July 9, 1929. R. E. MYERS 1,719,988

ELECTRON DEVICE AND THE LIKE ADAPTED FOR ALTERNATING CURRENT

Filed Jan. 26, 1923

FIG. 1.

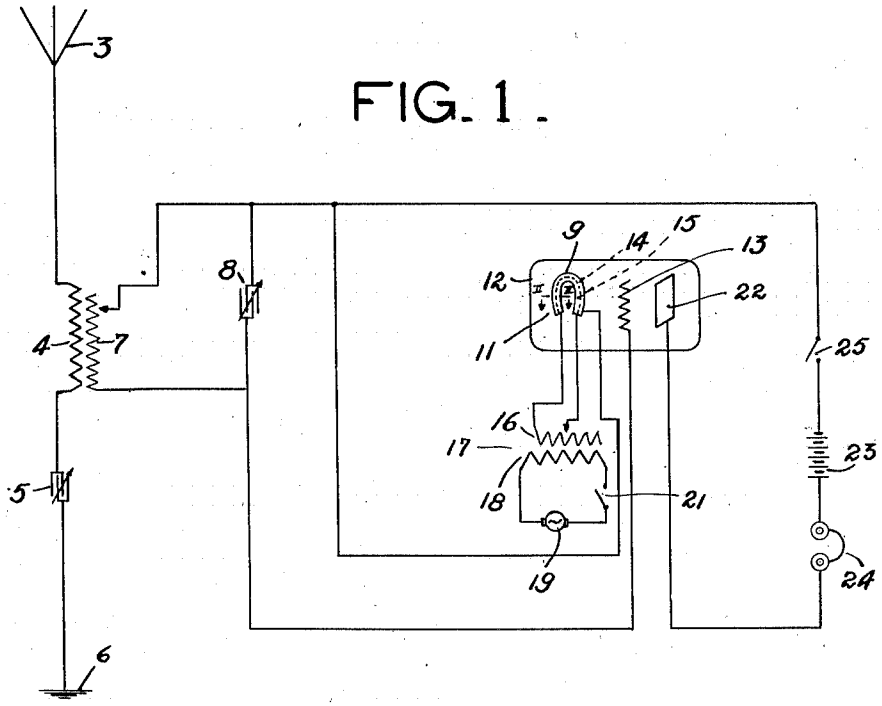
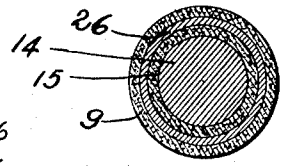


FIG. 2.



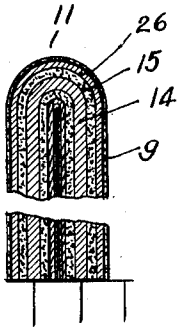


FIG. 3.

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UNITED STATES PATENT OFFICE.

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ELECTRON DEVICE AND THE LIKE ADAPTED FOR ALTERNATING CURRENT.

Application filed January 26, 1923. Serial No. 615,024.

This invention relates to electron tubes and more particularly to composite filamentary material for such devices adapted to be heated to electron-emitting temperatures by alternating current.

An object of my invention is the manufacture of electron devices and the like adapted to be operated from alternating current sources whereby storage batteries or the like, for such purpose, may be dispensed with.

Another object of my invention is the manufacture of electron-emitting filamentary material adapted to serve as hot cathodes for electron tubes and the like and be supplied with the necessary heat from a source of alternating current.

A further object of my invention is the manufacture of composite electron-emitting filamentary material, in which the heating circuit for the same, when serving as a hot cathode in an electron tube or the like, is adapted to be insulated from the active electron-emitting surface thereof, whereby such electron-emitting surface is not affected by the potential fluctuations of the heating circuit.

A still further object of my invention is the manufacture of electron tubes and the like containing composite hot-cathodes, in filamentary form, composed of a metal core adapted to be heated directly or through proper transformers, from a convenient source of electricity, for example, a commercial alternating-current lighting circuit, said core being encased in an insulating sheath of magnesia, thoria or other refractory insulating material carrying a good electron-emitter or surrounded by a metal sheath of a suitable conducting material, such as nickel or the like, coated with good electron-emission material such as the oxides of barium, strontium and the like.

Other objects and advantages of the invention will be clearly disclosed by the following detailed description.

In radio receiving sets and the like, it has been customary to heat the electron-emitting cathode of the radio tube or tubes by means of a storage battery or other source of direct current. The use of alternating current for heating such electron-emitting cathode has not been found feasible in the past because the rapid fluctuations in potential and current has been found to cause a hum in the telephones. The use of direct current for heating the electron-emitting filament is not very convenient because it requires power at a voltage which is not generally available except from storage or dry batteries. Even if a commercial lighting circuit is available to furnish direct current, it is at a voltage which is not suitable for heating the electron-emitting filament and, as is well known, direct current is not adapted to be readily transformed to other voltages.

