April 20, 1926. 1,581,520

P. SCHWERIN

VACUUM TUBE

Filed March 17, 1921

Fig. 1.

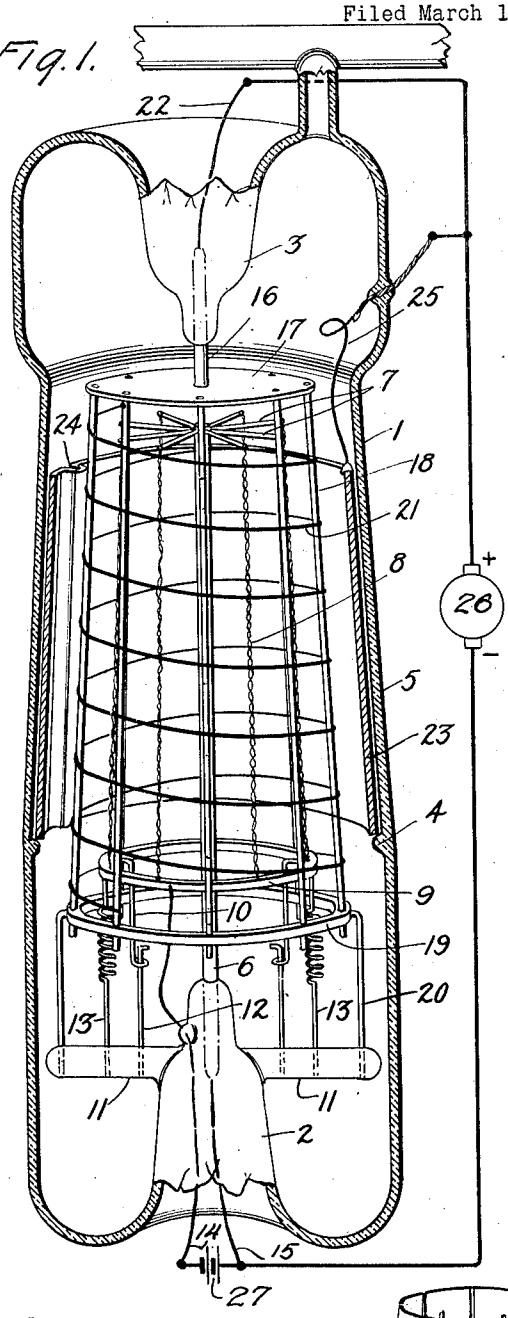


Fig. 2.

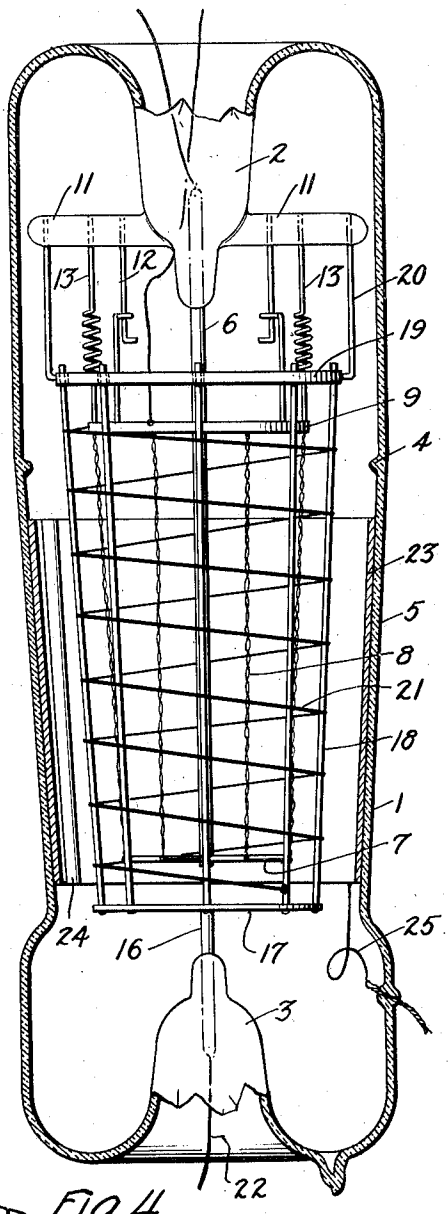
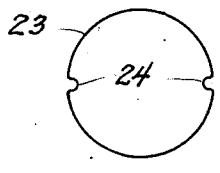


Fig. 3.



