Oct. 28, 1930. H. J. NOLTE ET AL 1,780,033

VACUUM TUBE

Filed March 12, 1927

Fig. 1

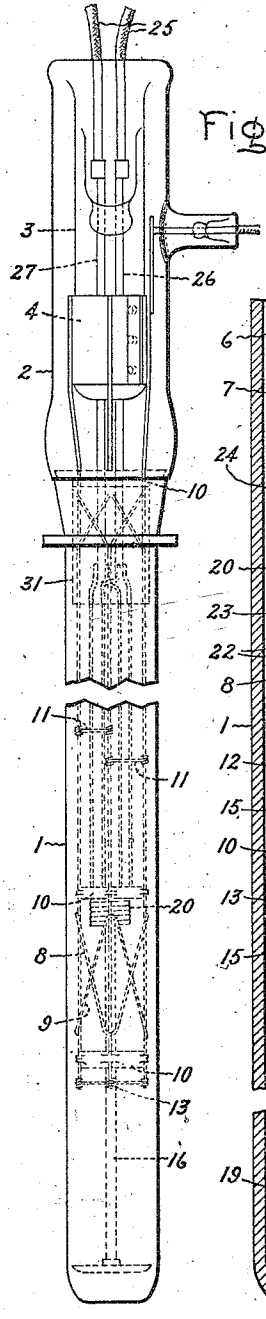


Fig. 2.

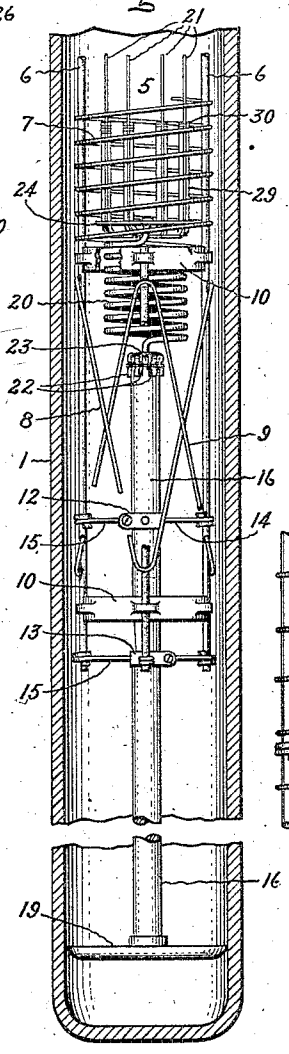


Fig. 7

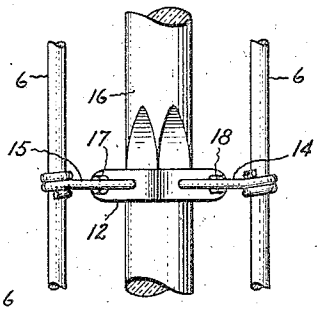


Fig. 8

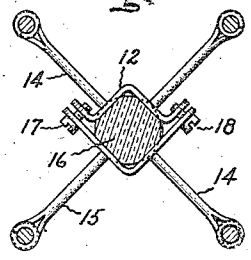


Fig. 4.

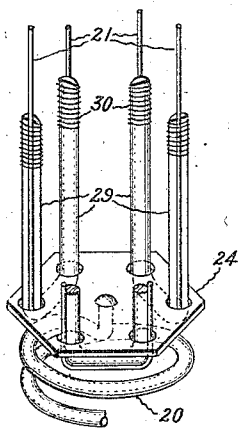


Fig. 5.

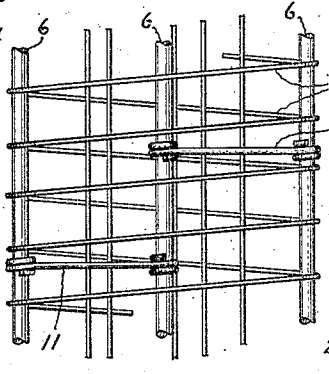


Fig. 3.

