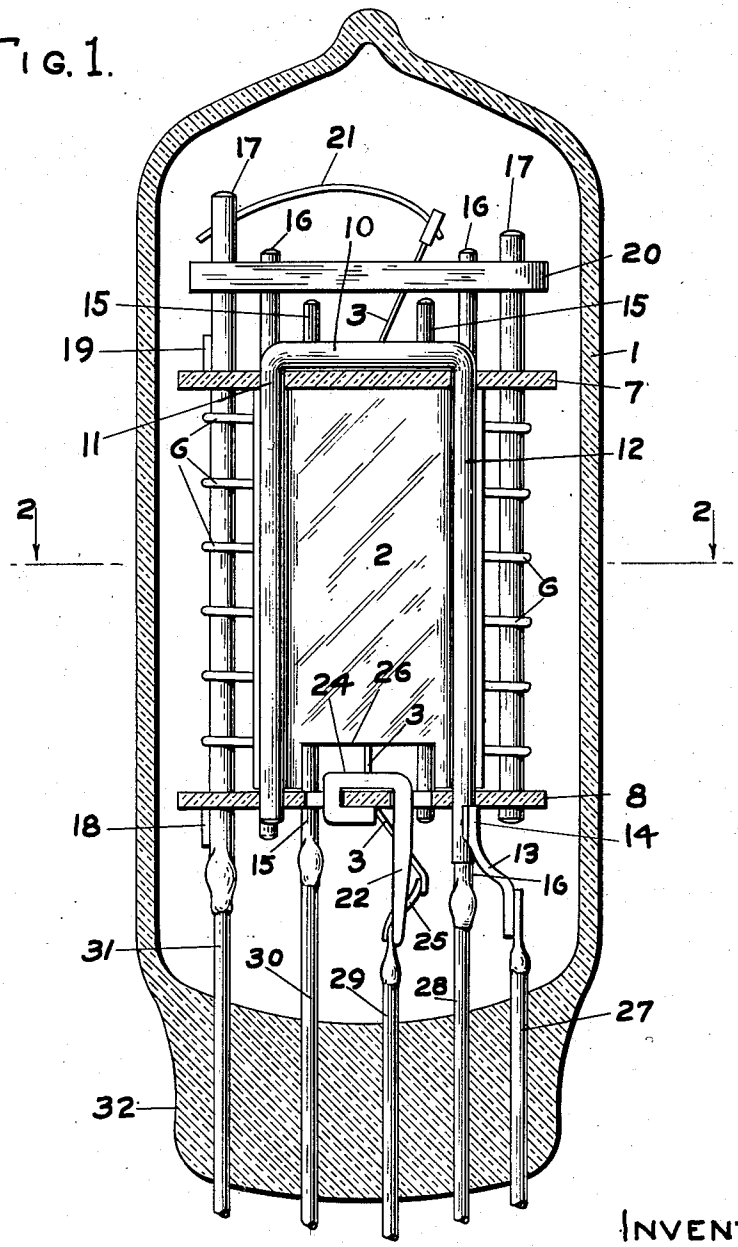
Aug. 8, 1944. N. B. KRIM 2,355,083

ELECTRODE ASSEMBLY FOR DISCHARGE TUBE

Filed Jan. 3, 1941 2 Sheets-Sheet 1

Fig. 1.



INVENTOR.
NORMAN B. KRIM,
BY Elmer J. Gorn
ATTY.

Aug. 8, 1944. N. B. KRIM 2,355,083

ELECTRODE ASSEMBLY FOR DISCHARGE TUBE

Filed Jan. 3, 1941 2 Sheets-Sheet 2

FIG. 2.

