March 11, 1930. O. T. McILVAINE 1,750,238

THERMIONIC TUBE

Filed July 2, 1925

Fig. 1

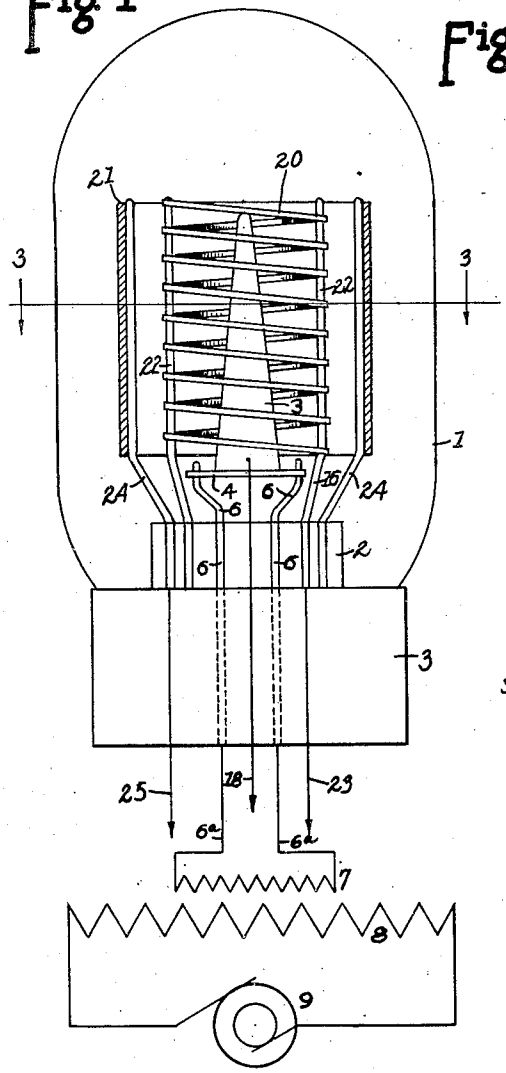
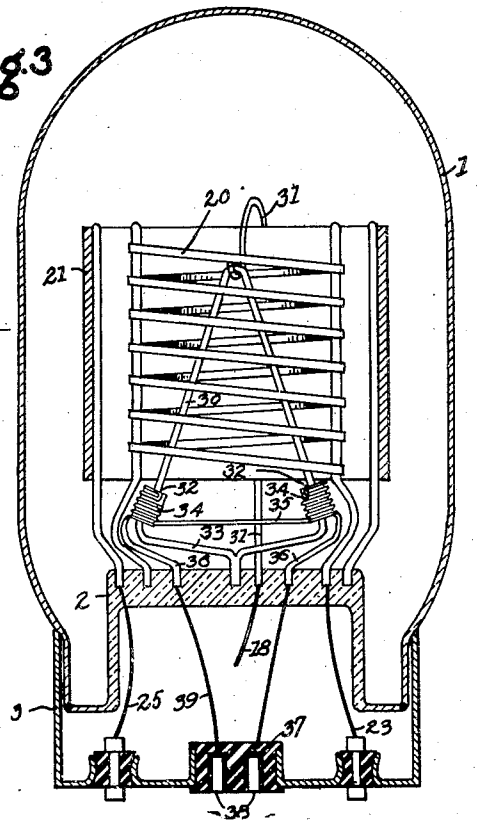


Fig. 3



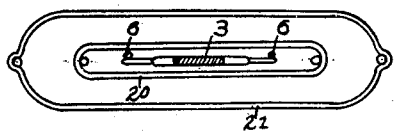


Fig. 2

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UNITED STATES PATENT OFFICE

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THERMIONIC TUBE

Application filed July 2, 1925. Serial No. 41,069.

