Feb. 14, 1928. 1,658,946

E. SCHRACK

GRID ELECTRODE FOR ELECTRON DISCHARGE TUBES

Filed Feb. 13, 1925 2 Sheets-Sheet 1

Fig. 1.

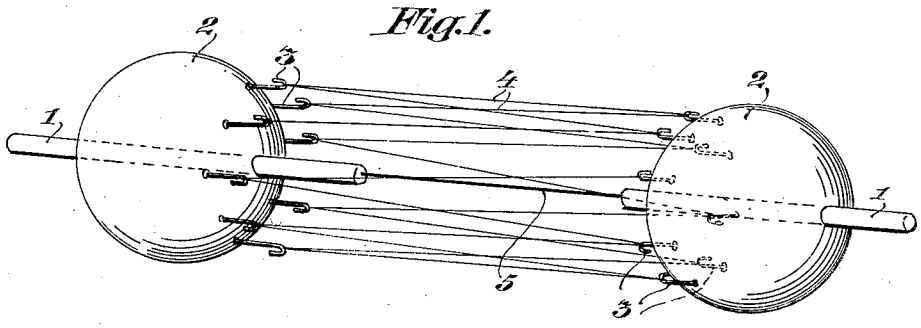


Fig. 2.

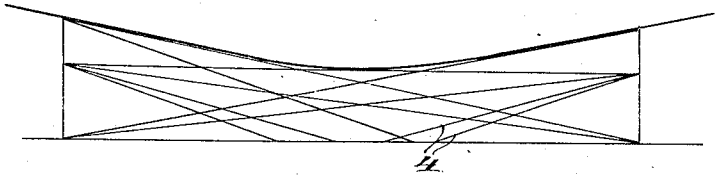
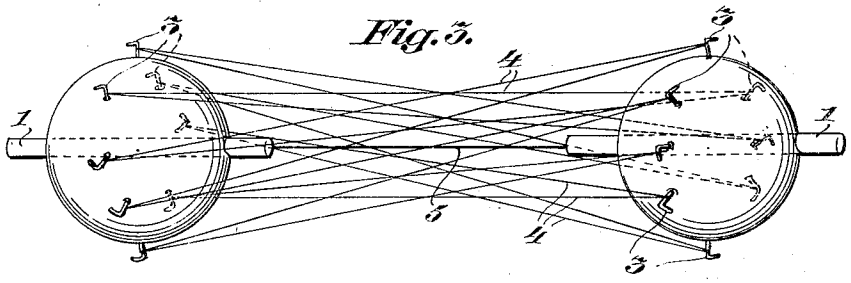


Fig. 3.



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Fig. 4.

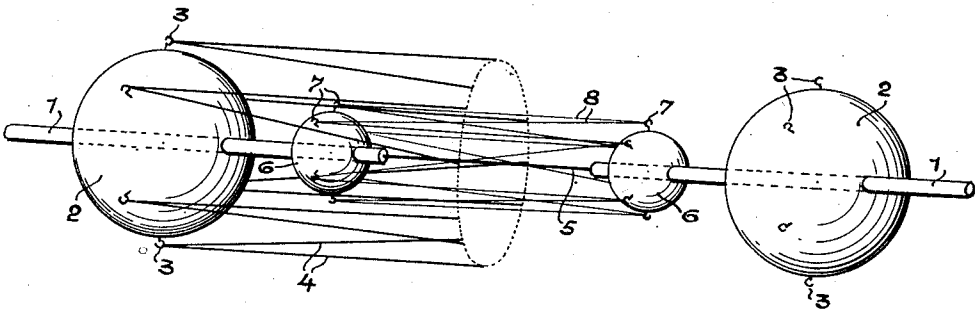
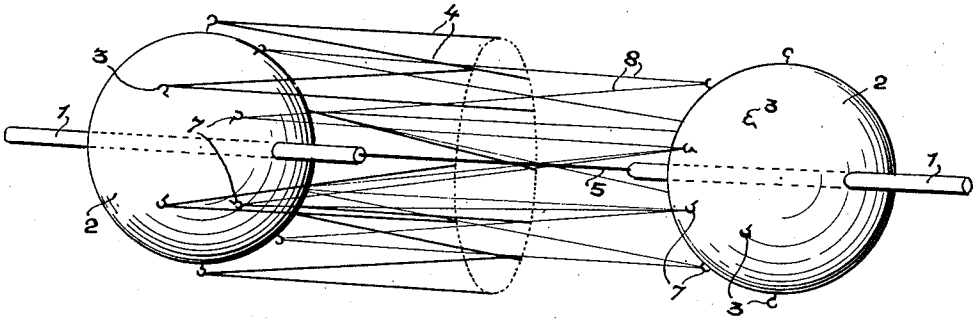