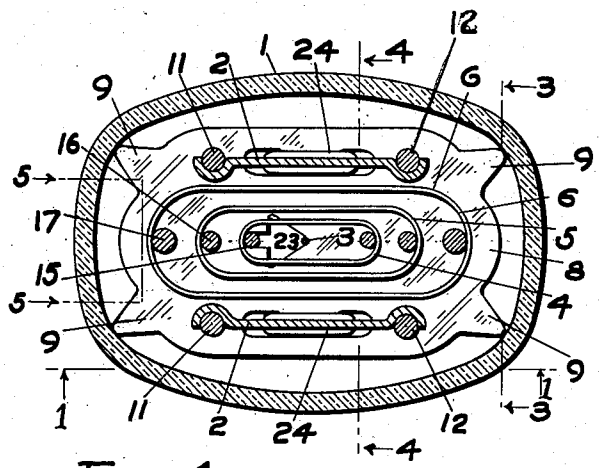


FIG. 3.

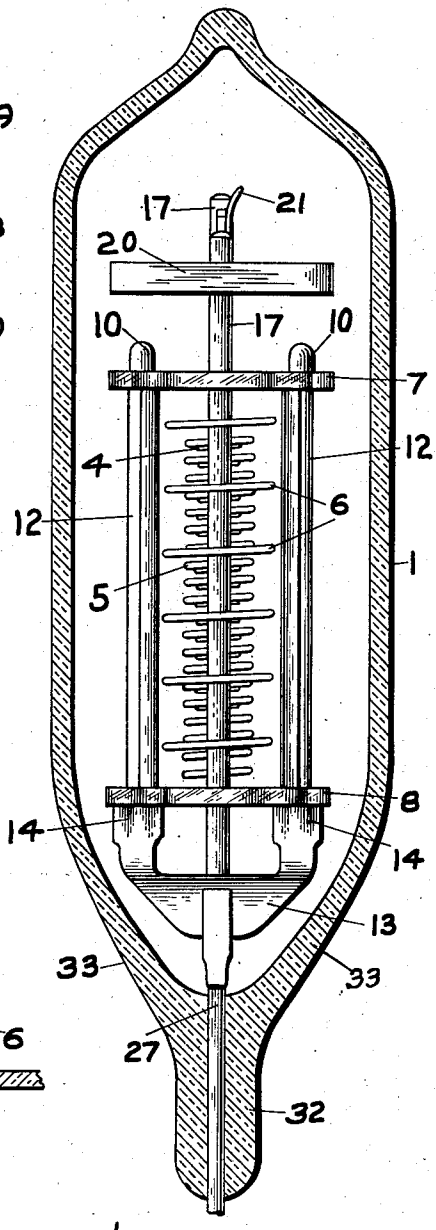


FIG. 4.

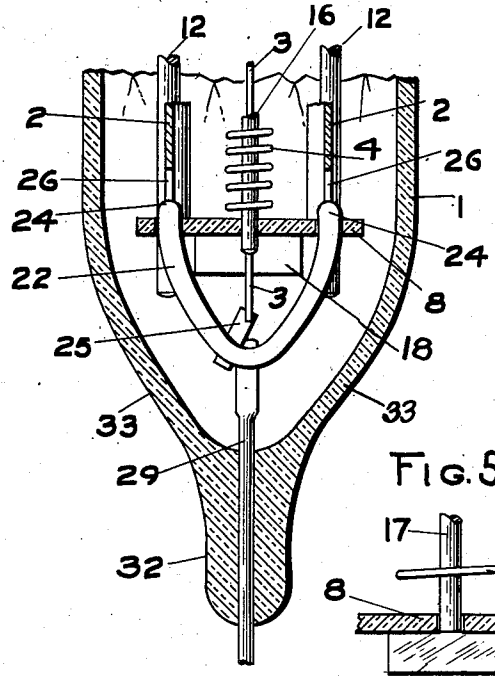
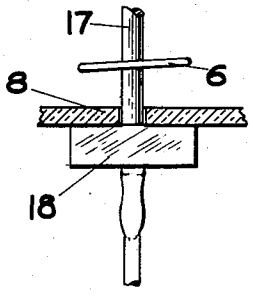


FIG. 5.



INVENTOR.
NORMAN B. KRIM,
BY Elmer J. Gow
ATTY.

