other ends of the plate support 16. The ends of the plate supports are seated in the collar 18' to permit longitudinal movement due to expansion. The cap 3 is provided with the filament terminals 4 and 5 to which the filament leads 22 and 23 are connected, and also has mounted thereon the insulating bushing 6 through which the grid lead extends.

The insulating supports 62 mounted on the collar 18' have secured at their outer ends an insulating member 85. The collar 18 also supports the insulating rods 24 which have secured to their outer ends an insulating disk 67. The insulating disk 67 provides the supports for the members 68 and 69, to which the filament and grid assembly is attached. The member 70 is a molybdenum shield for the end of the filament to prevent the escape of electrons to the grid at the end and the bombardment of the filament by electrons at the point where it is most positive. The grid is supported on the rods 26 which seat in the quartz bushing 31 secured to the insulating disk 30. This disk is supported from member 70 by means of rod 28, which is guided by the rod 62. The plate is shown at 17 and the filament at 33 which is supported on the disk 30 by the spring cap 34. The ends of the rods 26 are freely supported on the disk 30 to permit longitudinal movement thereof with respect to the disk due to unequal expansion of the rods 26 and rod 28. Quartz bushings 31 are mounted between the rods 26 and disk 30. It will be evident from the foregoing disclosure that I have provided a construction whereby the plate is supported on insulating members attached to both ends of the tube to provide a rigid construction. It is evident that the spring construction of the members 34 tends to maintain the filament tighter and in alignment, and that its assembly with the grid elements form a unitary construction, which is adapted to move longitudinally due to heat changes. It is evident, that I have provided a novel method of supporting the various terminals for the tube. It is also clear that by means of this construction employing synthetic ceramic supports, that the tendency of the tube to arc over between the elements or to puncture the glass envelope is reduced to a minimum. I have found that a synthetic ceramic material sold under the trade name of "Isolantite" is particularly adaptable for this purpose.

I am, of course, aware that many changes in the details and construction and relative arrangement of parts will suggest themselves to those skilled in the art, and I do not, therefore, desire to be limited to the exact construction disclosed

by me, but rather to the principles of my invention as they are defined in the appended claims.

What I seek to secure by United States Letters Patent is:

1. In a device as described, the combination with an exhausted envelope having an internally extending projection on each end and current terminals at each end one of said projections terminating in a press of a plate support on said projections including a collar at one end to which said supports are rigidly fastened, a collar on the other end, and a plate and a unitary grid and filament assembly supported on said collar, said assembly comprising a pair of insulator members between which the filament and grid are mounted, a pair of metallic uprights around which the grid is wound, said metallic uprights engaging at their opposite ends said insulator members, and means carried by one of said insulator members for engaging said press.

2. In a device as described, the combination with an exhausted envelope having an internally extending projection on each end, and current terminals at each end, one of said projections terminating in a press, of a plate supported on each of said projections and a unitary filament-grid assembly secured to one of said projections and in sliding contact with the other to permit unitary longitudinal movement of the filament-grid assembly without lateral movement, said assembly comprising a pair of insulator members between which said grid and filament are mounted, one of said insulator members carrying a projection to engage said press.

3. In a device as described the combination with an exhausted envelope having an internally extending projection on each end, one of said projections terminating in a press, and current terminals at each end of a plate supported on each of said projections and a unitary filament-grid assembly secured to one of said projections and in sliding contact with the other to permit longitudinal movement of the assembly without lateral movement, said filament being mounted so as to remain taut at all operating temperatures, said filament and grid assembly including a pair of spaced insulator members between which the grid and filament are mounted, and a projection carried by one of said insulator members to engage the press.

4. A grid, plate and filament assembly comprising two supports mounted at one end in a metallic collar and at the other slidably mounted in an insulating collar, a plate on said supports, and a grid-filament structure mounted on said insulating collar.

5. In a grid-filament structure the combination of an insulating member, a grid supported on said member, and having an insulating member, for holding the grid elements in alignment and a filament mounted on said insulating members, said grid elements having quartz bushings where they contact with said insulating members.

6. In a grid filament structure the combination of a synthetic ceramic member, a grid supported on said member and having a ceramic member for holding the grid elements in alignment and a filament mounted on said ceramic members, said grid elements having quartz bushings where they contact with said ceramic members.

7. In a vacuum tube device the combination with an envelope having two re-entrant projections of a plate structure including a two part synthetic ceramic collar secured to one of said projections and a grid-filament assembly supported on said collar at one end and means for guiding said assembly as it moves longitudinally due to temperature changes.

8. In a power vacuum tube the combination of an envelope having an internally extending and centrally located reentrant projection at each end one of said projections terminating in a press, a plate rigidly supported at one end on one of said projections and slidably supported on the other end of the other of said projections, and a grid-filament assembly having a common support on one of said projections, said assembly being slidably mounted as a unit on the other projection, said grid filament assembly comprising a pair of insulator members between which the grid and filament are mounted and a projection on one of said insulator members engaging said press.

9. In a power vacuum tube device the combination of an envelope having a reentrant portion, a synthetic ceramic cap at one end of said envelope, plate, filament and grid electrodes within said envelope, electrode terminals on said ceramic cap, a metallic cap at the other end serving as an electrical connecting terminal for one electrode, an insulating collar surrounding said reentrant portion and providing a unitary rigid support for one end of each of said electrodes, and means providing a sliding support for all said electrodes at their opposite ends, said last mentioned means comprising another re-entrant portion of said envelope, a collar surrounding the last mentioned re-entrant portion, members connected to said plate slidably engaging said collar, and a member connected to the said grid and filament slidably engaging the last mentioned reentrant portion.

10. In a power vacuum tube the combination of a glass envelope having a reentrant stem at each end, a plate electrode, a grid-filament assembly, means for rigidly securing the plate electrode to one of said stems including an insulating collar surrounding said stem, a pair of posts carried by said collar which provide a unitary support for the grid filament assembly, another insulating collar surrounding the other reentrant stem and providing a sliding support for said plate electrode.

11. A vacuum tube structure comprising an envelope having a re-entrant base portion, said base having a recess therein facing the interior of the envelope, a filament, a grid, a pair of insulating members between which said filament and grid are mounted, said filament being secured at one end to one of said insulators, and being secured at the opposite end to the other of said insulators, and a member carried by one of said insulators engaging said recess.

12. A tube according to claim 11, in which the said projection on said insulating member slidably engages said recess.

13. In a grid-filament structure the combination of an insulating member, a grid rigidly attached to said member, another insulating member holding the grid elements in alignment and in which the grid is slidingly mounted, and a filament secured to the first mentioned insulating member at one end of the structure and secured to the second mentioned insulating member at the other end of the structure for maintaining said filament in proper spaced relation to said grid.

STEPHEN J. POWERS.