June 14, 1927. 1,632,135

W. F. HENDRY

ELECTRODE STRUCTURE FOR ELECTRON DISCHARGE DEVICES

Filed April 1, 1920

Fig. 1.

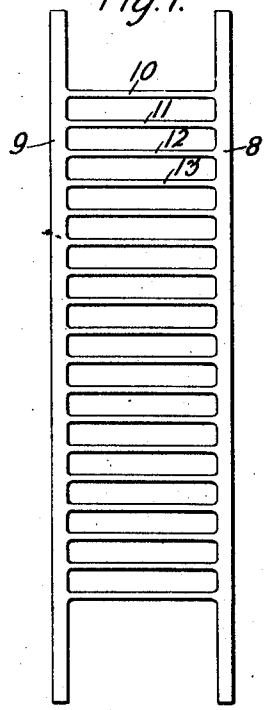


Fig. 2.

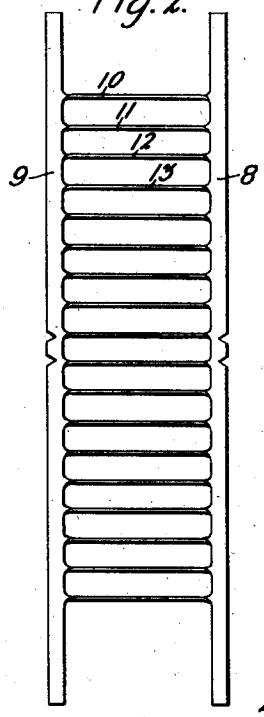


Fig. 3.

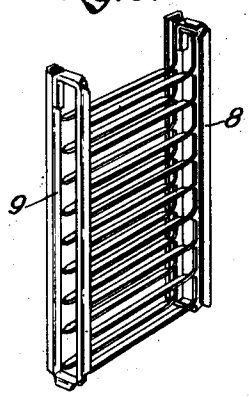


Fig. 4.

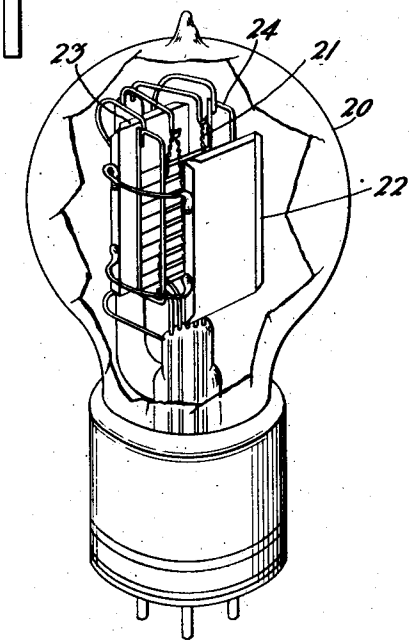


Fig. 5.

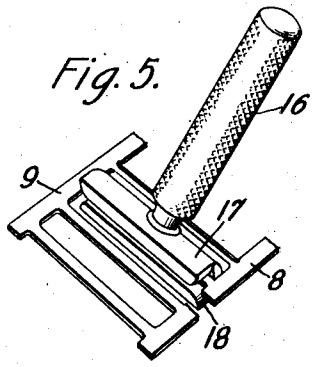
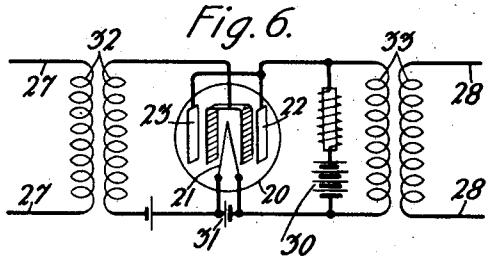


Fig. 6.



Inventor:
William F. Hendry.
by W. C. Beatty. Att'y.

Patented June 14, 1927. 1,632,135

UNITED STATES PATENT OFFICE.

WILLIAM FERRIS HENDRY, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

ELECTRODE STRUCTURE FOR ELECTRON-DISCHARGE DEVICES.

Application filed April 1, 1920. Serial No. 370,618.

This invention relates to an electrode structure for electron discharge devices and the method of making the same. More particularly, it relates to a novel type of grid electrode for a vacuum tube, in which certain cross bars of the grid have an effective width in the plane of the grid less than their actual width.

The electrode structure of this invention will be described for convenience in connection with a vacuum tube of the three electrode type, although it will be apparent that its utility is not limited to tubes of any particular type.

As is well known in the art, the vacuum tube of the three electrode type comprises a thermionic cathode, an anode, and a control electrode which usually, though not necessarily, is placed between the other two electrodes. The control electrode heretofore employed has usually comprised a plurality of parallel wires, to which have been fastened or welded cross wires at regular intervals so as to form a network or grid. Such a grid, however, is difficult and expensive to manufacture in any quantity because of the number of operations required in fastening the wires across at proper intervals on the framework. Some grids, for example, require as many as 150 welds or more to complete a single grid electrode.

It is proposed, as one form of this invention, to manufacture the grid electrode out of a sheet of metal by punching apertures, preferably rectangular in shape, in the sheet at spaced intervals, so that the sheet, after the punching, comprises two side pieces with a plurality of cross bars or strips therebetween. The distance between, and the width of the cross bars will depend on the type of tube in which the grid is to be used. For low power tubes, such as those operating on a plate voltage of 60 volts, a width of cross bars of .031 inch, and a distance between the cross bars of approximately .080 inch, has been found satisfactory. For high power tubes, however, such as those operating on a plate voltage of 275 volts, where the width of the cross bars becomes quite a factor in determining the electrical characteristics of the tube, it has been found that the width of the cross bars should be about .008 inch, which is less than it is practical to make it by punching the grid from sheet metal.

