June 22, 1937. G. F. METCALF 2,084,858

METAL RADIO TUBE

Filed Sept. 15, 1934

Fig. 1.

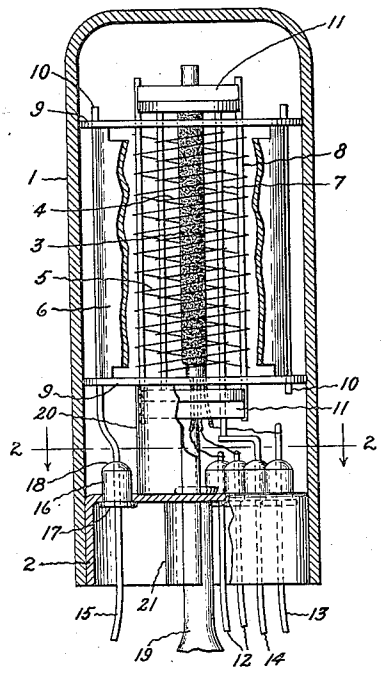


Fig. 3.

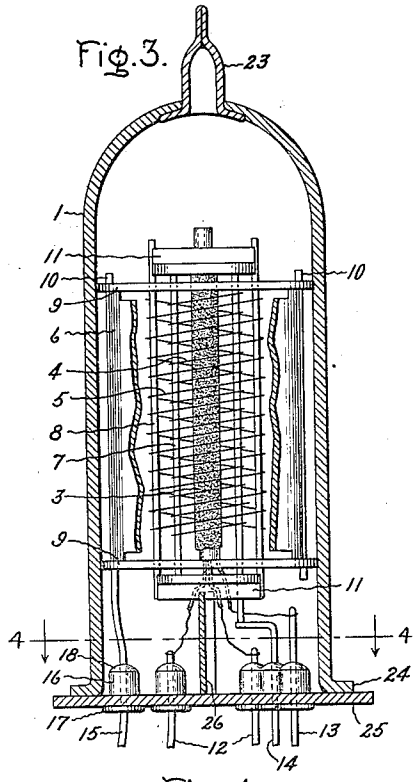


Fig. 2.

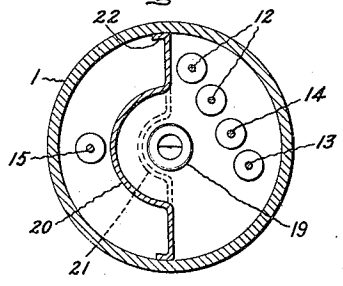
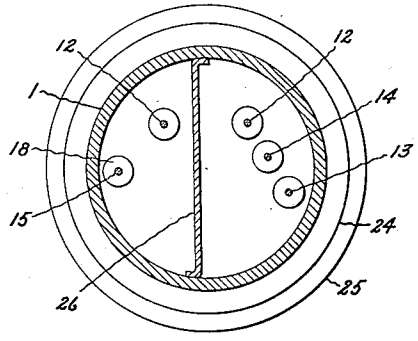


Fig. 4.



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UNITED STATES PATENT OFFICE

2,084,858

METAL RADIO TUBE

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Application September 15, 1934, Serial No. 744,158

5 Claims. (Cl. 250—27.5)

The present invention relates to electric discharge devices and more particularly to all-metal tubes.

In the design and manufacture of thermionic devices employing metal envelopes and particularly for convenience in mounting the devices in radio sets and making connections to the electrodes, it may be desirable, under certain circumstances, to bring out all of the leading-in conductors from one end of the device. Such a tube is commonly referred to as being "single-ended." However, under these conditions, there is considerable capacity residing, not only between the control grid and the anode of the tube but also between the leading-in conductors of these electrodes, on account of having the conductors adjacent one another for a considerable distance. Any one or all of these capacity effects may give rise to oscillations within the tube for well-known reasons, which prevents the tube from operating at its maximum translating efficiency.

An object of the present invention is to provide a single-ended tube of the all-metal envelope type in which the capacity effects between the control grid and the anode are eliminated or at least substantially reduced, and in addition, the capacity effects between the leading-in conductors are also reduced or preferably eliminated. In carrying out this object, I provide a tube in which a screening grid of ordinary and well-known design is interposed between the control grid and anode and in addition, a metal member is interposed between the leading-in conductors, which member is connected either to the screening grid or to the metal envelope, or to both. The invention will be better understood when reference is made to the following specification and the accompanying drawing in which Fig. 1 shows in partly cross-section, a tube improved in accordance with the present invention; Fig. 2 is a cross-sectional view taken along line 2—2 in Fig. 1, looking in the direction of the arrows; Fig. 3 is a view partly in section of a modified tube employing the improved features of the invention, while Fig. 4 is a cross-sectional view taken along line 4—4 of Fig. 3, looking in the direction of the arrows.