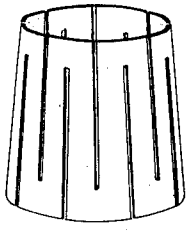


Fig. 4.

Inventor:
Paul Schwerin,
by W. E. Beatty.
Att'y

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UNITED STATES PATENT OFFICE.

PAUL SCHWERIN, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

VACUUM TUBE.

Application filed March 17, 1921. Serial No. 453,101.

To all whom it may concern:

Be it known that I, PAUL SCHWERIN, a citizen of the United States, residing at New York, in the county of Bronx and State of New York, have invented certain new and useful Improvements in Vacuum Tubes, of which the following is a full, clear, concise, and exact description.

This invention relates to vacuum tubes and has for an object a structural arrangement of the elements thereof whereby the anode may be subjected to the influence of a cooling agent exterior of the tube.

This object is accomplished by so designing and arranging the anode within the tube that it is in intimate contact with the inner wall thereof. In order that during the evacuation of the tube, the anode may be out of contact with the wall of the tube to allow the heating of the anode by bombardment without corresponding heating of the glass and to also allow free emission from all the surfaces of the anode of the gas occluded therein, the tube and anode taper in the same direction and the anode is mounted in the tube for movement longitudinally thereof. Furthermore, the structure of the anode is such as to allow expansion thereof during the operation of the tube without exerting undue pressure on the wall of the tube.

A further object of the invention lies in the structural arrangement of the cathode and control electrode whereby the former is maintained taut and the latter is allowed to expand freely when heated during the operation of the tube.

This invention will be better understood by having reference to the following specification and accompanying drawing wherein Fig. 1 is a sectional view of a vacuum tube embodying the invention in the process of being evacuated. Fig. 2 is a sectional view of a completed tube in operating position. Fig. 3 discloses diagrammatically the sectional outline of one form of anode. Fig. 4 is a reduced perspective view of another form of anode.

The vacuum tube comprises a glass envelope 1 which is substantially cylindrical and has the reentrant stems 2 and 3 at the ends thereof. Near the reentrant stem 2 are beads 4 projecting from the inner wall of the vessel 1. From these beads the vessel tapers conically toward the stem 3, as at 5, for a purpose to be later described. Sealed in the stem 2 and supported therefrom, is the metallic rod 6 which extends nearly to the stem 3 at the other end of the tube. Radially projecting from the free end of the rod 6 are the metallic arms 7 on which are supported the filamentary cables 8 comprising the cathode the other ends of said cables being attached to the ring or circular bus-bar 9. The ring 9 carries wires 10 projecting in the general direction of the stem 2 and having loops at their free ends. Extending from the stem 2 are the glass arms 11 in which are mounted wires 12, the free ends of which extend through the loops in the ends of the wires 10 and are bent over to prevent the loops slipping off the wires. The arms are so arranged that every point on them is more removed from the center of the tube than is the tip of the stem. Wires 13 extend from the arms 11 to the ring 9, the intermediate portions of which wires are coiled to form helical springs by means of which tension is applied to the ring 9. By virtue of this arrangement as filaments 8 expand during the operation of the tube the filaments are kept taut and the ring 9 is maintained in proper position to retain the filaments in the desired relation relative to the other elements of the tube. Leading-in wires 14 and 15 for the cathode are connected with the bus-bar or ring 9 and the rod 6.

Mounted in the stem 3 is the metal rod 16 which carries at its free end the circular plate 17. Rods 18 are attached to the plate 17 and have their free ends slidably mounted in apertures in the ring 19 supported from the arms 11 by the wires 20. Helically wound around these rods is the conductor 21 which together with the rods 18 constitutes the grid or control electrode. A leading-in wire 22, for the grid is attached to the rod 16.

The anode 23 comprises a frusto-conical sheet of metal arranged coaxial with the vessel and with the cathode and grid electrodes, The anode is arranged so that, when the tube is in the position shown in Fig. 1,

it will rest upon the beads 4 but that, when the tube is arranged in the position shown in Fig. 2, it will slide into position to bring the outer wall thereof into contact with the inner wall of the vessel. The structural arrangement of the anode is such that the metal composing it may expand under the influence of heat without substantially increasing its exterior diameter. In Figs. 1, 2, and 3 the anode is disclosed as being provided with inwardly stamped ridges 24 to allow for expansion of the metal without corresponding increase in its diameter or effective perimeter. By virtue of this arrangement the heating of the anode during the operation of the tube causes the anode to fit snugly against the inner wall of the tube but prevents the possibility of expansion of the anode cracking the glass of the tube.

