Oct. 25, 1949. C. N. SMYTH 2,485,668

THERMIONIC CATHODE

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FIG. 1.

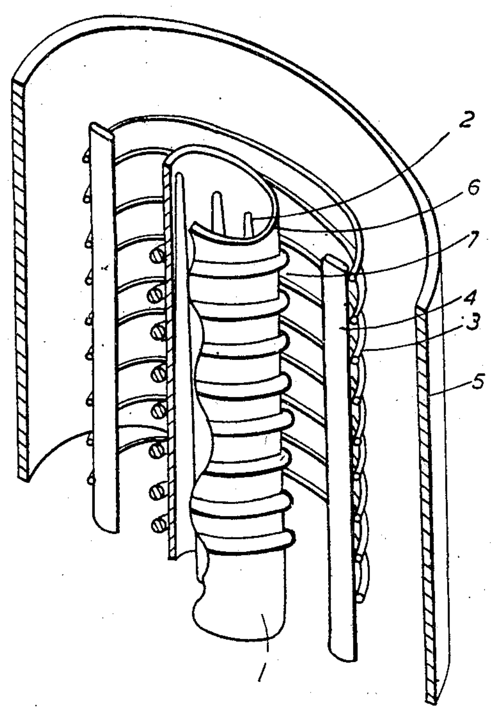
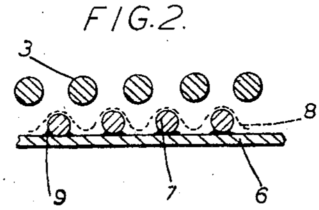


FIG. 2.



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THERMIONIC CATHODE

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5 Claims. (Cl. 250—27.5)

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The present invention relates to improved thermionic cathodes for electron discharge devices.

In thermionic valves, it is sometimes desirable to arrange so that electrons are drawn practically only from certain limited areas of the cathode; it may also be necessary to reduce to a minimum the capacity between the cathode and an adjacent electrode in order to reduce as far as possible the high frequency losses caused by the capacity current.

Thus in a triode oscillator, the grid current should be kept to a low value; and in a moderately high frequency amplifier the losses due to the capacity current may become serious. As the operation frequency is raised, additional losses become appreciable due to the power factor of the dielectric in the cathode coating and to what is called "total emission damping," which is due to the absorption of high frequency energy by electrons which leave the cathode, but which do not travel further than the space charge barrier. This latter effect is of second order magnitude, but becomes appreciable owing to the very large total emission obtainable from coated cathodes.

These effects can be reduced by restricting the emitting areas of the surface of the cathode so that the electrons are produced only where they can be efficiently employed. Attempts have previously been made to carry out this principle by "poisoning" the coated surface of the cathode over the areas where no emission is wanted, or by coating the cathode only over the areas where emission is required, such as by spraying through a stencil (or even through the adjacent grid electrode), or by coating the cathode all over and scraping the coating off the areas where it is not wanted.

None of these methods have been found to be satisfactory because they are difficult to apply and are not very effective, and further, in the case of amplifier tubes, noise is produced owing to the presence of temperature limited areas at the fringes of the active parts.

The difficulty has been overcome according to the present invention by providing an electron discharge device comprising a plurality of electrodes including a thermionic cathode having an electron emissive coating covering substantially the whole of its external surface, the said surface being shaped in such manner that when the normal operating potentials are applied to the several electrodes of the device (except that the cathode heating potential is not applied) an electric field is produced in the device having a relatively high intensity immediately adjacent to specified areas of the cathode from which a strong electron emission is desired when the cathode is

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heated, and a relatively low intensity in the neighbourhood of the remaining areas.

When the device is normally operated, the cathode is of course heated, and the electrons emitted therefrom will produce a space-charge barrier which considerably modifies the strength of the field at the surface of the cathode, but nevertheless it is found that the emission and losses are related to the strength of the field produced when the cathodes are cold.

A thermionic cathode for an electron discharge device according to the invention comprises a surface having raised portions separated by depressions, the whole of the surface being covered over with an electron emitting coating, and the raised portions being disposed so that they correspond with the perforations in an adjoining electrode or with openings between adjacent portions of an adjoining electrode, or so that the depressions correspond with the spaces between two or more adjoining electrodes.

An embodiment of the invention is illustrated in the accompanying drawing, in which Fig. 1 shows a perspective view of the electrodes of a triode valve having an indirectly heated cathode according to the invention, the electrodes being partly broken away so that the construction can be seen. Fig. 2 shows part of a longitudinal section through the cathode and control grid of the valve shown in Fig. 1.

The electrodes of the valve comprise a corrugated indirectly heated cathode **1**, according to the invention, enclosing a heating filament **2**, a helical control grid comprising wires **3** wound on longitudinal supporting wires **4** in a conventional manner, and a cylindrical anode **5**. The cathode comprises a metal tube or cylinder **6** on which is helically wound a wire **7** having the same pitch as the grid. The wire **7** is rigidly attached to the cylinder **6**, such as by welding, or by brazing with a metal of high melting point such as copper. The corrugated cathode so formed is then sprayed or otherwise covered all over with an electron emissive coating indicated by the dotted outline **8** in Fig. 2.