Alternating current, on the other hand, may be readily stepped down, by means of a suitable transformer, to such potential as is adapted for heating the electron emitter or hot cathode of a radiotron or the like.

According to my invention, I have devised a composite electron-emitting filament in which the core thereof serves to heat the same to electron-emitting temperatures and said core is insulated from the outer electron-emitting surface, thereby adapting the core to be heated from a convenient source of alternating current without affecting the potential of the electron-emitting surface, because it is insulated therefrom. The core is preferably formed of a metal, such as tungsten, or an alloy, such as nickel chromium alloy, and is surrounded by refractory insulating material, such as thoria, magnesia or the like. Outside of the insulating sheath may be directly attached an active electron-emission material, if such material is conductive, such as metallic thorium. If it is desired to use substantially non-conductive electron-emission material such as the oxides of barium and strontium, it is preferable to apply a conductive sheath of platinum, nickel or the like, for example, upon which such electron-emitting oxides are deposited. In this instance, it is necessary that the conductive carrier be inert with respect to the electron-emitting material applied thereto, i. e., if a metal is used to carry, for example, a mixture of the oxides of barium and strontium, it is essential that substantially no reaction shall take place between said metal and said oxides when the filament containing the same is heated.

My invention will better be understood by referring to the accompanying drawing, in which,

Fig. 1 illustrates, diagrammatically, a radio receiving set embodying my invention;

Fig. 2 is an enlarged cross-sectional view

of my composite electron-emitting material after drawing to the desired size, taken, for example, on the line II—II of Fig. 1; and,

Fig. 3 is an enlarged longitudinal cross-section of the electron-emitting cathode.

The antenna or aerial 3 (Fig. 1) may be connected through inductance 4 and variable condenser 5, to the ground 6. A variable inductance 7 is coupled with inductance 4 and connected to variable condenser 8, as shown. One side of the condenser 8 is connected to the electron-emitting coating 9 of the hot cathode 11 in evacuated electron-tube or radiotron 12, and the other side of said condenser is connected to grid 13. The inner core 14 of hot cathode 11 is insulated from the electron-emitting coating 9 by refractory insulating material 15. Inner core 14, provided with suitable leads through the bulb or tube, as shown, may be energized so that the hot cathode is raised to an electron-emitting temperature, by being connected to the secondary 16 of adjustable step-down transformer 17.

Primary 18 of said transformer 17 may be connected to any suitable source of alternating current, such, for example, as a single phase alternating-current generator 19 or to a commercial alternating-current lighting-circuit through a switch 21. The plate 22 of radiotron 12 is connected to the electron-emitting surface of cathode 11, through telephone receivers 24, battery 23 and switch 25.

The parts of the radio receiving circuit just described are of a simple form to illustrate the application of my invention and it will be obvious that my invention may be used with a transmitting circuit or with any radio circuit involving the use of electron tubes.

The radio energy received by the antenna 3 is transmitted by inductance to the grid and varies the potential difference between the electron-emitting filament or cathode 11 and grid 13, thereby regulating the electron discharge between the hot cathode 11 and the plate 22 so that the proper signals are received in the phones 24. The step-down transformer 17 may be adjusted to heat the core 14 of the hot cathode 11 to the desired temperature so that the requisite electron flow occurs between said cathode 11 and the plate 22.

The construction of the hot cathode 11 is clearly shown in Figs. 2 and 3 which illustrate cross and longitudinal sections thereof. Said cathode is preferably in filamentary form and may comprise a core of a metal of the tungsten class or, if electron-emitting oxides are employed, some other comparatively refractory metallic material, such as nickel chromium alloy, may be used. Such a core is encased in suitable refractory insulating material 15, such as magnesia, alumina, thoria or the like. Upon this insulating material 15 may be coated or deposited an electron-emission material 9, if such material is conductive, i. e., if it is composed of thorium for example. However, if it is desired to use non-conductive electron-emission material, such as a mixture of the oxides of barium and strontium, for example, it will be necessary to apply a sheath of conductive material 26 outside of the insulating coating 15. The conductive material 26 may be any metal that is fairly refractory, such as platinum or nickel, which does not react with the superficial electron-emission material to be coated thereon.

Another embodiment of my invention may comprise a coating of thorium on an outer conductive coating of graphite, molybdenum, tungsten or the like. Thorium may be deposited in any desired manner, for example, as described and claimed in the application of Marden, Conley and Thomas, Serial No. 578,813, filed July 31, 1922, now Patent No. 1,487,174 of March 18, 1924, electrolytic deposition of thorium, and assigned to the Westinghouse Lamp Company.

