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METHOD OF MAKING THERMIONIC TUBE GRIDS

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Fig. 1.

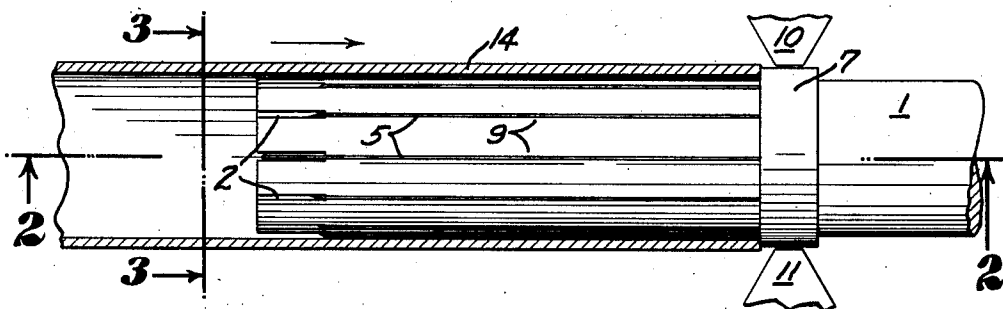


Fig. 2.

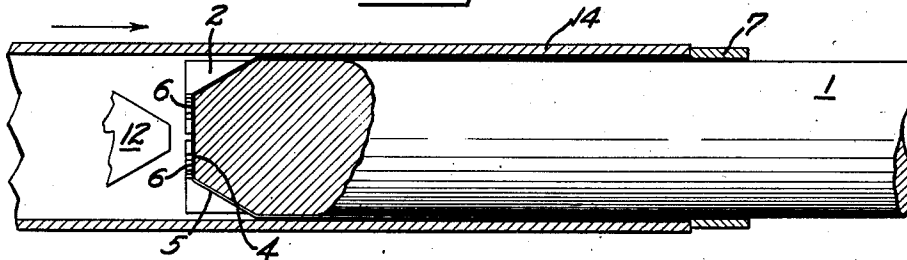


Fig. 3.

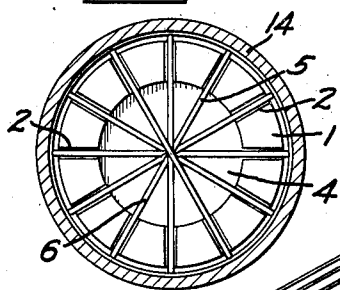
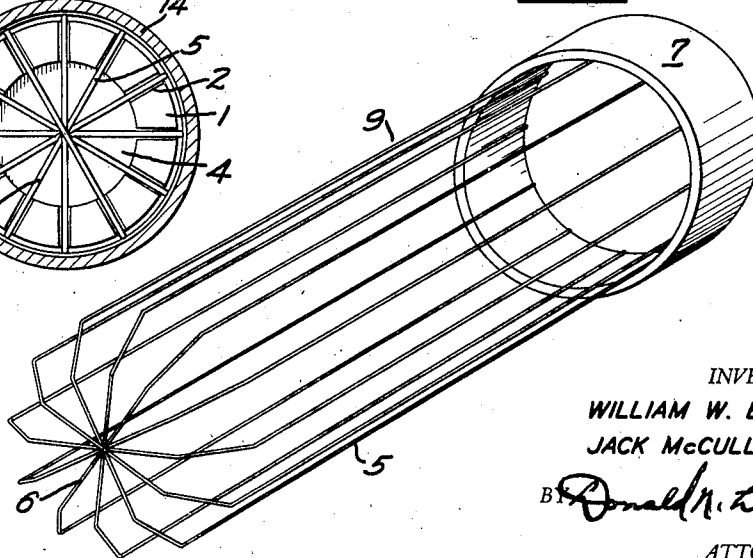


Fig. 4.



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METHOD OF MAKING THERMIONIC TUBE GRIDS

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4 Claims. (Cl. 140—71)

Our invention relates to a method of making grids for use in transmitting or receiving vacuum tubes or grid-controlled rectifiers, and more particularly to methods which will produce a self-supporting grid structure.

Among the objects of our invention are: To provide a method of making a self-supporting grid; to provide a method of making a grid having vertical control wires which also act as support wires; to provide a method of making a grid having a uniform field; to provide a method of stretching assembled grid wires; to provide a method of making a grid having vertical control wires rather than horizontal wires as is the custom; and to provide a method of making a simple, self-supporting grid.

Other objects of this invention will be apparent or will be specifically pointed out in the description forming a part of this specification, but we do not limit ourselves to the embodiment of the invention herein described, as various forms may be adopted within the scope of the claims.

In the drawing, which illustrates steps in the formation of a grid by the use of the methods, of our invention:

Figure 1 is a view partly in section and partly in elevation showing grid wires assembled on a form.

Figure 2 is a sectional view partly in elevation taken along a plane as indicated by the line 2—2 in Figure 1.

Figure 3 is a cross sectional view taken as indicated by the line 3—3 in Figure 1.

Figure 4 is a perspective view of a completed grid.

