Nov. 24, 1964 A. STECKER ETAL 3,158,777

GRID FOR ELECTRON TUBES

Filed May 24, 1960

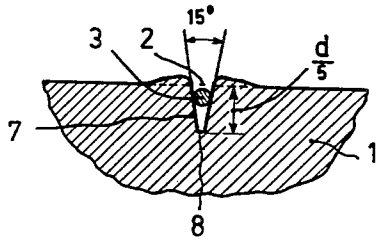

FIG.1

PRIOR ART

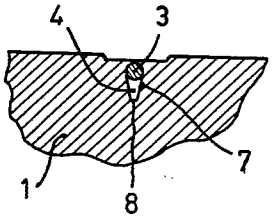

FIG.2

PRIOR ART

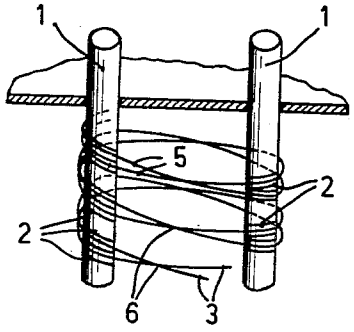

FIG. 3

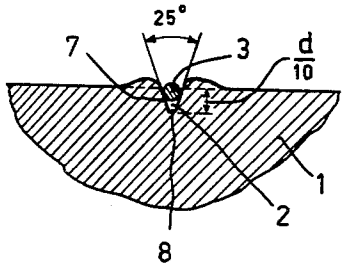

FIG.4

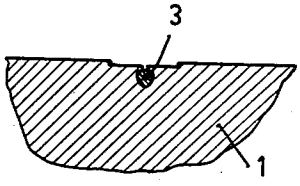

FIG.5

INVENTOR
A. STECKER
H. HILDEBRANDT

BY Frank R. Trifari

AGENT

United States Patent Office 3,158,777 Patented Nov. 24, 1964

3,158,777

GRID FOR ELECTRON TUBES

Albert Stecker, Hamburg-Lockstedt, and Hartmut Hildebrandt, Hamburg, Germany, assignors to North American Philips Company, Inc., New York, N.Y., a corporation of Delaware

Filed May 24, 1960, Ser. No. 31,360
Claims priority, application Germany June 16, 1959
5 Claims. (Cl. 313—350)

Vibrations or shocks may cause electrodes of electron tubes to vibrate mechanically and this mechanical vibration produces disturbances referred to as microphony. When the attachment is free from play, the amplitude of the oscillations is determined by the structure and the material of the electrodes, the mechanical natural frequency, the damping and by the resulting electrode movement.

The cathodes and anodes of electron tubes are generally robust; they are heavily damped and have a high natural frequency causing no inconvenience. Hence they substantially do not give rise to direct microphonic phenomenon. However, for electrical and manufacturing reasons the grids of electron tubes are built from thin support rods and grid wires the degree of damping of which is slight and the low natural frequency of which gives rise to microphonic disturbances.

The grid support rods of normal grids are comparatively slender and at their low natural frequency are subjected to large displacements which are transmitted in phase to all the grid windings. All the grid windings move in accordance with the vibrating grid stays at right angles to the grid plane and change the electrode spacings. These spacing variations produce inter alia variations in the mutual conductance and the capacitance of a tube.

In order to avoid the disturbances caused by these spacing variations it is necessary for the stability of the grid, in particular of the stay rods to be improved and for the stay oscillations to be damped. In this connection, the mechanical joints of the stays and the grid turns are of particular importance.

The invention will be described more fully with reference to the accompanying drawing in which:

FIGS. 1 and 2 show a portion of a grid made in accordance with the prior art;

FIG. 3 shows a portion of a grid in accordance with the invention;

FIG. 4 shows a detail of a grid stay rod in accordance with the invention in a notch of which a grid wire is arranged;

FIG. 5, shows the same detail after the grid wire has been secured by pressing.

As is shown in FIG. 1, it is known to provide stay rods 1 with notches 2 into which grid turns 3 are pressed in the manner shown in FIG. 2. By these notches 2, the sides of which usually are at an angle of about 15° to one another and which have a depth of about ⅕ of a rod diameter, the cross-sectional area of the rods 1, which determines the natural oscillation thereof, is reduced. This is due to the fact that the grid wires 3 when pressed into the notches do not completely fill them but leave apertures 4 between the bottom of the notch and wire. As a result the natural frequency is undesirably lowered. Apart from this disadvantage, in manufacturing such grids the hard grid wire is embedded in the soft support-rod material 8 without deformation and secured therein comparatively loosely.

Although this grid structure provides a self-supporting grid, the individual turns can still be slightly twisted in the notches. In accordance with the extent of the drawing and heating process following the winding and pressing processes and in which the grid turns may be further loosened in the notches, an insufficient mechanical bond between the grid turns and the support rods is produced. It has been found that the turns and support rods of such grids are damped only slightly, have a low natural frequency and vibrate strongly.

