

July 4, 1939.

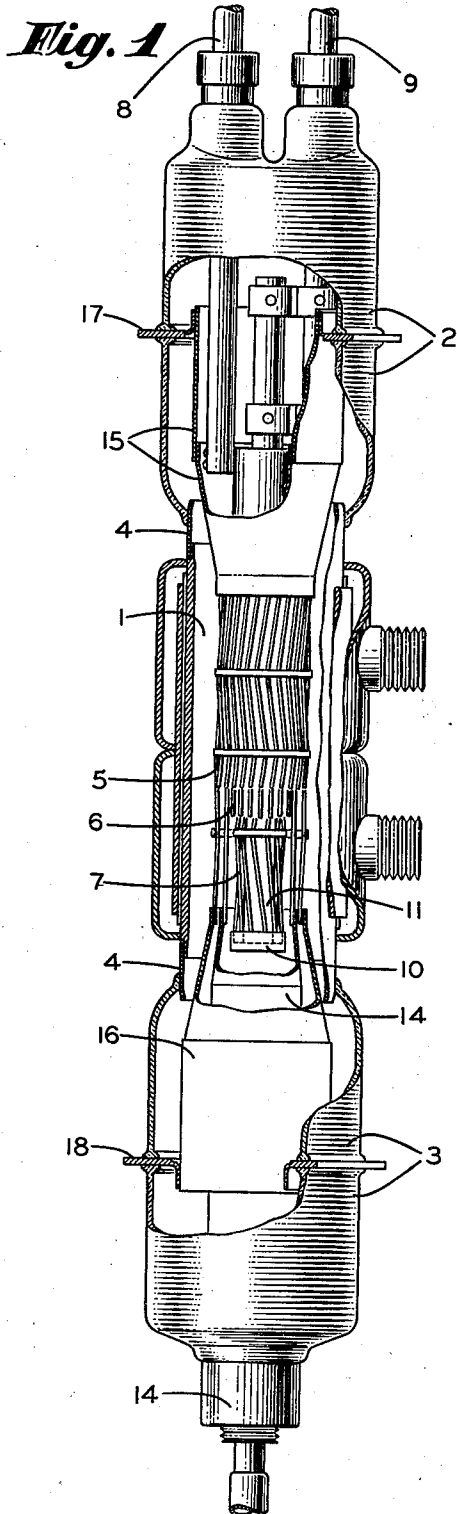
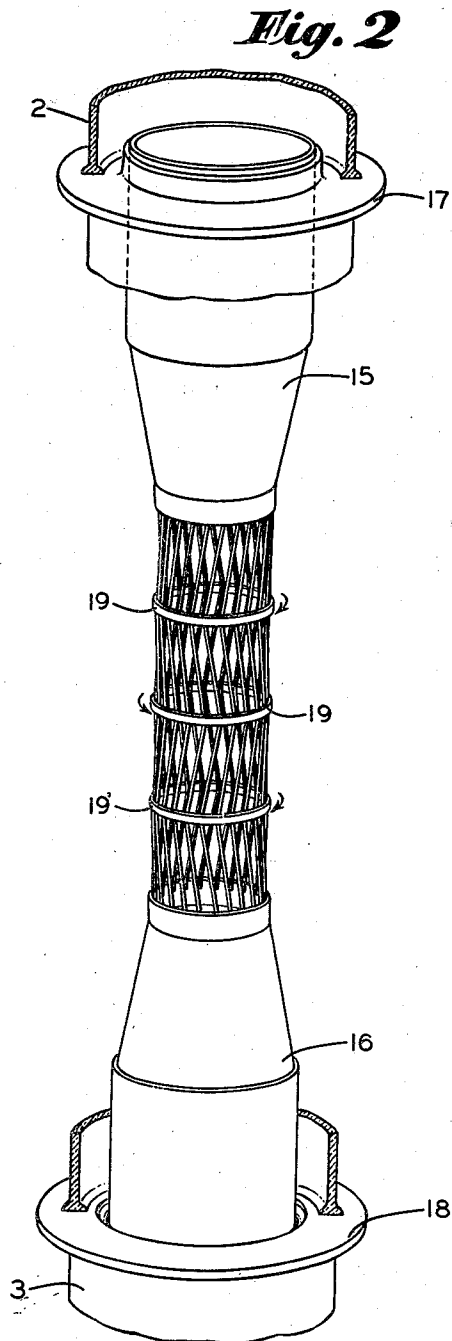
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2,165,135