A composite electron-emitting filament heretofore described may be manufactured in any desired manner or according to the following method. A rod of molybdenum, tungsten, nickel chromium alloy, nickel or the like of any convenient size may be inserted in a tube of molybdenum, tungsten, nickel or the like and the space therebetween filled with a refractory insulating material such as magnesia, alumina, thoria or the like, care being taken to have the core rod such as 14 spaced concentric with a tube 26, as shown in Fig. 2, the relative proportions of the parts being about as there indicated, although the exact proportions are not essential, the main idea being to form a composite body which may be swaged and drawn to filamentary form of reasonably small cross-section without rupturing either the core 14, the sheath 26, or impairing the insulation 15 therebetween.

When the operation of swaging and drawing the composite rod to the desired size of wire has been performed, the same may be coated with suitable electron-emission material, as, for example, passing said wire or filament, if provided with a nickel, platinum or platinum-iridium surface, through a suspension of the oxides of barium and strontium and baking the same thereon. If thorium is used as the electron-emission material, molybdenum, tungsten, or other similar refractory material should be used for the core and sheath. However, if electron-emitting oxides, such as those mentioned, are employed, nickel chromium alloy, nickel, platinum or platinum-iridium are suitable for the core, and nickel, nickel-plated iron, platinum or platinum-iridium are suitable for the tube or sheath. Such a filament may then be

sealed into an electron tube 12, such as shown in Fig. 1, and leads be provided for directly heating the core 14. It is only necessary to provide one additional lead through the tube 12, besides those usually provided, for connection with the electron-emitting coating 9 of the filament 11.

As shown in Fig. 3, the electron-emitting cathode 11 is preferably formed by doubling a section of composite filament, such as heretofore described, so that the portions of the doubled or looped cathode lie close together, side-by-side. By this construction, the electrostatic and electromagnetic effects of the alternating current in the cathode loop, are minimized.

Although only one loop or doubled section is illustrated as composing the cathode 11, I contemplate making the cathode as one or any desired number of loops, so that the resistance thereof corresponds to the impressed voltage. If enough loops are employed, it is obvious that the resistance of the cathode can be increased to such an extent that it will be unnecessary to use a step-down transformer, but merely a regulating resistance, to control the source of power, which may be a 110 volt lighting circuit. Even when using a transformer, it may be found convenient to employ a regulating resistance or rheostat, (not shown) to accurately control the cathode temperature, as is usual.

Some of the desirable embodiments of my invention, with respect to the formation of the cathode, as illustrated in Figs. 2 and 3, are as follows.

If the electron-emitter 9 is alkaline-earth material for example, a mixture of the oxides of barium and strontium, the core 14 may consist of a metallic material such as nickel chromium alloy, nickel, platinum or platinum-iridium. The insulation 15 may consist of thoria, magnesia or alumina. The sheath 26 should be formed of nickel, platinum or some other conductive material not reacting with the electron-emitting oxide or oxides used. Molybdenum and tungsten have been found to be unsuitable for the purpose.

On the other hand, if thorium is used as the electron-emitter, the core should consist of molybdenum, tungsten, or some other refractory metal. The insulation 15 may consist of magnesia, thoria or alumina as in the previous instance. The materials preferred for the sheath 26 when thorium is used are molybdenum, tungsten, tantalum or the like, which may carry the thorium alloyed therewith or applied thereupon in any suitable manner, for example, by electroplating according to the application of Marden, Conley and Thomas before mentioned.

Although I have described what I now consider to be the preferred embodiments of my invention, it is to be understood that modifications may occur to those skilled in the art within the spirit and scope of the appended claims.

What is claimed is:

1. An electron-emitting cathode adapted for a radio tube or the like comprising a core of a metal of high resistivity, a conductive tube therearound the outer surface of which is treated for electron-emission purposes and a filling of deformable refractory insulating material therebetween.

2. Filamentary material adapted for hot electron-emitting cathodes comprising a core of molybdenum surrounded by magnesia insulation upon which is applied a platinum sheath coated with the oxides of barium and strontium.

3. A cathode capable of being heated by alternating current for electron-emitting purposes comprising an inner refractory metal wire, a metal sheath therearound insulated from the inner wire by refractory oxide and coated with electron-emitting oxides, the component parts of said cathode being disposed in non-inductive relation.

4. An electron tube having an electron emitting cathode capable of being heated by alternating current sealed therein and comprising an inner heating element in an outer metallic sheath, coated with alkaline earth oxides, separated from the heating element by refractory insulating material, said core having its opposite end portions disposed in closely spaced relation whereby to neutralize the inductive effect of the alternating heating current.

5. An electron tube having a hot cathode sealed therein in the form of a loop having the leg portions thereof disposed close to each other, said cathode consisting of a molybdenum core surrounded by a platinum sheath with magnesia insulation therebetween, said platinum sheath being coated with a mixture of the oxides of barium and strontium.

6. The method of manufacturing composite material for electron-emission purposes comprising inserting a conductive core into a conductive sheath, filling the space therebetween with insulating material, drawing the same to filamentary size and coating said sheath with electron-emission material.

In testimony whereof, I have hereunto subscribed my name this 25th day of January, 1923.

RALPH EMERSON MYERS.