Referring to Fig. 1, numeral 1 designates a cylindrical envelope which is constituted of an inexpensive metal, such as iron or nickel, and closed at the top (as shown) by a flat portion integral with the cylindrical member. The envelope is conveniently formed out of sheet metal by a deep-drawing process. The other or lower end of the envelope is closed by a reentrant header member 2 which has an external diameter of such size as to fit snugly within the cylindrical portion 1 and to which it is secured in any suitable manner, for example by welding.

The electrode structure within the envelope consists of an indirectly heated cathode 3 of any suitable and well-known design, for example a nickel cylinder coated with barium carbonate and containing a tungsten heater, a control grid 4, a screening grid 5 and an anode 6. The control and screening grids are preferably formed as helices wound upon suitably positioned uprights 7 and 8 respectively, and the anode may be constituted of sheet metal in cylindrical form. Both grids and the anode are concentrically mounted about the cathode in any suitable manner. For example, and as shown in Fig. 1, the upper and lower ends of the grid uprights, also of the anode, may pass through openings in a pair of mica disks 9 which fit snugly within the envelope. For convenience in securing the anode to the mica disk, there may be provided several stapling projections 10. In addition, the upper and lower ends of the screening grid uprights 8 are secured to a pair of circular metal plates 11 which are provided with a longitudinal slot (not shown) for clearing the upper and lower ends of the control grid uprights 7, also both ends of the cathode 3 and the various conductors leading to the cathode and to the enclosed heater. Leading-in conductors 12, 13, 14 and 15 are provided for the heater, cathode, control grid, and anode respectively. No conductor is required for the screening grid because, as will be explained presently, the envelope itself is connected to the screening grid.

For bringing out the leading-in conductors through the envelope, improved seals are employed as disclosed and specifically claimed in the Beggs application Serial No. 744,165, filed September 15, 1934, entitled "Glass- to metal-seals" and assigned to the same assignee as the present invention. The seal employs a metal eyelet 16 provided at the lower end with a flange 17 for securing, as by welding, to the under side of the header member 2. Between each leading-in conductor and the eyelet, there is a mass of glass 18 which is hermetically sealed to the metal parts by heating the eyelet at the proper position, and causing the glass to settle within the eyelet and to leave at the top, a mound of glass which serves to increase the leakage distance between the leading-in conductor and the metal eyelet. As stated in the Beggs application referred to, the glass and metal preferably should have substantially the

same thermal expansion characteristic over the entire temperature range from 0° C. to the softening temperature of the glass. An alloy which serves this purpose satisfactorily may consist of 18% cobalt (Co), 28% nickel (Ni) and 54% iron (Fe), which may be sealed in a stress- and strain-free manner to a glass which consists of 65% silica (SiO_2), 23% boric oxide (B_2O_3), 7% sodium oxide (Na_2O), and 5% aluminum oxide (Al_2O_3). The lower header member is provided with openings to accommodate the eyelets and after the seals have been completed as a unit, apart from the envelope, the flanged portion of each eyelet is secured to the header as explained hereinbefore.

In addition to the seals, the lower header member carries a metal seal-off which is constituted of a tubulation 19 formed of any easily workable metal, such as steel, and which is welded or otherwise hermetically secured to the header. It is apparent that the entire electrode structure, including connections between the electrodes and the leading-in conductors which pass through the seals, also the metal tubulation 19, are mounted on the header member before the latter is welded to the envelope. After the envelope has been closed in this manner, the interior is evacuated by connecting an exhaust pump to the tubulation 19 and when the proper degree of vacuum has been obtained and if desired, inert gas or a source of vapor introduced, the tubulation 19 is completely collapsed and welded to form a metal seal-off, as is disclosed and claimed in the Nolte application Serial No. 743,832, filed September 13, 1934, entitled "Metal vacuum tubes" and assigned to the same assignee as the present invention.

When a tube such as described is connected to appropriate and well-known circuits for amplification or detection purposes and particularly when the screening grid 5 is maintained either at cathode or other suitable potential, the screening grid will serve to intercept a considerable portion of the electrostatic lines of force which pass between the control grid and the anode and which normally would give rise to oscillations. However, there will still exist an appreciable electrostatic coupling between the leading-in conductors of the anode and control member which coupling is not materially affected by the screening grid and which may also cause deleterious operation of the tube.

In accordance with the present invention, the coupling between the leading-in conductors is eliminated or at least materially reduced by interposing between them a metal member 20 which may take the form of a transversely mounted plate, shown more clearly in Fig. 2, and which has a portion at the middle, bent into semicylindrical form so as to clear the metal tubulation 19 and to fit tightly about the circular plate 11. The height or width of the metal member 20 may be such as to fit snugly between the upper surface of the header 2 and the lower surface of the mica disk 9. The screening grid 5, the metal plate 11, the metal member or baffle 20 and the header member 2 are all in physical contact and hence electrically connected together. It is to be understood that while in the electrode structure shown in Fig. 1, the screening grid is essentially at the same potential as the metal envelope, if desired, the screening grid may be so supported as to be electrically insulated from the envelope so that a different potential may be applied to the screening grid than is applied to the envelope. It is also apparent that, if desired, the plate or baffle member 20 may be insulated from the envelope and thus adapted to be charged to a different potential than the envelope.