WIRE ELECTRODE

Filed April 30, 1938

2 Sheets-Sheet 1



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Fig. 3

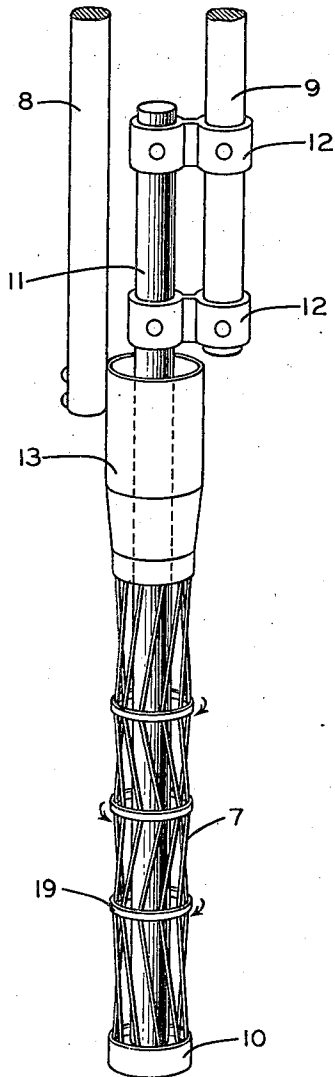


Fig. 4

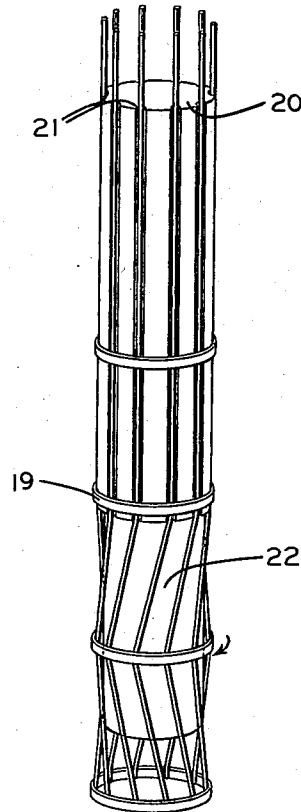
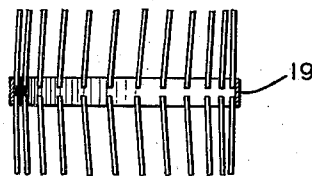


Fig. 5



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WIRE ELECTRODE

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Application April 30, 1938, Serial No. 205,214

8 Claims. (Cl. 250—27.5)

My invention relates to electron discharge devices, particularly to electrodes such as wire grids and filaments for such devices.

Electrodes in electron discharge devices, particularly in the larger types used for power and transmitting purposes, commonly comprise a number of straight parallel wires in a cylindrical surface and electrically connected to lead-in conductors. One end of each electrode is fixed and, to permit elongation when heated, the other end is slidably guided. In many cases the sliding end of the electrode is difficult to maintain in correct spaced relation to the cooperating electrodes, good electrical contact is impractical and the guiding means may at certain temperatures bind the end of the electrode and cause the electrode to bow or buckle.

An object of my invention is to make wire electrodes for electron discharge devices which may be rigidly secured at each end yet will not bow or buckle when heated, and which are inexpensive to manufacture and easy to install.

My invention is defined with particularity in the appended claims and preferred embodiments are described in the following specification and the accompanying drawings in which Figure 1 is a sectioned view of an assembled tube embodying my invention, Figure 2 is a detailed view of a grid constructed according to my invention, Figure 3 is a cathode constructed according to my invention, Figure 4 shows means for constructing an electrode according to my invention, and Figure 5 shows a detail of construction of my improved electrode.

The envelope of the tube shown in Figure 1, chosen for illustrating my invention, is similar to the tube shown in the Zottu et al. Patent 2,113,671 issued April 12, 1938, and comprises a cylindrical metal anode 1 closed gas-tight at its ends by cylindrical glass end sections or bulbs 2 and 3 joined coaxially with the anode by sealing rings 4 of a metal which readily wets with glass and welds or brazes with the metal of the anode. Within the anode are concentric screen grid 5, control grid 6 and cathode 7.

The cathode comprises a plurality of heater wires extending longitudinally of the anode and arranged in a cylindrical plane concentric with the anode and attached at their ends to supporting means for keeping the cathode in insulated spaced relation to the other electrodes. Supporting and current supply means for the filament wires comprise two relatively heavy lead-in conductors 8 and 9 sealed gas-tight through collars in the outer end of the upper

glass bulb 2. As shown in detail in Figure 3, the lower end of the filament wires are attached, preferably by welding or brazing, to disc 10 on the end of center support rod 11 which is rigidly secured to conductor 9 with brackets 12. The upper end of the filament wires are attached to tubular collar 13 carried on the end of conductor 8. While the ends of the filament are held stationary, the filament wires will not bow or buckle, or change their spacing with adjacent electrodes, as more fully hereinafter described.

The parallel wires of the control grid are cylindrically arranged and attached at their ends to round collars, the lower collar being welded to the end of a tubular support 14 sealed in the outer end to the lower glass bulb 3 to support the wire grid concentric with the circuit of the heater wires.