Fig. 5.



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UNITED STATES PATENT OFFICE.

EDUARD SCHRACK, OF VIENNA, AUSTRIA.

GRID ELECTRODE FOR ELECTRON-DISCHARGE TUBES.

Application filed February 13, 1925, Serial No. 8,955, and in Austria December 15, 1924.

My invention relates to improvements in grid electrodes for electron discharge tubes.

The efficiency of an electron discharge tube having three electrodes and serving as an amplifier is according to the formula of Barkhausen equal to the product of amplifying factor and pitch of the characteristic. Both of these factors increase as the distance between the grid and the filament decreases. But in the structures hitherto known such approaching of the two electrodes is unavoidably limited:

(*a*) by the risk of a contact arising between the filament and the grid resulting from a deformation or distortion of the supporting wires and

(*b*) by undesired grid currents being produced.

The circumstance marked (*a*) makes it impossible to reduce the distance between the filament and grid so as to be less than 1 m/m. The circumstance marked (*b*) is of importance in all grid structures, where the grid is freely bearing or is only supported at the ends thereof, for example a spiral or punched grid etc. With the said structures the dimension of the material and therewith the surface being exposed to the flow of electrons cannot be reduced below a certain limit, in order to maintain the steadiness of the form. If wires being exposed to tensile stress are used, such difficulty is obviated. Of course, structures are well known, in which between sheet metal rings grid wires are tensioned approximately in parallel relation to the filament, but the advantage offered by the thin grid wires will be neutralized by the large cross section of the bridge pieces connecting the two rings with each other. Moreover the difficulty mentioned in paragraph marked (*a*) will be unavoidably encountered. All the aforesaid drawbacks are obviated by the grid electrode according to the present invention.

In the drawings:

Figure 1 is an enlarged perspective view of an embodiment of the invention.

Figure 2 is a diagram illustrating an arrangement of the grid wires out of parallel relation to the axis of the grid.

Figure 3 is a perspective of the apparatus embodying the arrangement shown in Figure 2.

Figure 4 is a similar view of a modified form of the apparatus.

Figure 5 is a similar view of another modified form of the apparatus.

The leading in wires 1 to which the filament or heating cathode 5 is connected, carry at or near their ends drops or pieces 2 made of insulating material and melted on said ends. In the said drops, by preference made of quartz or glass, similarly as in the lenses of the metal filament lamps, hooked members 3 are introduced but in such manner that no contact with the leading in wires 1 may take place. Said hooked members for example made of molybdenum serve to support the grid wires 4 being tensioned in zigzag. This arrangement of the grid wire is somewhat similar to that of the filament in a metal filament lamp. By securing the grid to the insulating drops a proper distancing from the filament 5 will be effected. Therefore it is impossible that a subsequent bending may cause a contact between said electrodes.

By the solid mechanical anchoring a further advantage will be obtained. By the present invention the known "singing" of the tube caused hitherto by the filament oscillating in relation to the grid owing to percussions will be avoided. This advantage is of great importance, since in some tube structures such oscillation results in a very-bell ringing.

