May 5, 1925. 1,536,855

W. G. HOUSKEEPER

ELECTRON DISCHARGE DEVICE

Filed July 20, 1920

Fig. 1.

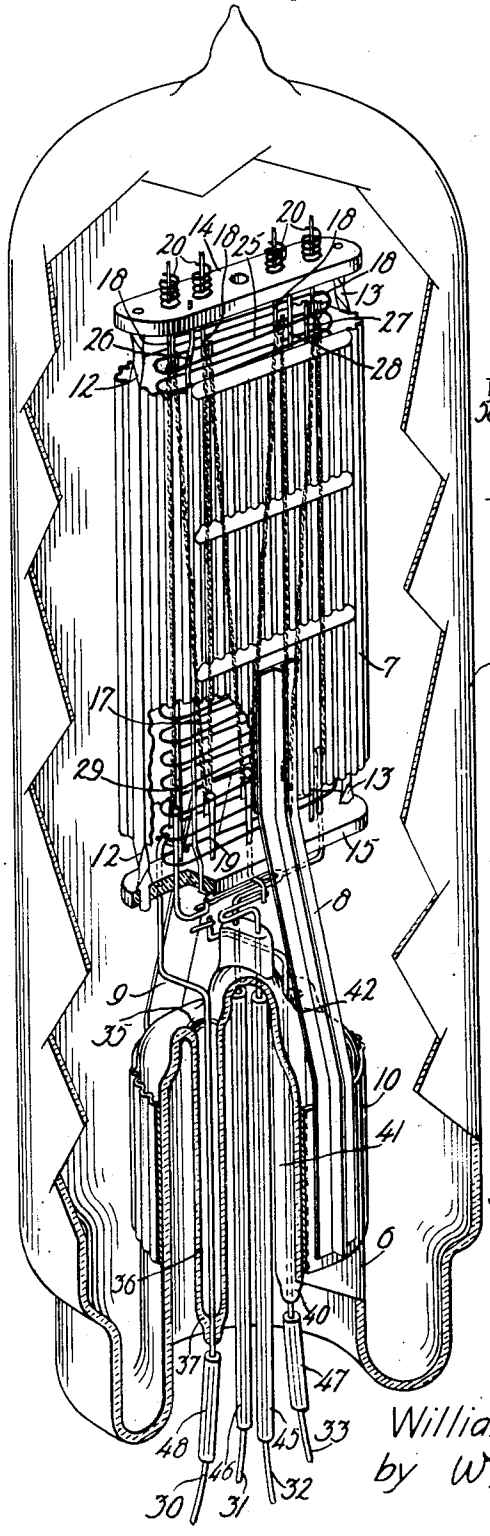


Fig. 3.

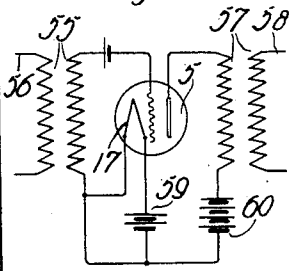
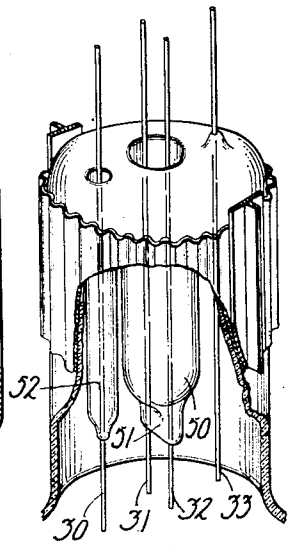


Fig. 2.



Inventor:
William G. Houskeeper
by W. E. Beatty
Att'y.

Patented May 5, 1925. 1,536,855

UNITED STATES PATENT OFFICE.

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

ELECTRON-DISCHARGE DEVICE.

Application filed July 20, 1920. Serial No. 397,764.

To all whom it may concern:

Be it known that I, WILLIAM G. HOUSKEEPER, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Electron-Discharge Devices, of which the following is a full, clear, concise, and exact description.

This invention relates to electron discharge devices, such as the audion, and pertains more especially to the electrode supporting structure and the arrangement of the lead wires for the electrodes.

An object of this invention is to provide a rugged and compact electrode unit which is capable of being subjected to high voltages without injury. Another object is to provide a simple and efficient means of supporting such an electrode unit. A further object is to prevent leakage currents between the lead-in wires for the various electrodes of a vacuum tube. Still other objects will be apparent from the detailed description of the drawings.