To minimize the impedance of the screen grid throughout its length it is constructed of a number of closely spaced wires extending longitudinally along the grid and arranged in a cylindrical surface concentric with the other electrodes. To reduce the impedance of the lead-in conductors for the screen grid and to isolate the cathode and control grid lead-in conductors from the anode and its circuit, as described in the Zottu et al. patent mentioned above, screen grid supporting means shown in Figures 1 and 2 comprise tubular supporting members 15 and 16 tapered to the diameter of the grid and attached at their inner ends to the ends of the screen grid wires and supported at their outer ends in concentric spaced relation to the envelope by annular screen grid lead-in rings 17 and 18, each ring being sealed in the glass with its outer edge extending radially beyond the envelope. In the embodiment shown the upper tubular supporting member 15 is attached, preferably by welding or brazing, to an up-turned flange on the inner periphery of ring 17, and tubular supporting member 16 at the lower end of the screen grid is attached to a flange on the inner periphery of ring 18.

As distinguished from the construction of the device shown in the Zottu et al. patent mentioned above, in which the tubular piece 16 is slidably journaled in the flange of the lead-in ring 18 to permit longitudinal heat expansion of the screen grid, the tubular member 16 is solidly fastened as by welding or brazing to the flange of the lead-in ring 18. This construction rigidly fixes the ends of the screen grid so that movement during handling and use is prevented and the spacing to the other electrodes remains constant throughout the life of the tube. By eliminating a slidable

telescoping connection with the flange of the lead-in ring 18, tubular cylinder 16 at all times remains in its coaxial position in the tube.

One grid constructed according to my invention, which may be fixed at its end and which may be heated from room to operating temperatures or to white heat temperatures without deforming or distorting the grid conductors or without bowing or buckling the grid cylinder, is shown in detail in Figure 2. The inner ends of the coaxial tubular terminal members 15 and 16 define a cylindrical plane between the members. One or more bands or rings 19 coaxial with and between the tubular members are secured to each of the grid conductors. The grid conductors are divided into sections of grid rods between the rings 54 and between the rings and the terminal members. The wire sections or rods adjacent the terminal member 16, for example, are each joined at one end to the terminal member, the other end of each of the rods being attached to the lowermost ring 19 and the point of attachment of the upper end of each rod being displaced along said ring out of alignment with a longitudinal line through the lower end of the rod. The set of parallel rods in the adjacent section are joined at one end to the ring, the other ends being attached to the next ring above, preferably at a point on said longitudinal line.

Adjacent rods in one section are substantially parallel and lie in a cylindrical surface, a second set of parallel rods lying in said cylindrical surface end-to-end with the first set of rods, adjacent ends of the two sets of rods being joined to ring 19 and the angle between adjacent end-to-end rods being less than 180°. While each ring is held against longitudinal movement, it is free to rotate so that as the temperature of the grid rises each rod elongates and each ring rotates about its axis in the grid cylinder, the rotation being sufficient to compensate for the elongation of the connected sections of the grid rods. Each ring rotates in a direction opposite to the direction of the next adjacent ring. Except for a slight elongation of the chord defined by each rod on the surface of the grid cylinder, the mean diameter of the cylinder remains unchanged and the lateral position of the cylinder at the rings and the terminal members remains fixed.

Obviously the adjacent end-to-end rods of the sections depicted in Figure 5 may, if desired, be made from a single piece of relatively heavy wire, the ends being joined to the tubular terminal members 15 and 16 and the wire being bent in a zigzag formation with the bends in adjacent wires lying in a circle in the cylindrical surface and joined to rings 19.

One convenient way of making an electrode according to my invention is shown in Figure 4. A round mandrel 20 with an outside diameter substantially that of the diameter of the desired electrode is provided with a number of longitudinal grooves 21 and with an integral end section 22 equal in diameter to the diameter of a circle through the bottom of grooves 21. Wires of the desired cross sectional size and shape of refractory metal suitable for the electrode desired, such as iron, nickel, tantalum, molybdenum, tungsten, etc., are laid in grooves 21. Rings 19 are slipped over the mandrel and spot welded to each wire. The first section of the electrode is slipped down, in Figure 4, over the smooth portion of the mandrel 22 and the end ring rotated to bend the attached wires and to set each wire at an angle of 5° to 10°. The grid is slid to the next ring along

the mandrel bringing the third ring to the ends of grooves 21 and the second ring is rotated in a direction opposite to the direction of rotation of the first. Each succeeding section of the electrode is similarly deformed, the angular displacement of each ring preferably being uniform. The end rings of the electrode may then be attached to tubular support members 15 and 16 and mounted in the tube, the tubular members being rigidly secured to ring supports 17 and 18.