Patented Aug. 8, 1944

2,355,083

UNITED STATES PATENT OFFICE

2,355,083

ELECTRODE ASSEMBLY FOR DISCHARGE TUBES

Norman B. Krim, Cambridge, Mass., assignor, by mesne assignments, to Raytheon Manufacturing Company, Newton, Mass., a corporation of Delaware

Application January 3, 1941, Serial No. 373,006

9 Claims. (Cl. 250—27.5)

This invention relates to an electrical space discharge tube of the vacuum type in which the dimensions of the tube are reduced to relatively small values. Such tubes are particularly useful in small portable devices, such as hearing aids and pocket radios. Devices of this kind are so small in size that they may be carried by the user concealed in the clothing. Therefore, it is important that the tubes be made extremely small in order that they may be utilized in such devices. In such a tube, the problem of assembling the various tube elements within the confined space presents various difficulties because of the limited space available.

An object of this invention is to device a novel arrangement for the electrode assembly and support whereby the tube elements may be easily mounted in a very small space.

Another object of this invention is to simplify the assembly and manufacture of tubes of small sizes.

The foregoing and other objects of this invention will be best understood from the following description of an exemplification thereof, reference being had to the accompanying driwings wherein:

Fig. 1 is a cross section of my novel tube taken along line 1—1 of Fig. 2;

Fig. 2 is a cross section taken along line 2—2 of Fig. 1;

Fig. 3 is a longitudinal cross section of the tube shown in Fig. 1, taken along line 3—3 of Fig. 2;

Fig. 4 is a cross section of the lower portion of the tube taken along line 4—4 of Fig. 2; and

Fig. 5 is a fragmentary cross section of a detail of the tube taken along line 5—5 of Fig. 2.

The tube assembly illustrated is contained within a sealed envelope 1 of some suitable material such as glass. The electrodes consist of a pair of anode plates 2—2, a filamentary cathode 3, and a plurality of grids 4, 5, and 6 interposed between the cathode and the anode plates. Proper spacing and support of the electrodes is provided by upper and lower insulating spacers 7 and 8, preferably of mica. The edge of these spacers is provided with a plurality of resilient projections 9 which are adapted to resiliently engage the inner walls of the envelope 1.

The anode plates 2—2 are each mounted upon a U-shaped frame 10 made of some suitable material such as nickel wire. Each of the frames 10 is bent so as to provide a straight top portion and a pair of depending side arms 11 and 12. In assembling the tube, the ends of the side arms 11 and 12 are inserted through holes in the upper spacer 7 and the frame 10 is pushed down until its straight top portion engages the top of said insulating spacer 7. Thereupon the associated anode plate 2 is welded to the side arms 11 and 12 with the upper edge of said anode plate engaging the lower side of the upper insulating spacer 7. As indicated in Fig. 2, the anode plates 2 may each be formed with grooved side edges to more readily receive the side arms 11 and 12 to be welded thereto. Thereupon the side arms 11 and 12 of each of the frames 10 are inserted through openings in the lower insulating spacer 8 which in this way is assembled in place on the anode structure. A double-armed anode bracket 13 is then welded to the lower ends of each of the side arms 12. Each arm of the anode bracket 13 is provided with a pair of ears 14 which engage the lower side of the insulating spacer 8. In this way, the anode assembly is completed with the two anode plates 2 electrically connected and securely fastened in place on the insulating spacers 7 and 8.

The grids 4, 5 and 6 are wound upon and supported by grid side rods 15—15, 16—16, and 17—17 respectively. These side rods likewise project through openings in the upper and lower insulating spacers 7 and 8. The assembly of these grids on the insulating spacers may take place at any convenient time during the assembly of the electrode structure. One of the side rods 17 of the grid 6 is adapted to support the filament 3 as will be described below. In order to prevent motion of the grid 6 and its associated side rod 17 relative to the spacers 7 and 8, a pair of tabs 18 and 19 are welded on to one of the side rods 17, engaging the lower side of the insulating spacer 8 and the upper side of the insulating spacer 17 respectively. A ring 20 of getter material may be conveniently supported on the electrode assembly by being welded to the upper end of one of the side rods 17.

