This invention relates to electron tubes for ultra high frequency currents and is particularly applicable to tubes with two electrodes.

Due to the increased use of ultra high frequency circuits in communication and other fields, the development of diode electron tubes giving good response in such circuits has become of great importance. For good operation of a tube at ultra short wave lengths, the requirements are low electrode inductance and capacitance, small cathode-anode spacing and improved tube geometry, to bring the active cathode surface and adjacent anode surface into intimate electrical relationship with its associated circuits. It is an object of this invention to provide an electron tube meeting these requirements.

Another object of the invention is to provide a diode of such construction as to permit close and accurate spacing between cathode and anode.

Fig. 1 is a perspective view of the improved diode.

Fig. 2 is a vertical section of the tube in Fig. 1.

Fig. 3 illustrates one method of completing the cathode assembly.

Referring to the drawing, the envelope 1 of glass or other non-conducting material is most conveniently made in cylindrical form open at each end prior to assembling with the tube elements. The anode support 2 and the cathode support 3 are made in the shape of hollow frustums of cone-like members. A preferred shape of the anode and cathode supports considered as an assembly is that of a hyperboloid of revolution, with a section missing at the middle or gorge plane. The enlarged ends of each have flanges 4, 5 for sealing to glass to comprise the envelope.

The anode support 2 may have a flat anode disc or collector surface 6, which may be secured thereto by soldering or welding, but is preferably made integral therewith. The cathode support 3 is open at the top, which opening may be of approximately the same diameter as the top 8 of the anode. A metal tube 7 is aligned so as to be substantially coaxial with the cathode support 3 and is brazed thereto at 8 to form an airtight joint. The tube 7 has a circular insulating bead 9 of glass (Fig. 3) sealed to its outer end, and the top of the cone-like member 3 is perforated at 10 so that the tube may subsequently be evacuated more readily. The cathode tip 11 is in the shape of a cylindrical cup having an activated disc 12 constituting the cathode proper. The cathode cap, or cup, is welded or brazed to a stub cylinder 13 before the cathode unit is assembled in the tube.

To assemble the parts, the anode and cathode supports 2 and 3 are inserted in the envelope 1 with their small ends or apices adjacent to each other and their flanges 5 and 4 abutting the ends of the envelope. These electrodes may be held in correct axial position by suitable jigs while their base flanges are sealed airtight to the ends of the envelope, as well known in the art. The cathode unit is then assembled on the end of a copper rod 14, which abuts against the end of the cathode cup 11 and snugly fits the inside of cathode supporting cylinder 15. This copper rod is used as a welding electrode, which contacts the tab 13. Before performing the welding operation, however, a small thickness gauge 16 is inserted through the hole 16 and the cathode assembly is pushed inwards to lightly press the cathode top 12 against the anode top 6, thus providing the desired spacing.

Welding current may then be sent through the rod 14, cathode cylinder 13 and cone 3 to the other electrode of the welder (not shown). This welds the cathode the desired distance from the anode and the gauge 16 and welding electrode are removed. The joint between the tab 13 and cone 3 need not be airtight.

The cathode heater may consist of any suitable resistance coil, but preferably a flat spiral heater 16' having lead-in wires 17, 18 is used. One of these wires may be welded to the stem 1 and the other brought out at the end of the stem. This end of the stem is then sealed, as at 19, by means of the glass bead 9 to which additional glass may be added if required. The envelope is exhausted by a tubulation at the hole 16 which is afterwards sealed off, as at 20 in Fig. 1.

The cathode support 13 may be of a material of low thermal conductivity, such as an alloy of nickel, iron and cobalt, or other alloy of suitable characteristics. The cone-like members 2 and 3 and tube 7 may be made of any desired materials, such as alloys of nickel, iron and cobalt found on the market that are suitable for sealing to glass. The cathode cup 12 may be made of nickel.

A tube constructed as described may be made so the tube envelope is very small, such as one-quarter inch in diameter, and it also may be made as large as desired. The construction provides relatively low capacitance and inductance. The circuit connections may be made through the flanges 4 and 5 by contact therewith, which
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is suitable for use in concentric line and cavity type circuits as well as various other circuits.