The usual type of grid is a wire wound spirally on and welded to a number of vertical supports. The presence of these supports, particularly in a cylindrical structure, distorts the fields when in use in thermionic tubes, the most pronounced result being an unequal heating of the anode even when used with a cathode having a uniform emitting surface. This feature is highly objectionable in tubes of high power, the anodes often being melted and destroyed by the formation of hot spots.

The control portion in the grid of our invention is composed solely of vertical wires, and a uniform field is thereby provided. In broad terms, our invention comprises the steps of laying parallel wires around the outside of a form, welding one end of these wires to a support member, and fastening the other ends of the wires to each other, thus making a strong self-supporting cage. We prefer to form the wires in hair-

pin shape and assemble them over the end of a form, with the bends of the hairpins crossing. A single weld made at the crossing point will join all the wires and unify the cage. We also prefer to use the form as a welding electrode, applying a second electrode to the proper point and passing the welding current to the weld through the form.

The operation of our method may be best disclosed by reference to the drawing.

A form 1, in the present example of cylindrical shape, is provided with end slots 2 and a counter-sunk end face 4. The number of slots will correspond to the number of vertical wires desired, and they are preferably equally spaced around the circumference. As the form may be used to carry the welding current, it is preferable that the form have good conductivity, and made out of copper, for example.

Grid wires 5, preferably of tungsten, tantalum or molybdenum, are laid in the slots to extend lengthwise of the form. It is preferable that these wires be of hairpin shape as shown, the bends 6 crossing each other on the end face 4. Separate wires, however, may obviously be used, a bend being made in one end of each so that they will cross or connect at or near the center of the end face.

A ring support 7 also preferably of a refractory metal is placed around the ends of the straight runs 9 to position the wires between the ring and the form. It is then a simple matter to apply a welding electrode 10 to the outside of the ring over the wires and pass a current through that electrode and the form to weld each wire to the ring. It may in certain cases be desirable to use two opposed electrodes, current being passed from a second welding electrode 11 through the ring and wire into the form, through the form into the opposite wire and ring portion and out through the first electrode, thus completing a series weld and welding two spots at once. In both cases the welding current passes through the form.

It is then convenient to weld the bends or crossed portions of the wire together by applying a third welding electrode 12 to the end crossing, pressing the crossed wires between this electrode and the end face 4 and passing a current therebetween, thus welding the upper ends of the wires firmly together.

If the grid wires are large, stiff and well pre-formed, the grid may be removed at this stage from the form, by sliding it off the end. We prefer, however, especially when wire which has been

partly annealed is used, to stretch the vertical wires so that they will take on and preserve the shape of the form. We do this by placing a sleeve 14 over the form having the welded grid thereon, and causing this sleeve to bear on the ring. Further pressure on the sleeve will cause the ring to progress along the form and stretch the grid wires. When the proper set has been obtained, the sleeve and the grid may be removed, the finished grid being shown in Figure 4.

This stretching operation also serves to break any slight sticking of the grid wires to the form at the weld points around the ring, allowing the structure to be readily removed after the set has been obtained.

We have found grids made by the methods as described to be exceedingly strong, to resist deformation in use, and to give uniform field distribution, when used with the proper cathode. The method is applicable to the largest as well as the smallest constructions. The form may be of any shape desired, the ring being correspondingly shaped and the opposite ends of the grid wires being gathered and welded as described.

The heat distribution on the anode, however, will largely depend on the filament structure in those shapes of grids which depart substantially from the cylindrical, rather than on the shape or structure of the grid.

We claim:

1. The method of making a vacuum tube grid which comprises assembling a plurality of hairpin shaped wires in the form of a cylinder, the straight runs of said hairpins being parallel and equally spaced, welding the open ends of said hairpins to a ring support, welding the bends of said hairpins together, and applying pressure between said support and said bends to stretch said straight runs.

2. The method of making a vacuum tube grid which comprises equally spacing a plurality of wires longitudinally along a cylindrical conductive form, placing a ring around one end of said wires and around said form to enclose said wires between said ring and said form, applying a welding electrode to the outside of said ring above said wires, passing a current through said welding electrode and said form to weld said wires to said ring, bending the other ends of said wires around the end of said form to cross at substantially the center thereof, applying a welding electrode to the crossing point, and passing a current through said latter electrode and said form to weld said bends together.

3. The method of making a vacuum tube grid which comprises assembling a plurality of hairpin shaped wires in the form of a cylinder, the straight runs on said hairpins being parallel and equally spaced, welding the open ends of said hairpins to a ring support, welding the bends of said hairpins together, and stretching the longitudinal runs of said hairpins by pressure applied axially thereto.

4. The method of making a vacuum tube grid which comprises equally spacing a plurality of wires circumferentially about a cylindrical form, joining together and welding all of said wires at one end thereof, placing a ring about the other ends of said wires and around said form, welding said ring to said wires, maintaining the joined ends of the wires in fixed relationship relative to the form, and applying pressure to said ring to urge said ring longitudinally of the form to stretch said wires.

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