The filament 3 is supported between a conducting spring member 21 at its upper end and a filament clip 22 at its lower end. The spring member 21 is welded at one end to the upper end of the filamentary cathode 3 and at its other end to one of the side rods 17. The lower end of the filament 3 is welded to the filament clip 22 by means of a connector tab 25. The filamentary cathode 3 is retained in the apexes of a pair of triangular slots 23 formed in the upper and lower insulating spacers 7 and 8, through the tension exerted on said filament by the spring 21. The form of these triangular slots and their re-

lationship to the cathode supporting arrangement is more fully described and claimed in the copending application of Alan C. Rockwood for "Discharge tube spacers, Serial No. 353,108, filed August 17, 1940, now Patent No. 2,266,080, dated December 16, 1941. The filament clip 22 is made in a V-shape with two end portions 24—24. These end portions are firmly secured to the insulating spacer 8 by being inserted through holes in said lower insulating spacer and by being bent over so as to engage both the top and the bottom of said insulating spacer 8. In the small space available, the points at which the ends 24 of the filament clip 22 are secured to the insulating spacer 8, are substantially in line with the anode plates 2—2. In order to provide space for the ends 24, and to avoid electrical contact therewith, the anode plates 2—2 are each cut away to provide an opening 26 adjacent the respective ends 24 of the clip 22.

A plurality of lead-in conductors 27, 28, 29, 30 and 31, are provided for the electrodes 2, 5, 3, 4, and 6 respectively. For this purpose, the lead-in 27 is welded to the anode bracket 13, the lead-in 28 is welded to one of the side rods 16 of the grid 5, the lead-in 29 is welded to the filament clip 22, the lead-in 30 is welded to one of the side rods 15 of the grid 4, and the lead-in 31 is welded to one of the side rods 17 of the grid 6. All of the lead-ins are sealed through a lower press 32 formed externally on the envelope 1. In this way the electrode assembly is retained in place within said envelope and external electrical connections are provided to the respective electrodes.

One of the main factors determining the maximum width of the electrode assembly is the space necessary for the filament 3, the side rods 15, 16 and 17, and the associated grid windings. A certain minimum amount of space is necessary to be left between these various elements. It will be noted that the filament 3 occupies a minimum amount of space by being made as a straight filament, the return connection for said filament being made through one of the side rods 17. In the present structure, I have also decreased the overall dimensions by making the width of each of the plate elements 2 narrower than the maximum width of the grid 6. This is possible because the electron stream which passes from the filament 3 to the plates 2 is substantially non-existent or non-effective upon the dimensions of the plate as described above. By narrowing the plate in this way, the sides of the glass envelope 1 in the cross section as illustrated in Fig. 2 can be curved inward sooner thus decreasing substantially the minor width of the tube, permitting the use of the comparatively flat tube cross section illustrated.

From Figs. 3 and 4 it will be seen that the sides of the anode bracket 13 and the filament clip 22 are tapered toward the bottom portions thereof. This is done so that these members do not come into contact with the lower side walls 33 of the glass envelope 1. In the form of tube as illustrated, it is necessary for the lower side walls 33 to taper down toward the press 32. By similarly tapering the sides of the anode bracket 13 and of the filament clip 22, a considerable amount of space is saved and the size of the tube correspondingly reduced.

By the above arrangement, I have been able to produce tubes as illustrated herein of very small size on a mass production basis. For example, a tube exactly as described above has been constructed with the outside overall dimensions of the tube being .285 inch thick, .385 inch wide, and 1⅛ inches long.

Of course it is to be understood that this invention is not limited to the particular details as described above as many equivalents will suggest themselves to those skilled in the art. For example, the invention can be applied to tubes of other types in which other numbers of grids might be used. Various other changes embodying the teachings of this invention will suggest themselves to those skilled in the art.