For convenience this invention will be illustrated and described in connection with a tube of the three-electrode type comprising an anode, a cathode and a control or grid electrode enclosed in a gas tight, preferably evacuated vessel.

The electrode unit hereinafter described in detail as constituting one form of this invention, comprises a flattened cylindrical anode supporting at either end a block of insulating material. The cathode and grid electrodes are located within the anode and are supported by suitable means fastened to the blocks of insulating material. The electrode unit comprising the three above mentioned electrodes is supported in the tube by having the anode terminate in a metallic collar which surrounds an inwardly projecting neck of the containing vessel and which is preferably frictionally held thereto. Such a structure is very rugged and is adapted to be employed with high anode-cathode voltages.

In employing such a tube in high voltage circuits, special precautions are frequently necessary to prevent discharges or corona effects between the various lead-in wires for the electrodes or between one of the wires and the above mentioned supporting collar and also to prevent appreciable leakage currents through the glass located between the lead-in wires due to high frequency potential differences therebetween. These deleterious effects may be prevented by surrounding one or more of the lead-in wires by evacuated glass tubes in a manner hereinafter described in detail.

This invention will be better understood by reference to the following detailed description taken in connection with the accompanying drawings in which Fig. 1 represents a vacuum tube of the three-electrode type embodying this invention; Fig. 2 represents a modification of the sealing-in arrangement for the lead-in wires of the tube and Fig. 3 illustrates how the tube of this invention may be employed in an electric circuit for amplifying or repeating electric currents.

The electron discharge device illustrated in Fig. 1 comprises an evacuated container 5 of glass which has an inwardly projecting neck 6 also of glass. The flattened cylindrical anode 7 of the electrode unit of the device is supported by two T-shaped members, 8 and 9, which are fastened to a metallic collar 10 surrounding neck 6. The collar 10 is maintained in position on neck 6, preferably by friction only. Collar 10 is preferably made crimped in a plurality of places and is fashioned so as to originally have an effective diameter slightly less than the diameter of the neck 6. The collar 10 may then be forced on neck 6 so that it is tightly held thereto by friction.

Fastened on opposite sides of anode 7 are metallic posts 12 and 13 for supporting at either end of the anode, blocks of insulating material 14 and 15. The blocks 14 and 15 are preferably made of lavite, since such a material can be readily machined and freed of absorbed gases. The use of lavite, however, in a vacuum tube is not a part of this invention, but is described and claimed in a copending application of William A. Knoop, filed April 18, 1919, Serial No. 290,968.

Within the anode 7 is located a double M-shaped filament 17 supported at one end by wires 18 and by wires 19 at the other end. Wires 19 are preferably rigidly set in the lavite block 15, while wires 18 pass up

through apertures in block 14 and are resiliently supported by springs 20. This manner of resiliently supporting a filament is not a part of this invention, but is described and claimed in a copending application of Paul A. Watrous, filed November 25, 1919, Serial No. 340,455.

The control or grid electrode for the device comprises a helical wire 25 which is welded at a plurality of points to a plurality of wires 26, 27, 28 and 29. Upright wires 26 and 28 are rigidly connected at their lower ends to insulating block 15; at their upper ends, wires 26 and 28 pass loosely through apertures in block 14 so as to allow the expansion of the grid electrode due to heat. Upright wires 27 and 29 are preferably not fastened to either of the blocks 14 or 15 since it is generally found sufficient to fasten only two of the vertical grid wires to the insulating blocks.