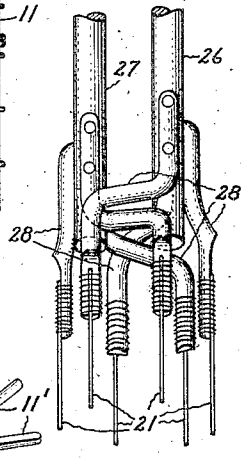
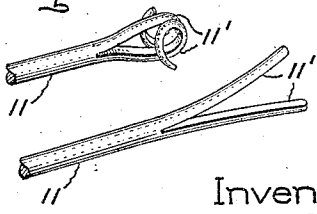


Fig. 6.



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UNITED STATES PATENT OFFICE

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VACUUM TUBE

Application filed March 12, 1927. Serial No. 174,863.

The present invention relates to vacuum tubes and more particularly to power vacuum tubes employing water cooled anodes and operating at relatively high voltages.

In the use of power tubes employing relatively long electrodes, it is difficult to provide a rigid electrode construction whereby the electrodes may be maintained in proper spaced relation and will not bend or warp at high temperatures and under electrostatic strain. A further difficulty is encountered in providing means whereby the different electrodes may be properly insulated from one another.

It is one of the objects of the present invention to provide in a power tube means whereby both of the above difficulties may be effectively overcome.

The novel features which are characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, will best be understood from reference to the following specification taken in connection with the accompanying drawing in which Fig. 1 is an elevation partly broken away of a water cooled electron discharge device which embodies the features of our invention; Fig. 2 is a cross section and elevation partly broken away of the lower portions of the electrodes; Figs. 3 and 4 are detail views of the upper and lower portions respectively of the filamentary electrode; Fig. 5 is an elevation of a portion of the grid or control electrode; Fig. 6 shows a detail of the grid construction; while Figs. 7 and 8 show an elevation and cross section respectively of the lower portion of the grid structure.

Referring to the drawing, we have shown in Fig. 1 a power, electron discharge device which has a rating of about 100 kw. It comprises an anode 1 made from seamless drawn copper tubing and an upper glass portion 2 joined to the anode in any suitable manner and provided with a reentrant portion 3. The reentrant portion 3 is surrounded by a metallic collar 4 on which a grid or control electrode 5 is mounted.

Grid 5 comprises four supporting wires 6 of refractory metal supporting a coiled wire 7. The supporting wires extend beyond both ends of coil 7 and are braced at these points by means of wires 8 and 9 which are welded to the supporting wires. In order to ensure further the rigidity of the grid structure, a plurality of flat metal collars 10 are mounted on the supporting wires 6 at the opposite ends thereof. Intermediate the ends of the grid structure a plurality of wire braces 11 engage wires 6. These braces comprise short wires, the ends of which are slit to provide relatively thin wire portions as indicated at 11′ which are coiled in opposite directions around the supporting wires 6. The slit portions can be coiled sufficiently tight around the wires 6 to avoid the use of a weld. If it is desired to weld the braces to the supporting wires, however, the welds may be made at the ends of the slit portions rather than at the junction of the braces with the wire 6. Since these welds are removed from the junction of the brace and supporting wire relative movement between the supporting wires 6 will not cause the braces to become loosened.

A pair of spaced collars 12 and 13 are mounted adjacent one end of the grid supporting wires 6 and secured thereto by braces 14 and 15. The collars engage an elongated clear quartz rod 16 having cut-away or grooved portions to provide suitable bearings for the collars. The collars which may be detachably secured to the quartz stem by means of suitable screw threaded bolts 17 and 18, serve to clamp the insulating rod rigidly in position. The lower end of rod 16 is provided with a thin metal or other suitable plate 19 which acts as a guide and spaces the grid from the anode 1. Collar 13 is spaced about five inches from the plate 19, while the collar 12 is about three inches from a tensioning spring 20 connected to the filamentary electrode 21. The insulating rod in this manner provides a spacing between the various electrodes which is substantially proportional to the potential difference existing between them. The upper end of rod 16 is provided with a groove adapted to accommodate a series of spring fingers 22 mounted on and integral with a plate 23 which is connected to one end of spring 20. A wire may be wound in the

groove and about the spring fingers to maintain them in position on the insulating rod. The upper end of spring 20 is connected to a perforated, hexagonal plate 24 through which the wires comprising the filament 21 may be threaded.