In accordance with this invention, the use of a punched grid in a high power tube is made possible by twisting the cross bars until the planes of the cross bars are at right angles to the plane of the electrode. The cross bars of such a grid offer practically no obstruction to the passage of electrons between the cathode and anode, since the effective width of each cross bar is now the thickness of a sheet of metal and not the actual width between the punches made originally in the sheet of metal.

This invention will be better understood by reference to the following detailed description taken in connection with the accompanying drawings, in which

Figure 1, represents a sheet of metal after a plurality of rectangular apertures have been made therein to form a grid-like structure.

Figure 2 represents the grid after the cross bars have been twisted until the planes of the cross bars are at right angles to the plane of the grid.

Figure 3 shows the grid bent double, in order that it may be used in a double-grid double-plate tube, such as that shown in Figure 4.

Figure 5 illustrates a tool that may be employed in twisting the cross bars of the grid; and

Figure 6 shows how the tube, of the type illustrated in Figure 4, may be adapted to repeat or amplify electric currents in a signaling system.

Referring to the drawings, Figure 1 shows a rectangular sheet of metal after a plurality of rectangular apertures have been made in the sheet, so as to form a grid-like structure. The grid, as shown, comprises two parallel side pieces, 8 and 9, which are connected by a plurality of cross bars 10, 11, 12, 13, and so forth. In the manufacture of a punched grid, such as that shown in Figure 1, it has been found practically impossible to make the width of the cross bars much less than about .031 inch where the thickness of the sheet was only .009 inch. Any attempt to make the cross bars of a much narrower width results in the punching machine carrying away the cross bars with it.

In accordance with this invention, the use of a punched grid in a vacuum tube, requiring cross bars of a narrower width than

it is possible to make them by the punching process, is made possible by twisting the cross bars. Such a grid, with twisted cross bars, is illustrated in Figure 2. When the cross bars are twisted at right angles to the plane of the grid, the effective width of each cross bar becomes the thickness of the sheet metal employed, which, in the example cited above, was only .009 inch.

It is evident that the cross bars may be twisted by any suitable means, such as pincers or the like. Figure 5 illustrates a type of tool that may be employed in twisting the cross bars. The tool comprises a handle, 16, attached to two stationary jaws, 17 and 18, the length of which is slightly less than the distance between the side pieces, 8 and 9, of the grid. A slit between the two jaws, 17 and 18, is just sufficient to receive one of the cross bars of the grid.

Figure 3 represents the grid structure of Figure 2 bent so as to form two parallel portions, thereby adapting the grid to be employed in the double-grid double-plate tube shown in Figure 4. The tube, 20, comprises a cathode, 21, two anode plates, 22, 23, and a grid electrode, 24, which may be of the punched grid type illustrated in Figure 3.

Figure 6 shows how the tube 20 may be employed in an electric system to repeat and amplify currents from line 27—27 to line 28—28. Space current for tube 20 is supplied by a battery, 30, while the cathode, 21, is heated by a battery, 31. The grid and cathode electrodes are connected to the incoming line by a transformer 32, while the anode and cathode are connected to the outgoing line 28—28 by a transformer, 33. Tube 20, connected up in such a manner, will impress on line 28—28 amplified currents of the form received by the tube from the incoming line 27—27.

It is apparent that the punched grid with twisted cross bars, described above, represents only one of various ways of manufacturing a grid having cross bars arranged so that the projection of each cross bar, on a plane parallel to the plane of the grid, is less than the actual width of each cross bar. It is also apparent that this invention may be applied to grids of other types than that described above. Thus it is within the scope of this invention to make the cross bars, in the well-known welded grid, have an effective width in the plane of the grid less than their actual width. Furthermore, this invention is not limited to types in which the decrease in the effective width is accomplished by distorting the cross bars. Distorting the side pieces, for example, to make each in a zig-zag form, will produce the same result.

What is claimed is:

1. The process of manufacturing a grid electrode out of a sheet of metal, which comprises forming apertures in said sheet, so shaping the sheet that a plurality of the strips of metal remaining between said apertures present an effective width in the plane of said grid less than the actual width of said strips, and bending said sheet to provide two parallel surfaces.

2. The process of manufacturing a unitary grid electrode out of a sheet of metal, which comprises punching apertures in said sheet, shaping the strips of metal remaining between the apertures to prevent the planes thereof substantially at right angles to the plane of the grid, and bending said sheet to provide two parallel surfaces.

3. The process of manufacturing a unitary grid electrode out of a sheet of metal, which comprises punching apertures in said sheet, placing the strips of metal remaining between the apertures at an angle to the plane of the sheet, and bending said sheet to provide two parallel surfaces.

4. The process of manufacturing a grid electrode out of a sheet of metal, which comprises forming apertures in said sheet, shaping the sheet so that one of the strips of metal remaining between said apertures has an effective width in the plane of said grid less than the actual width of said strip, and bending said sheet to provide a pair of parallel surfaces.

In witness whereof, I hereunto subscribe my name this 30th day of March, A. D., 1920.

W. FERRIS HENDRY.