External connections for the anode, cathode and grid are provided by the lead-in wires 30, 31, 32 and 33, lead-in wire 30 being connected to the grid, wire 31 being connected to the two ends and wire 32 to the midpoint of the double M-shaped filament and wire 33 being connected to the anode. It is to be noted that wire 30 is not sealed in the glass at the point 35 of the neck as is the usual practice, but instead is sealed in the glass at the lower end of an evacuated tube 36, the other end of which is sealed to the point 35 of the neck of the tube. Lead-in wire 30 is therefore surrounded by a vacuum from the point 35 to point 37. The lead-in wire 33 for the anode is similarly sealed in at the lower end 40 of an evacuated tube 41, the upper end of which is sealed to the point 42 of the neck 6. Such an arrangement increases enormously the distance along the glass between the points where the lead-in wires 30 and 33 are sealed in the glass with respect to the sealing-in point for the cathode. Leakage currents between the various lead-in wires by means of these evacuated tubes is therefore reduced to a negligible value on account of the long leakage path between the sealing points of the lead-in wires. The provision of the evacuated tubes 36 and 41 also aids in preventing arcing or other discharges between the portion of the lead-in wires enclosed or surrounded by the neck 6. In order to aid in insulating the filament lead-in wires 31 and 32 from the other lead-in wires of the tube it is frequently found convenient to surround the wires 31 and 32 by glass tubes 45 and 46 which, however, need not necessarily be evacuated. Similarly, glass tubes 47 and 48 may be placed on lead-in wires 30 and 33 at their lower ends for aiding in the insulation of these two wires from the filament lead-in wires.

Another way in which leakage currents between the sealing-in points of the lead-in wires may be reduced to negligible value is shown in Fig. 2. In this modification the two filament lead-in wires 31 and 32 are surrounded by an evacuated tube 50 to which the lead-in wires are sealed only at the lower end 51. Similarly the grid lead-in wire 30 is enclosed in an evacuated tube 52 as in Fig. 1. The lead-in wire 33 for the anode in this modification, need not be enclosed in an evacuated tube, since ample protection from leakage currents over the glass and discharges between the lead-in wires is secured by tubes 50 and 52.

One way in which the tube illustrated in Fig. 1 may be employed for repeating electric currents is shown in Fig. 3 in which the tube 5 is shown as having its input terminals connected by a transformer 55 to an incoming line 56, while its output terminals are connected by a transformer 57 to an outgoing line 58. Cathode 17 is heated by a battery 59 while space current for the tube is provided by a source of voltage 60. The source of voltage 60 for the type of tube disclosed in Fig. 1 may safely be as high as 2000 volts or more. With such an arrangement tube 5 may be employed for repeating to line 58 amplified currents received by tube 5 from line 56.

It is to be understood that the electrode structure above described represents only one form in which applicant's invention may be used and that the above described form may be variously modified without departing in anywise from the spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising a gas tight vessel having a reentrant integral stem, a metallic collar held to said stem solely by friction, and an electrode supported by said collar.

2. An electron discharge device comprising a gas tight vessel having an inwardly projecting neck, a crimped metallic collar on said neck, and an electrode supported by said collar.

3. An electron discharge device comprising a gas tight vessel having an inwardly projecting neck, a crimped metallic collar surrounding said neck, an electrode unit in said vessel and a plurality of T-shaped members fastened to said collar for supporting said unit.

4. An electron discharge device comprising a cathode, a control electrode, an anode surrounding said cathode and control electrode, a pair of supports carried by said anode out of contact with the major portion of said anode, said pair of supports being located at opposite ends of said anode and means for supporting said cathode and control electrode from said pair of supports.

5. An electron discharge device compris-

ing a gas tight vessel having an inwardly projecting neck, an anode supported by said neck, a pair of supports carried by said anode out of contact with the major portion of said anode, said pair of supports being located at opposite ends of said anode, a cathode, a control electrode and supporting means for said cathode carried by each of said pair of supports.

6. An electron discharge device comprising a gas tight vessel having an inwardly projecting neck, an anode supported by said neck, a pair of supports carried by said anode but out of contact with the major portion of said anode, said pair of supports being located at opposite ends of said anode, a cathode, a control electrode and supporting means for said control electrode engaging each of said pair of supports.

7. An electron discharge device comprising a containing vessel having an inwardly projecting neck, an anode frictionally supported by said neck, cathode and control electrodes surrounded by said anode, a block of insulating material carried by said anode at either end thereof and supporting means for said control electrode engaging each of said blocks.

8. An electron discharge device comprising a containing vessel having an inwardly projecting neck, an anode supported by a crimped collar surrounding said neck, blocks of insulating material carried by said anode at opposite ends thereof, and cathode and control electrodes supported by said blocks.

9. An electrode assembly comprising an anode, cathode and control electrodes surrounded by said anode, a block of insulating material carried by said anode at either end thereof and out of contact with the major portion of said anode and means for supporting said control electrode and said cathode between said blocks.