In Fig. 4 the anode is shown as being a tubular member having saw cuts extending alternately from one end thereof nearly to the opposite end. The enclosing wall of the tubular member is continuous however, as none of the saw cuts extend the full length thereof. Thus, the expansion of the material of the tubular member will bring together the edges of the saw cuts without increasing the effective perimeter of the anode. It is, of course, understood that other structural arrangements of the anode are capable of performing the same function. A leading-in wire 25 is sealed in the vessel and connected to the anode.

As shown in Fig. 1, the tube, in the manufacture thereof, is connected with the evacuating pump, not shown, in such a manner that the stem 3 is above the stem 2. In this position the anode drops down onto the annular ridge 4. While in this position and during the evacuating operation the anode and grid electrodes are electrically connected with the positive side of a generator 26 the negative side of which is connected to the cathode, the latter being heated by the battery 27 and the anode is bombarded in substantially the same manner as is disclosed in the patent to Arnold 1,297,309 to free it of the occluded gases without excessively heating the glass of the tube. Furthermore, the occluded gases may be freely emitted from the exterior wall of the anode as it is not in contact with the glass. When the tube is completed and ready for operation, it is arranged in the position shown in Fig. 2 and a cooling medium may be directed against the envelope 1 to carry away heat conducted from the anode through the glass wall.

What is claimed is:

1. A vacuum tube comprising a glass enclosing vessel having a tapered portion, and a tapered metal electrode coaxial therewith and slidably mounted in said vessel, the movement of said electrode in one direction being limited by the contact of its exterior surface with the interior surface of said tapered portion.

2. A vacuum tube comprising a glass enclosing vessel having a tapered portion, and a metal tapered electrode coaxial therewith and slidably mounted in said vessel, the movement of said electrode in one direction being limited by the contact of its exterior surface with the interior surface of said tapered portion, and means in said tube for limiting the movement of said electrode in the opposite direction.

3. A vacuum tube comprising a glass enclosing vessel having a tapered portion, a substantially cylindrical tapered metal electrode having its exterior surface in contact with the inner wall of the tapered portion of said vessel, said electrode having inwardly bowed portions whereby the material of said electrode may expand without an increase in the effective perimeter of the cylinder.

4. A vacuum tube comprising a stem having radially extending projections, a metallic post sealed in said stem, arms extending radially from said post, a bus bar, resilient connections between said projections and said bus bar, filaments fastened to said arms and bus bar, and lead wires connected with said post and bus bar.

5. A vacuum tube comprising a stem having radially extending projections, a metallic post sealed in said stem, arms extending from said post, an annular bus bar, wires on said projections supporting said bus bar, said wires being coiled intermediate their ends, filaments fastened to said arms and bus bar, and lead wires connected with said post and bus bar.

6. A vacuum vessel comprising inwardly projecting stems oppositely disposed therein, a post sealed in one stem, rods supported by said post and extending longitudinally of said post, an annular member supported by the other stem and having apertures through which extend free ends of said rods and a conductor helically wound around said rods.

7. A vacuum vessel comprising inwardly projecting stems oppositely disposed therein, a post sealed in one stem, a circular plate carried by said post, rods carried by said plate and extending longitudinally of the post, an annular member supported by the other stem having apertures through which extend the free ends of said rods, and a conductor helically wound around said rod.

8. A vacuum tube comprising a stem having radially extending projections, a metallic post sealed in said stem, arms extending radially from said post, a bus bar resiliently attached to said projections, filaments fastened to said arms and bus bar, and cooperating guiding means carried by said bus bar and said stem arms.

9. A vacuum tube comprising a substantially cylindrical vessel having inwardly projecting stems at either end, a metallic post sealed in each stem, a control electrode supported at one end by one of said posts, expansible connections between the other end of said control electrode and the stem adjacent thereto, a cathode supported by said other post and means resiliently fastening said cathode to the stem in which it its supporting post is sealed.

In witness whereof, I hereunto subscribe my name this 11th day of March A. D., 1921.

PAUL SCHWERIN.