An additional baffle member may also be employed on the exterior of the envelope within the well formed by the header member. This additional member may also take the form of a metal wall or baffle 21 which is bent so as to accommodate the metal tubulation 19. The metal baffles 20, 21 conveniently may be secured to the envelope, if desired, at their extremities by providing flanges indicated at 22 which may be welded directly to the envelope.

An inspection of Fig. 2 will show that the anode leading-in conductor 15 is on the opposite side of both baffle members from the control leading-in conductor 14 and hence, any electrostatic lines of force which originate at either of these conductors, are intercepted by the metal baffle and cannot reach the other leading-in conductor to cause oscillations. Inasmuch as both baffle members are essentially at the same potential as the screening grid 5 and as the envelope 1, the inter-conductor capacity is effectively eliminated or at least substantially reduced.

The tube shown in Fig. 3 involves a modified form of envelope which, however, may contain an electrode structure similar to that shown and described in connection with Fig. 1 and for that reason is designated by similar reference characters. However, in this case, the metal seal-off is taken through the upper portion of the envelope which for convenience terminates in a hemisphere and is provided with an opening to receive the tubulation 23. The other or lower end of the envelope may be provided with a circular flange 24 in order to be secured, for example by welding, to a bottom plate 25. The plate 25 carries the seals for the various leading-in conductors and also a flat metal plate or baffle 26 which is interposed between the anode leading-in conductor 15 and the control grid leading-in conductor 14. The plate 26 is of such a height or width as to fit snugly between the upper surface of the bottom plate 25 and the lower surface of the circular plate 11 and thus, assists in supporting the electrode structure within the envelope. If desired, a slot may be provided in the plate 11 to receive the upper edge of the baffle. As shown in Fig. 4, the plate 26 may terminate in oppositely directed flanges and is of such a length as to fit snugly within the cylindrical portion of the envelope to which it may be welded.

It is apparent that, as in the case of Figs. 1 and 2, the metal plate 26 is metallically connected not only to the bottom plate 25 but also to the circular plate 11 which in turn, receives the uprights 5 of the screening grid. Thus the plate, the screening grid and the envelope are electrically connected and together constitute a complete screening system for intercepting electrostatic lines of force which may originate either at the control grid or at the anode, or at their respective leading-in conductors, and which normally give rise to internal oscillations.

While I have shown one of the heater leading-in conductors 12 as being positioned on one side of the flat metal plate 26 and the other heater leading-in conductor positioned on the other side thereof, it is apparent that if desired, both of the heater leads may be positioned on the same side of the metal plate, either adjacent to the anode leading-in conductor or to the control grid leading-in conductor.

The tube shown in Figs. 3 and 4 offers the ad-

vantage over the tube shown in Figs. 1 and 2 in that the metal plate 26 may be given a rectilinear configuration, due to the fact that the metal seal-off 23 is not positioned at the same end where the metal plate is located.

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

1. An electric discharge device comprising a metal envelope containing a plurality of electrodes including a cathode, an anode and a control member, leading-in conductors for said electrodes, the leading-in conductors for the control member and the anode taken through the same end of the envelope, said envelope being constituted of metal and completely enclosing said electrodes whereby the electrostatic lines of force extending between the anode and control member are intercepted, and a metal barrier interposed between the control grid and anode leading-in conductors for intercepting the electrostatic lines of force which extend between said conductors.

2. An electric discharge device comprising a metal envelope containing a plurality of electrodes including a cathode, an anode and a control member, leading-in conductors for said electrodes, the leading-in conductors for the control member and the anode taken through the same end of the envelope, a metal barrier interposed between the control grid and anode leading-in conductors, said barrier being connected to said envelope.

3. An electric discharge device comprising a metal envelope containing a plurality of electrodes including a cathode, an anode, a control grid and an electrostatic screening member interposed between the anode and control grid, means for eliminating the effect of capacity between the leads by which current is supplied to the anode and control grid, said means including a metal member interposed between said leads and connected to said screening member and to said envelope.

4. An electric discharge device comprising a metal envelope closed at one end by a metal header, said envelope containing a plurality of electrodes including a cathode, a control member and an anode, leading-in conductors for said electrodes passing through said header, means for eliminating capacity effects between the leading-in conductors for the control member and anode, said means including a metal member interposed between said last-mentioned conductors within the envelope, and including a metal member interposed between said last-mentioned conductors external to the envelope, said metal members being secured to said header.

5. An electric discharge device comprising a metal envelope closed at one end by a metal header, said envelope containing a plurality of electrodes including a cathode, an anode and an electrostatic screening member interposed between the anode and control member, means for eliminating capacity effects between leads by which current is supplied to the anode and control member, said means including a metal member interposed between said leads within the envelope and including a metal member interposed between said leads external to the envelope, said metal members being secured to said header and electrically connected to said screening member.

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