10. An electrode assembly comprising an electrode, a block of insulating material supported by said electrode at either end thereof and out of contact with the major portion of said electrode, a second electrode surrounded by said first electrode and means for supporting said second electrode between said blocks.

11. An electron discharge device comprising a gas tight vessel having a stem, a metallic collar surrounding said stem and held thereto by friction only, an electrode supported by said collar, a pair of insulating blocks supported by said electrode and a second electrode spaced between said blocks and supported thereby.

12. An electron discharge device comprising a gas tight vessel having a stem, an electrode supported by said stem, two blocks of insulating material supported by said electrode, said blocks having their greatest dimensions parallel to each other and parallel to a surface of said electrode and a second electrode mounted between said blocks and supported thereby.

13. An electron discharge device comprising a containing vessel having an inwardly projecting neck, a cathode, an anode surrounding said cathode and supported from said neck, a block of insulating material carried by either end of said anode, said blocks having their greatest dimensions parallel to each other and parallel to a surface of said anode, said cathode being mounted between said blocks and supported thereby.

14. An electron discharge device comprising a stem, an anode supported by said stem, a block of insulating material at either end of said anode, said anode having projections passing through apertures in each of said blocks whereby said blocks are fastened to said anode, a cathode, a control electrode and supporting wires for said cathode and control electrode inserted in apertures in each of said blocks.

15. An electron discharge device comprisan evacuated vessel having a stem, an electrode supported by said stem, a tubular member carried by the stem and communicating with the interior of the vessel a lead-in wire for said electrode passing through said stem and sealed in the outer end of said tubular member, said lead-in wire being out of electrical contact with said tubular member except at the sealing-in point.

16. An electron discharge device comprising an evacuated vessel having a stem, cathode, control and anode electrodes supported by said stem, lead-in wires for said electrodes passing through said stem, an evacuated tubular member within said stem and surrounding a plurality of said lead-in wires.

17. An electron discharge device comprising an evacuated vessel having an inwardly projecting neck, cathode, anode and control electrodes supported by said neck, lead-in wires for said electrodes passing through said neck and an evacuated tubular member of insulating material surrounding the cathode and control electrode lead-in wires.

18. An electron discharge device comprising an evacuated vessel having a neck, the interior of said neck being substantially at atmospheric pressure, electrodes in said vessel, lead-in wires within said neck for said electrodes and evacuated tubular members within said neck and surrounding a plurality of said lead-in wires.

19. An electron discharge device comprising an evacuated vessel having an inwardly projecting neck, cathode, anode and control electrodes supported by said neck, lead-in wires for said electrodes passing through said neck and evacuated tubular members of

glass within said neck and surrounding a plurality of said lead-in wires, said tubular members being sealed to said lead-in wires only at that end of each tubular member remote from said electrodes.

20. An electron discharge device comprising an evacuated vessel having a stem, an electrode supported by a collar surrounding said stem, a second electrode cooperating with said first electrode, a lead-in wire for one of said electrodes sealed in said stem, and a tubular member surrounding said lead-in wire for preventing electric discharge effects from said wire, said tubular member being free of electrical conductive material except for said lead-in wire.

21. An electron discharge device comprising an evacuated vessel having an inwardly projecting neck, an anode supported by a metallic collar attached to said neck, a cathode, a lead-in wire for said cathode sealed in said neck, and a tubular member surrounding the portion of said wire adjacent said collar for preventing corona effects between said wire and said collar when high voltages are applied to said anode and cathode, said tubular member being free of electrical conductive material other than said lead-in wire.

22. An electron discharge device comprising an evacuated vessel having a neck, a plurality of electrodes, lead-in wires sealed in said neck for said electrodes, and a tubular member cooperating with said neck to provide a housing for one of said lead-in wires for preventing discharge effects from the housed lead-in wire, said tubular member being free of electrical conductive material other than said lead-in wire.

23. An electron discharge device comprising a containing vessel having a neck, a collar engaging said neck, and an electrode supported by said collar, said collar having corrugations extending in the direction of its axis for rendering said collar expansible.

24. An electron discharge device comprising a containing vessel having a neck, a normally contracting readily expansible collar adapted to be expanded and slipped over said neck and released to grip the same, and an electrode supported by said collar.

In witness whereof, I hereunto subscribe my name this 14th day of July A. D., 1920.

WILLIAM G. HOUSKEEPER.