If the grid turns are clamped more securely in the notches by suitable steps, this enables the rod movements to be reduced and hence their vibration to be materially damped.

According to the invention, in a grid for electron tubes the stay rods of which are provided with notches in which at least part of the turns of grid wires are pressed, in order to reduce mechanical grid vibrations, in particular support rod vibrations, the grid wires are deformed in the notches. The deformation of the grid wire, which usually consists of molybdenum, is enabled by the use of grid stays made of a suitable copper chrome alloy.

In grids in accordance with the invention, the deformed grid wires completely fill the notches so that the maximum high natural vibration at which the stay rods oscillate in the absence of notches is retained. Furthermore the deformation, which substantially consists in a flattening of the wires at the areas at which they engage the notch sides, is so considerable that the wires cannot move or twist in the notches. This provides intimate bonds between the windings and the stay rods which ensure a stable grid the natural frequency of which substantially is a maximum.

In addition, the mechanically rigid bonds between the stay rods and the turns produce a satisfactory heat conduction from the turns to the rods and hence a satisfactory heat exchange. Furthermore, the rigid bonds produce considerable damping of the grids; this is due to the fact that the stay rod displacements, which are small already owing to their high natural oscillation are further reduced because the grid turns joined to the rods counteract the vibration thereof.

If furthermore the grid turns are arranged in known manner in the form of a cross winding in which each disengaged curved part of a turn at least once crosses the disengaged part of another turn so as to engage it, the grid turns damp one another already at the slightest movement of the stay rods and thus increase the resistance of the grid to microphony.

Grid wires 3 are wound with different pitches on two stay rods 1 shown in FIG. 3. Each pair of turns 5 of the two grid wires 3 cross midway between the stay rods 1 so as to engage one another at points 6.

The stay rods 1 are provided with notches 2 (FIG. 4) along the lines along which ahey are engaged by the grid wires 3. It is sufficient, however, for the notches 2 to be provided only in the sides of the rods 1 on both sides of the grid plane.

FIG. 4 shows an enlarged detail of a grid support-rod 1 made of a copper-chrome alloy and provided with notches 2. The sides of the notches are at an angle of about 25° to one another and the depth of the notches is about $\frac{1}{10}$ of the diameter of the rod 1. This may be 0.75 mm. In the notches 2 are arranged molybdenum grid wires 3 having a diameter of for example 0.08 mm., which are softer than the rods 1 and, owing to the fact that the angle between the notch sides exceeds that of the known grid constructions, have a wider contact area.

With these proportions the grid wires are not entirely received in the notches but about 25 to 35% of their diameter projects beyond the undeformed rod parts. To secure the wires in the notches 2 the former are pressed into the latter by means of pressure rollers which act directly upon the wire since these project beyond the rods. Thus, the grid wires are deformed at the areas at which they are engaged by the rollers and at the areas at which

they are pressed against the hard sides 7 of the notches. The deformation substantially consists in the wires being flattened at the contact areas. When the deformed wires are finally rolled in, they penetrate to the notch bottom 8 and completely fill the notches 2 (FIG. 5).

The grid wires 2 rolled into the notches are intimately joined to the rods 1 and cannot be twisted therein. In order to prevent these bonds from being loosened again in the subsequent process of straightening the grids, the final stretching is performed at a low a temperature as possible.

The appreciable mechanical strength and damping of the grids in accordance with the invention is further increased by turns of the grid wires crossing and engaging one another between the rods. Preferably the crossing wires 3 are joined to one another at the joints of contact, for example by dip-soldering.

A sufficient damping is also obtained with a normal arrangement of the turns so that the use of cross winding may be dispensed with.

What is claimed is:

1. A grid for an electron discharge tube comprising a stay rod provided with notches the sides of which form an angle of about 25° in which a wire, softer than the material of the stay-rod, is pressed and deformed to accommodate the sides of the notch and filling the notch, said notches having a depth which is about one-tenth the diameter of the support rod.

2. A grid as claimed in claim 1 in which the stay-rod is constituted of a copper-chrome alloy.

3. A grid for an electron discharge tube comprising a plurality of turns of wire wound on a plurality of stay-rods each having notches the sides of which form an angle of about 25° and in which wire softer than the material of the stay-rod is pressed and deformed to accommodate the sides of the notch and filling the notch, said notches having a depth which is about one-tenth the diameter of the support rod, said turns of wire engaging one another between the stay-rods.

4. A grid for an electron discharge tube comprising a plurality of turns of wire wound on a plurality of stay-rods each having notches the sides of which form an angle of about 25° and in which wire softer than the material of the stay-rod is pressed and deformed to accommodate the sides of the notch and filling the notch, said turns of wire engaging one another between the stay-rods and being joined together at the points of engagement.

5. A grid as claimed in claim 4 in which the wire turns are joined by solder.

References Cited in the file of this patent

UNITED STATES PATENTS

1,570,265	Lebbink	Jan. 19, 1926
1,792,219	Grebel	Feb. 10, 1931
2,829,298	Te Gude	Apr. 1, 1958