What is claimed is:

1. An electrical space discharge tube comprising an insulating spacer, a metal frame member having a portion engaging one side of said spacer and a portion projecting through said spacer, an electrode secured to said latter portion and engaging the other side of said spacer and at least one additional electrode spaced from said first named electrode by said spacer.

2. An electrical space discharge tube comprising an insulating spacer, a metal frame member having a portion engaging one side of said spacer and a portion projecting through said spacer, an electrode secured to said latter portion and engaging the other side of said spacer, a second insulating spacer, said electrode engaging one side of said second spacer, said latter portion of said frame member also projecting through said second insulating spacer, a stop member secured to said latter portion and engaging the other side of said second spacer, and at least one additional electrode spaced from said first named electrode by said spacers.

3. An electrical space discharge tube comprising an insulating spacer, a U-shaped metal frame member having its end portion engaging one side of said spacer and its leg portions projecting through said spacer, an electrode secured to said leg portions and engaging the other side of said spacer and at least one additional electrode spaced from said first named electrode by said spacer.

4. An electrical space discharge tube comprising an insulating spacer, a U-shaped metal frame member having its end portion engaging one side of said spacer and its leg portions projecting through said spacer, an electrode secured to said leg portions and engaging the other side of said spacer, a second insulating spacer, said electrode engaging one side of said second spacer, said leg portions of said frame member also projecting through said second insulating spacer, a stop member secured to one of said leg portions and engaging the other side of said second spacer and at least one additional electrode spaced from said first named electrode by said spacers.

5. An electrical space discharge tube comprising an insulating spacer, a pair of metal frame members each having a portion engaging one side of said spacer and a portion projecting through said spacer, an electrode element secured to said latter portion and engaging the other side of said spacer, a second insulating spacer, said electrode element engaging one side of said second spacer, said latter portion of said frame member also projecting through said second insulating spacer, an electrically conducting yoke member secured to and electrically interconnecting the latter portions of both of said frame members and engaging the other side of said second spacer and at least one additional electrode spaced from said first named electrode by said spacers.

6. An electrical space discharge tube comprising an insulating spacer, a pair of U-shaped

metal frame members each having its end portion engaging one side of said spacer and its leg portions projecting through said spacer, an electrode element secured to said leg portions and engaging the other side of said spacer, a second insulating spacer, said electrode element engaging one side of said second spacer, said leg portions of said frame member also projecting through said second insulating spacer, an electrically conducting yoke member secured to and electrically interconnecting both of said frame members and engaging the other side of said second spacer and at least one additional electrode spaced from said first named electrode by said spacers.

7. An electrical space discharge tube comprising an insulating spacer, a relatively extended electrode closely adjacent said spacer, a conducting fastening member secured to said insulating spacer and lying substantially in the plane of said electrode, said electrode being provided with an opening adjacent said fastening member whereby said fastening member projects into said opening and is insulated from said electrode.

8. An electrical space discharge tube comprising an electrode assembly having a planer spacer at one end thereof, an envelope enclosing said electrode assembly and having a non-circular cross-sectional area providing a plurality of corner regions of substantially increased curvature, the distances between diagonally opposite corner regions constituting the maximum straight line distances within said cross-sectional area, said spacer likewise having a plurality of corners projecting into and intimately contacting the inner wall of said envelope at said corner regions, whereby said spacer can be inserted into said envelope only in a predetermined orientation.

9. An electrical space discharge tube comprising an electrode assembly having a planer spacer at one end thereof, an envelope enclosing said electrode assembly and having a cross-sectional area with one cross-sectional dimension substantially shorter than another, producing four corner regions of substantially increased curvature, the distances between diagonally opposite corner regions constituting the maximum straight line distances within said cross-sectional area, said spacer having likewise four corners projecting into and intimately contacting the inner wall of said envelope at said corner regions, whereby said spacer can be inserted into said envelope only in a predetermined orientation.

NORMAN B. KRIM.