The filamentary electrode is supplied with current through a pair of copper conductors 25 connected with refractory leading-in wires 26 and 27. The lower end of each leading-in wire is provided with three Z shaped members or extensions 28 which are secured in any suitable manner to the leading-in wires and mounted so that the lower ends of the extensions on each leading-in wire are spaced apart 120°. The ends of members 28 on one leading-in wire are disposed in alternate relation with the Z shaped extensions 28 on the other leading-in wire so that the wires which are connected to the ends of the Z shaped members are arranged substantially in a circle and the adjacent or successive wires in the circle will be positive and negative respectively when current is supplied to the leading-in wires from the conductors 25.

Each of the wires comprising the filament is threaded through openings in plate 24. A series of U shaped members 29 are inserted through adjacent openings in the plate 24. The filament extends along the outer periphery of the members 29 and are firmly secured thereto by thin wires 30. The presence of members 29 prevents overheating of the plate 24 by the filament current and at the same time insures a definite lighted filament length and provides a certain degree of rigidity to the filament. The looped wires comprising the filament are circularly disposed in substantially parallel relation to one another and adjacent wires are connected to the positive and negative leading-in wires respectively. This arrangement is particularly advantageous as the magnetic fields produced by the current flowing through the filament wires do not tend to cause displacement or bowing of the filament wires.

A wire screen 31 indicated in dotted lines (Fig. 1) is mounted on the upper end of the grid supporting wires and serves to protect the upper glass portion 2 from positive ion and electron bombardment and, consequently, punctures during the operation of the tube.

What we claim as new and desire to secure by Letters Patent of the United States is:—

1. In combination, an electron discharge device comprising an anode, a filamentary cathode and a control electrode, supporting means for the control electrode, an elongated insulator positioned longitudinally of the discharge device and secured to said means, said insulator having flat bearing surfaces, a clamp on said surfaces and connected to said supporting means, and means for applying a tension to the filamentary cathode, said latter means comprising a spring connected to one end of said insulator.

2. In combination, an electron discharge device comprising an anode, a filamentary cathode and a control electrode, supporting means for the control electrode, an elongated insulator positioned longitudinally of the discharge device and provided with a groove, means mounted in said groove and connected to said supporting means, means comprising a spring connected to one end of the insulator for applying a tension to the filamentary cathode, and means on the opposite end of the insulator for spacing the insulator from the anode, the distance between said groove and the opposite ends of the insulator being proportional to the normal operating potential difference between the control electrode and cathode and between the control electrode and anode respectively.

3. In combination, an electron discharge device comprising an anode and a control electrode, an insulator supported from said control electrode, a filamentary electrode comprising a plurality of circumferentially arranged looped wires substantially parallel throughout their entire length, means for applying a tension to said filamentary electrode, said means comprising a perforated metal plate, a plurality of U shaped members extending through said perforated plate and connected to said filament and a spring connected at one end to said plate and at the other end to said insulator.

4. A filamentary electrode comprising a plurality of substantially parallel looped wires, the ends of said loops being arranged in a circle, a pair of leading-in wires connected to the ends of said looped conductors to supply current thereto, the adjacent wires of the filament being connected to different leading-in conductors, a perforated plate mounted on said filament wires, and means for appying a tension to said plate.

5. In combination, a plate having a plurality of openings therein, a U shaped member mounted on said plate and having portions extending through said openings, and a filamentary electrode connected to the ends of said U shaped member.

6. In combination, a plate having a plurality of openings, a U shaped member mounted on said plate and having portions extending through said openings, a looped filament extending through said openings and along said U shaped member, and means securing the filament to the U shaped member.

7. In combination, a plate having a plurality of openings, a U shaped member mounted on said plate and having portions extending through said openings, a looped filament extending through said openings and along the outer periphery of said U shaped member, means securing the filament

to the U shaped member, and means for applying a tension to said plate.

8. An electrode comprising a plurality of supporting wires and a wire brace connecting said supporting wires, the opposite ends of said brace being slit to provide relatively thin wire portions, said portions at each end of the brace being wound in opposite directions around one of said supporting wires.

In witness whereof, we have hereto set our hands this 11th day of March, 1927.

HENRY J. NOLTE.
WALTER I. RELYEA.