The grid wires may be given any small cross section, whereby the grid currents will be reduced to a negligible amount. The advantage being attained thereby is of utmost importance, since hitherto only such portion of the grid voltage-anode current-characteristic which lies in the region of negative grid voltages could be utilized for a distortionless low frequency amplifying. But with the present construction the entire characteristic up to saturation can be utilized. Thereby the necessity is obviated to use high anode voltages for the purpose of shifting the characteristic towards negative values and to use either a special battery for impressing a preliminary voltage upon the grid or voltage drops etc.

Since small quantities of material are required precious metals as for example molybdenum or tungsten may be used for the grid wires, said metals being easily made free from gases and exclude each danger of melting through.

From the commercial and manufacturing standpoint it is important that by the pres-

ent invention the process of melting in foot or supporting members in glass is dispensed with. Whereas a freely bearing grid has in general two melting in places, the grid according to the present invention, requires only a single place for passing the leading in wire.

With the described structure also the problem to bring the grid nearer to the mid-portion of the filament than to the end portions which of course are less emitting, will be solved. By such an arrangement not only the pitch of the characteristic will be increased but also the mounting of the grid wires will be facilitated. The said effect may be obtained for example as shown in Fig. 2 by arranging the grid wires out of parallel relation in respect to the axis of the grid, so that the envelope embracing all of the oblique grid wires forms substantially a hyperboloid, the opening of which is in its mid-portion the more strictured the more obliquely the individual wires are arranged. Fig. 3 shows a practical form of the aforesaid structure in a perspective view. The wires 4 are tensioned in an oblique position between the hooked members 3 carried by the insulating bodies or drops 2 on the supply wires 1 supporting the filament 1.

Conveniently the said hooked members will be secured by sticking the same while in glowing condition into the insulating body.

Especially in tubes having a plurality of grids very high mechanical properties are required concerning the structures of electrodes, since an increased probability of short circuits occurring between the said electrodes exists. In the present case it is of importance to support the electrodes rigidly against each other. Also the selection of the cross section of the grid elements which section will be exposed to the flow of electrons grows very important, since the auxiliary electrodes such as the grids have in most cases a positive charge, (space charging grid, fore-anode). The above specified grid arrangement therefore is also well adapted for tubes comprising two or more grids. In such case it is possible to secure the hooked members for both of the grids in the same insulating drop.

Fig. 4 shows an arrangement with two grids 4 and 8 of the kind specified. The inner or second grid is held by hooked members 7 secured on insulating bodies 6, 6 which are supported by the conductors 1 supporting also the insulating bodies 2 for the outer grid 4. The structure shown in Fig. 5 comprises also two grids 4 and 8 which are held by hooked members 3 and 7 respectively, said hooked members 4 and 8 being secured only to two insulating bodies 2.

What I claim is:

1. A grid for an electron tube consisting of a continuous thin wire leading to and fro in a zigzag line and exposed to tensile stress, conductors for leading the current to the filament of the tube, said grid being supported by insulating bodies which are supported by the said conductors, all portions of the grid wire between said bodies being mounted in an oblique position relative to the filament, so that the surface of an envelope containing all portions of said wire forms approximately a hyperboloid.

2. A multi-grid structure for an electron tube, comprising at least two grids made of thin zig-zag wires, insulating bodies provided with hooked members supporting said grids, a conductor for leading the current to the filament of the tube, said common insulating bodies being rigidly held on said conductor.

3. A grid for an electron tube said grid having knees and comprising a continuous thin wire leading to and fro in a zigzag line and exposed to tensile stress, conductors for leading the current to the filament of the tube, means supporting the grid, said means comprising insulating bodies which support the knees of the zigzag grid and are rigidly supported by the said conductors.

4. A grid for an electron tube consisting of a continuous thin wire leading to and fro in a zigzag line and exposed to tensile stress, conductors for leading the current to the filament of the tube, means supporting the grid, said means comprising insulating drops rigidly supported by the said conductors and having hooked metal members for securing said grid wires.

In witness whereof I affix my signature.

EDUARD SCHRACK.