This invention relates to thermionic tubes such as are employed in rectifiers and in the transmission, reception, detection, and amplification of sounds and signals as in wireless, radio, telephone, announcers and the like, and has for its object the provision of new and improved expedients for producing a uniform and reliable electronic emission by the use of alternating current, thereby dispensing with the battery often employed for this purpose Another object of the invention is the provision of a thermionic tube wherein the variable circuit is entirely distinct from the circuit which energizes the electron source; the provision of a new and improved relation and arrangement of the heat producing and electron emitting members; the provision of an alternating current tube which can be used in standard radio sets with a minimum of rearrangement; while further objects and advantages of the invention will become apparent as the description proceeds.

In the drawings accompanying and forming a part of this application I have shown certain simple forms in which my inventive idea can be embodied although it will be understood that these drawings are largely diagrammatic and that their purpose is only to set forth the general idea of the invention and not to exhaust the many possible modes of employing the same. Fig. 1 is a side elevation, partly in section, of a tube embodying my improvements; Fig. 2 is a cross sectional view corresponding to the lines 3—3 of Fig. 1; and Fig. 3 is a side elevation, partly in section, of a modified form of tube.

My invention applies equally to all kinds of electronic emission tubes, whether employed for rectifying purposes or for detecting or amplifying purposes and therefore concerns directly only the element which emits these electrons, regardless of the presence, nature, number, or arrangement of any other elements which the tube contains. However, for purposes of clearness in the following description, and because of the fact that the requirements of such use are most rigid, I have shown my improvements as employed in connection with a radio tube as employed for detecting and amplifying purposes. Such a tube comprises a globe 1 having at one end the flattened glass tube or "press" 2 through which the leading-in wires enter the vacuum chamber, and suitably provided with a base member 3 of any suitable or desired material, shape, or construction. Mounted inside the globe, axially thereof, is an electron-emitting element which in the form shown in Fig. 1 comprises an elongated, tapering, metal member 3 the larger end of which makes thermally conductive contact with an electric heating element 4, which here comprises a short transverse electric-resistance heating filament 5 connected to leading-in wires 6—6 which are carried by the press 2 and are connected to some suitable source of alternating current. In Fig. 1 I have shown these wires as connected by leads 6^a to the secondary 7 of a step-down transformer whose primary 8 is connected to the generator 9. The member 3 is preferably made as thin as is compatible with the necessary physical strength and stiffness, since its electronic emission is independent of its thickness while the power required to raise it to and maintain it at the emitting temperature is a function of its thickness. I have shown it as tapering from bottom to top at the angle necessary to afford a substantially uniform temperature throughout. Many different metals can be used although I have used nickel with good results, and the surface is preferably treated or impregnated with some substance such as an oxide of calcium, barium, thorium, etc., which shall facilitate the electronic emission.

I prefer to spotweld this member to the filament 4, the latter being of any suitable resistance wire. By making the leading-in wires 6, 6, of high electric conductivity they can be kept from overheating under the influence of the current, and by making them fairly long the loss of heat by conduction is minimized. The transformer and filament are necessarily balanced, one against the other, that condition being preferable wherein a low voltage (e. g. 1 volt) and high amperage is employed, since this enables the use of a short, thick filament and also reduces the

electrostatic effect so much as to render the alternations substantially innocuous. The effect of the latter are also diminished by having the filament located wholly outside the area bounded by the active elements of the tube, which here comprise a grid 20 and a plate 21, the former consisting of a thin metal ribbon or wire wound on suitable upright posts 22—22 carried by the press 2 and having a suitably connected wire 23 by which it is coupled to the A circuit; and the plate consists of a metal sheet surrounding the grid at a little distance and carried by bracket arms 24—24 also fused in the press, one of which is connected with a wire 25 which will be well understood by those skilled in the art. The member 3 is connected to the cathode wire 18, preferably at a little distance from the filament and midway of its width since this further decreases the electro-static effect of the alternating current.

In Fig. 3 I have shown another arrangement in which the electron emitting member consists of a thin bar 30 bent into V-shape or hairpin form and having its loop supported from a bracket 31 carried by the press 2, its two ends being joined to the metal blocks 32—32 which are carried by the two arms of a bracket 33 also fused in the press. Surrounding these blocks in heating relation are filament coils 34—34 connected together by the transverse lead 35 and having their terminals connected to leading-in wires 36—36 mounted in the press. I have here shown the lamp base 3 as provided at the center with an insulating block 37 having therein two metal sockets 38, one of which is connected to each of these leading-in wires by conductors 39—39. Surrounding the emitting member 30 are the grid 20 and plate 21 as before, or any other tube elements desired to be employed. In the present instance the plate 21 is connected to the anode wire 25, the bracket 31 is connected to the cathode wire 18, and the grid is provided with the terminal wire 23 in the usual manner.