A cathode constructed according to my invention and adapted for mounting in the tube of Figure 1 is shown in detail in Figure 3. The electrode wires 76 of a refractory metal, such as tungsten and thoriated to render the wire electron emissive at high temperatures, are constructed in the same manner as the grids above described. Although the ends of the filament are held stationary by disc 10 and collar 13 so that the overall length of the filament may not change during heating, the spaced rings fastened to the filament wires rotate to take up the expansion of the filament wires and prevent bowing or buckling of the wires and lateral displacement of the electrode.

While it is desirable that the bends or bights in the conductors be guided along a circular path by rings 19 attached to the conductors, it has been found that the rings may be displaced along the cylinder from the bends to permit the bends to travel a short distance in a path tangential to the cylinder. Further, the rings may, if desired, loosely encircle the conductors and may be held in spaced relation along the cylinder by suitable spacing means. When the conductors are relatively heavy and self-sustaining the rings may be omitted, it having been found the slight deformation of the electrode caused by the displacement of the conductors is negligible, especially where the radius of the electrode is large or where the surface of the electrode is substantially planar.

Electrodes constructed according to my invention may be mechanically fixed at both ends, will not bow or buckle when heated, are inexpensive to manufacture and easy to install.

I claim:

1. A cylindrical electrode comprising spaced coaxial annular members, a ring coaxial with and between said annular members in the cylindrical surface of said members, a plurality of substantially parallel rods, each joined at one end to one of said annular members, and attached at the other end to said ring, the point of attachment of said other end of each rod being displaced along said ring out of longitudinal alignment with the rod ends joined to said one tubular member, a second set of substantially parallel rods each joined at one end to said ring, the other end of each rod of said second set of rods lying in said cylindrical surface and in longitudinal alignment with said one end of each of the first mentioned rods and mechanically fastened to the other annular member.

2. An electrode for an electron discharge device comprising a first set of substantially parallel rods disposed in a cylindrical surface, a second set of substantially parallel rods disposed in a cylindrical surface coaxial and end-to-end with the first set of rods, a ring, adjacent ends of the two sets of rods being joined to said ring, means to hold the outer ends of the rods against longitudinal movement, the angle between adjacent end-to-end rods in the two sets of rods being less than 180°.

3. An electrode adapted to be fixed against elongation without deformation comprising a first set of parallel rods lying in a surface, a second set of parallel rods lying in a second surface co-extensive and end-to-end with the first mentioned surface, means joined to adjacent ends of the two sets of rods to hold the ends of the rods in each set in fixed spaced relation, means to hold the outer ends of the rods against the longitudinal movement, adjacent ends of each pair of end-to-end rods being out of alignment with the outer ends of said end-to-end rods, and said means being free to move upon elongation of said rods.

4. An electrode comprising spaced coaxial tubular metal terminal members, a ring between and coaxial with said members, a plurality of parallel spaced wires joined to said members and to said ring with a section of each wire on either side of said ring, the angle between one side of each section of each wire on one side of said ring being less than 90° with a plane through said ring and the angle between said plane and said one side of each wire on the other side of said ring being less than 90° .

5. An electrode for an electron discharge device comprising a plurality of wires, two coaxial terminal tubular members secured to the end of said wires, a plurality of spaced metal rings coaxial with said members, each wire extending from one terminal member to the other along a zigzag path and attached to said rings, the bends in adjacent wires lying in circles.

6. An electron discharge device comprising an envelope, an electrode in said envelope, two spaced support means for said electrode, the electrode comprising two coaxial tubular support

members, each member rigidly secured to one of said support means, a plurality of substantially parallel spaced conductors in a cylindrical surface coaxial with said members and joined at their ends to said members, the conductors being made in a zigzag form, adjacent bends in adjacent conductors lying in circles coaxial with said members, and spaced rings surrounding said conductors and secured to the conductors.

7. An electron discharge device comprising an envelope, two spaced supports a fixed distance apart in said envelope, an electrode between said supports comprising a plurality of uniformly spaced conductors in the surface of said electrode supported at their ends by said supports, each conductor extending along a zigzag path, means mechanically connecting adjacent bends of adjacent conductors in fixed spaced relation to permit thermal expansion of the conductors without materially deforming said electrode.

8. An electron discharge device comprising an envelope, an anode, a plurality of spaced tubular electrodes in and concentric with said anode, one of said electrodes comprising a plurality of substantially parallel conductors extending lengthwise of the electrode and lying in a cylindrical surface, annular support members fixed in coaxial spaced relation, the ends of the conductors being joined to the support members, each conductor being bent to form a zigzag, the bends in the conductors lying in circles, rings around the electrode and joined to the wires at said bends, the rings being free to rotate about the axis of the electrode upon an elongation of the conductors.

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