As an example, the tube may be constructed so that the cathode area is as small as about one square millimeter with a spacing between anode and cathode of five mils or less. Such a tube would have a direct capacitance of the order of 0.07 micro-microfarad or a total capacitance of about 0.09 micro-microfarad. The inductance would be less than 0.01 microhenry and the tube would have a resonant wave length of about five centimeters. From these figures the usefulness of the improved tube in ultra-high frequency circuits will be apparent.

I claim:

1. An electron tube comprising a cylindrical envelope, a pair of re-entrant electrode supports having base flanges extending outwardly substantially at right angles to the axis of the electrodes, said flanges being sealed to the ends of said envelope, said electrode supports having surfaces which together constitute substantially an hyperboloid of revolution having a section parallel to the garge circle removed therefrom, a cathode secured to the apex of one support and an anode secured to the apex of the other support, said cathode and anode being spaced from each other and being parallel to the garge plane of said hyperboloid surface.

2. An electron tube comprising a cylindrical envelope, a pair of cone-like electrode supports therein having base flanges extending outwardly substantially at right angles to the axis of the electrodes, said flanges being sealed to the ends of said envelope, said electrode supports having surfaces which together constitute substantially an hyperboloid of revolution having a section parallel to the garge circle removed therefrom, a cathode secured to the apex of one support and an anode secured to the apex of the other support, said cathode and anode being spaced from each other and being parallel to the garge plane of said hyperboloid surface.

3. An electron tube assembly comprising a cylindrical envelope, a frustum of a cone-like sheet metal anode support having its top extending into said envelope, a frustum of a cone-like sheet metal cathode support having its top extending into said envelope, said anode and cathode supports having flanges extending outwardly substantially at right angles to the axis thereof, said metal anode support having a flat anode disc sealed to its top and said cathode support having a cathode cup at its top spaced from said anode disc, and a heater under said cathode cup said envelope having a vent substantially opposite the space between the anode and cathode discs for insertion of a thickness gauze.

4. An electron tube comprising a cylindrical envelope, a frustum of a cone-like sheet metal anode support having its top extending into said envelope, a frustum of a cone-like sheet metal cathode support having its top extending into said envelope said anode and cathode supports having flanges extending outwardly substantially at right angles to the axis thereof, said metal anode support having a flat anode disc sealed to its top and said cathode support having a cathode cup at its top spaced from said anode disc, a metal tube having one end sealed to the inside surface of said cone-like cathode support, said cathode support having an exhaust vent communicating with the inside of said tube, a heater under said cathode cup and a vacuum seal at the other end of said metal tube.

5. An ultra high frequency electron tube comprising an evacuated glass cylinder, a hollow metallic frustum of a cone-like member having an outwardly extending flange at its large end integral therewith and sealed to one end of the glass cylinder, the small end of said member being a flat disc sealed vacuum tight to the sides of said member with said small end extending into said cylinder, a second hollow metallic frustum of a cone-like member having an outwardly extending base flange at its large end integral therewith and sealed to the other end of said glass cylinder, an impervious disc attached to the sides of the last mentioned cone-like member at its small end, said last mentioned end extending into said glass cylinder, two small ends being spaced apart and constituting anode and cathode electrodes respectively of the tube having said flanges as contact terminals, and a heater adjacent said cathode electrode.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,278,441</td>
<td>Cunningham</td>
<td>Sept. 10, 1918</td>
</tr>
<tr>
<td>1,334,150</td>
<td>Green et al.</td>
<td>Mar. 16, 1920</td>
</tr>
<tr>
<td>2,407,607</td>
<td>Cairns</td>
<td>Sept. 10, 1946</td>
</tr>
<tr>
<td>2,414,137</td>
<td>Branson</td>
<td>Jan. 14, 1947</td>
</tr>
<tr>
<td>2,440,153</td>
<td>Oles</td>
<td>Apr. 20, 1946</td>
</tr>
</tbody>
</table>

FOREIGN PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Country</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>676,845</td>
<td>France</td>
<td>Nov. 29, 1929</td>
</tr>
</tbody>
</table>