The member 30 is preferably made of a metal which is a good conductor of heat and is preferably coated or treated with some substance which facilitates electronic emission, such as one of the alkali-earth or rare-earth-oxides. It is heated entirely by conduction from the blocks 32—32, these being heated from the filament coils 34—34. In some ways it is most desirable that this heating should be entirely by radiation, but owing to the difficulty of supporting the coils entirely without reference to these blocks, it is more customary to interpose longitudinal spacers, or even continuous sheets, of mica, quartz, or the like, which will withstand the high temperatures necessarily employed and conduct heat to the blocks without conducting a sensible quantity of electricity.

This arrangement permits the use of higher voltages than are conveniently employed in the device shown in Fig. 1, and the emitting member, since it is heated from both ends, may be made of more elongated shape, although I do not limit myself to such elongated shape as it obviously may comprise a triangular shape as shown in Fig. 1, in case the thickness of the different parts be properly chosen. In any event the connection of the cathode wire 18 to the center of the emitting member instead of to one end thereof serves further to decrease the injurious effect of alternating currents; while removing the alternating current a point outside of the limits of the grid and plate as shown in Figs. 1 and 3 still further reduces the effect of the alternations and produces a tube sufficiently sensitive and quiet for practically any known purpose.

A device of the character herein described can be made extremely rugged and long-lived. The device being devoid of fine wires or fragile parts exhibits no warping or sagging, or bending, of parts during use and is not subject to breaking or burning out. While it has been devised primarily for use with alternating currents it will be obvious that it can be used with equal facility in a direct current circuit of the proper voltage; and while I have necessarily illustrated certain definite, specific, mechanical instructions for the purpose of explaining my inventive idea, it will be understood that said idea can also be embodied in numerous other forms not herein shown wherefore I do not limit myself to any of the details of construction, arrangement and design herein set forth excepting as the same are specifically recited in my several claims which I desire may be construed each independent of limitations contained in other claims.

Having thus described my invention what I claim is:

1. In a thermionic tube, the combination with a plate and a grid of a substantially V-shaped electron-emitting member, an alternating current heating element thermally connected to the wide end of the V and a cathode connection to a remote point of the emitting member which is substantially equidistant from its two sides.

2. In a thermionic tube, in combination, a heating filament, and a flat, tapered, metal plate supported by said filament and in thermal conducting relation therewith.

3. In a thermionic tube, in combination, a plate element having two spaced parallel side walls, a grid element having two spaced parallel side walls located between said first side walls, a V shaped emitting member having its wider projecting part located outside the limits of said plate and grid elements and its tapering portion projecting between the sides of said grid element, and electric resistance heating means thermally connected in

conducting relation to the wider end of said V, said emitting member consisting of a thermally conductive metal.

4. In a thermionic tube, in combination, a plate element, a grid element located in facial opposition therewith, a V shaped emitting member having its wider projecting part located outside the limits of said plate and grid elements and its tapering portion located in facial opposition with said grid element, electric resistance heating means located outside the area of said elements and thermally connected in conduction relation to the wider end of said V, said emitting member consisting of a thermally conductive metal, and a cathode connecting to a part of said emitting element which is equally distant from the two under extremities of the V.

5. In a thermionic tube in combination, a glass globe, a plate element and a grid element located in facial opposition inside said globe, electric resistance heating means located at the side of said elements between said elements and the base of the globe, and an electric emitting element projecting into facial opposition with said plate and grid elements, said emitting member consisting of a thermally conductive metal and having a portion projecting beyond said elements and joined to said heating means in thermally conducting relation.

In testimony whereof I hereunto affix my signature.

ORAN T. McILVAINE.