The cylinder **6** and wires **7** are preferably of nickel and may be brazed together with copper at the points **9** in Fig. 2. This may be done by plating the cylinder and/or the wire with copper before winding on the wire, and then heating them in an atmosphere free from oxygen until the copper melts, thus securing them firmly together. The emissive coating can then be sprayed all over the surface filling up the corners between the wires and the cylinder so as to have a profile something like the dotted line **8**.

The cathode so formed is adjusted in the valve so that the wires 7 come opposite the spaces between the wires 3 as indicated in Fig. 2, when the cathode is heated to the operating temperature. The pitch of winding of the helix of the wire 7 should be adjusted so that when the cathode is hot, the pitch (which may change as a result of expansion on heating) is the same as that of the grid wires 3.

The corrugated surface of the cathode produced in this way has the advantage that the crests of the surface are in a relatively strong electric field, and the troughs, being further from the grid wires, are in a weaker field. The electrons are accordingly emitted mainly from the crests, and the greater accumulation of the active material in the troughs forms a reservoir of metallic ions which can feed the crests by diffusing along the surface of the cathode and thus prolong the life of the cathode. Another advantage of this form of cathode is that the existence of the troughs opposite the grid wires means that the capacity between the cathode and grid is reduced. The emissive surface of an ordinary equivalent plain cathode would need to be about level with the crests, so that it would effectively be much closer to the grid, and would have a higher capacity thereto.

Although the valve described for illustration has a helical grid, the cathode design can be modified to suit any type of grid, such as a mesh grid, or one of squirrel cage form, or a flat grid formed of parallel wires or a mesh. Whatever the form of the adjoining electrode, the cathode surface should have a number of raised portions corresponding to and arranged opposite to the spaces or perforations in the electrode through which the electrons are to pass, the raised portions being separated by depressions which are placed opposite the corresponding wires or metallic portions of the electrode. The raised portions may be provided by attaching a wire or wires suitably to the surface of the cathode in the manner exemplified in Fig. 1, but there are other ways in which the cathode could be constructed. For example, it could be formed by just corrugating a thin plain tube. Alternatively, the base of the cathode could be moulded ceramic material having the desired external form, with a metallic film deposited on the surface. This form is particularly suitable when the adjacent electrode is a mesh grid. The base of the cathode might be a metal tube on which a suitable groove or grooves are cut or rolled. The cathode base formed in any of these ways is finally covered with electron emissive material.

A cathode of the kind described may be provided in any type of multi-electrode device having two or more grid electrodes. It may be provided with suitable means whereby its position with respect to the neighbouring electrode may be adjusted after assembly, in order to ensure accurate registration of the corrugations with the spaces of the electrode.

A cathode of this kind is also applicable to multiple diodes not containing any grid electrodes. In this case there will be two or more plate electrodes arranged opposite the cathode, and the requirement is that the electrons shall be emitted in large quantities opposite each plate but in small quantities opposite the spaces between the plates. The cathode according to the invention will accordingly have raised portions facing the plates separated by depression registering with the spaces between the plates.

In the following claims, the term "perforated

electrode" means any electrode having solid portions separated by spaces through which electrons can be passed, and includes a wire wound helical electrode.

What is claimed is:

1. An electron discharge device comprising an indirectly heated thermionic cathode of ribbed tubular form, a grid electrode mounted adjacent said cathode, and an electron emissive coating covering substantially the whole of the surface of said cathode adjacent said grid electrode, said ribbed portions of said coated cathode surface being spaced close to said grid, the remaining portions of said coated cathode surface being spaced at a relatively greater distance from said grid than the spacing of said ribbed portions whereby when normal operating potentials are applied to the device an electric field of relatively high intensity is produced immediately adjacent said specified portions from which a strong electron emission is desired and an electric field of relatively low intensity is produced immediately adjacent said remaining portions from which a weak electron emission is desired.

2. An electron discharge device comprising a grid electrode consisting of turns of wire and an indirectly heated cathode mounted inside said grid electrode, said indirectly heated cathode including a tube of given diameter having turns of wire secured to its external surface and a coating of electron emissive material covering the said tube and turns of wire, the said turns of wire being of small diameter compared with said given diameter and being positioned opposite the spaces between corresponding wire turns of the grid electrode.

3. An electron discharge device comprising a wire wound grid electrode surrounding an indirectly heated thermionic cathode consisting of a metal tube of given diameter having separated turns of wire secured to its external surface and a coating of electron emissive material covering the said tube and turns of wire, the said turns of wire being of small diameter compared with said given diameter and being positioned opposite the spaces between corresponding wire turns of the grid electrode.

4. A device according to claim 2 in which the said cathode comprising a base of moulded ceramic material having a metallic film deposited on the surface thereof.

5. An electron discharge device according to claim 2, in which the said tube and the said turns of wire secured thereto are of nickel plated with copper whereby the said wire turns may be secured to the tube by brazing.

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