Aug. 30, 1932. G. HOLST 1,875,002

DISCHARGE TUBE WITH GLOW CATHODE

Filed March 17, 1924

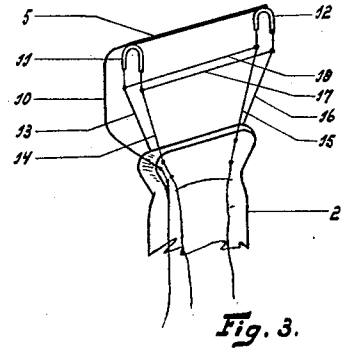


Fig. 3.

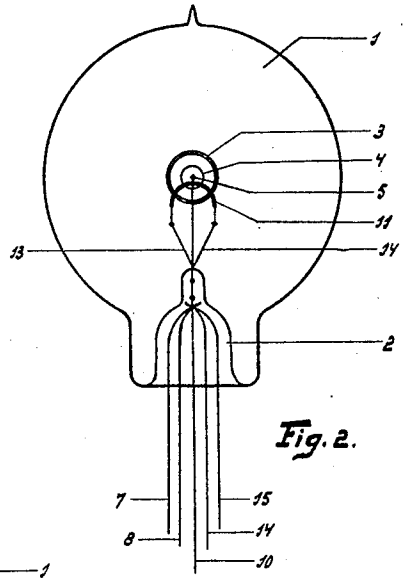


Fig. 2.

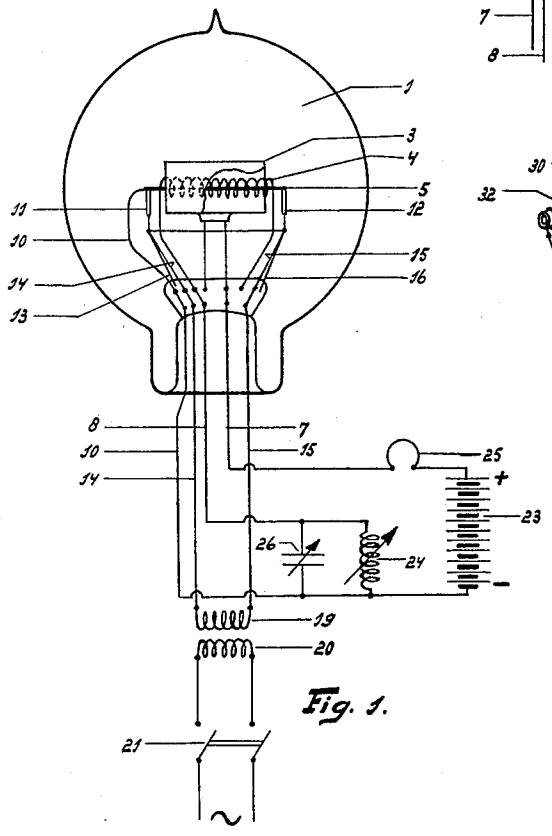


Fig. 1.

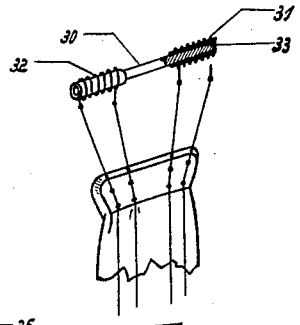


Fig. 4.

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Patented Aug. 30, 1932

1,875,002

UNITED STATES PATENT OFFICE

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DISCHARGE TUBE WITH GLOW CATHODE

Application filed March 17, 1924, Serial No. 699,906, and in the Netherlands March 29, 1923.

This invention relates to improvements in incandescent cathode-discharge tubes, and more particularly to the arrangement and the construction of the incandescent cathode as well as in the way of heating the same.

The invention has special advantages when applied to electric discharge tubes having three electrodes and used as receiving tubes for detectors in wireless telegraphy, wireless telephony and similar purposes.

In this kind of discharge tubes particularly when used by amateurs the disadvantage has made itself felt, in that a battery of direct current is necessary for heating the cathode and the repeated recharging of said battery is troublesome and expensive. Heating the filament with alternating current has the disadvantage that in consequence of the changes of temperature of the incandescent cathode and the changes in intensity of the magnetic field produced around the latter additional sounds are observed in the telephone.

The invention has for its purpose to enable the use of alternating current whilst avoiding the aforesaid detrimental effects.

It is known to heat the incandescent cathode of electric discharge tubes by conduction or radiation of heat with the aid of heating units disposed within the tube. It has also been suggested to provide incandescent cathodes, the surface of which contains material which yields an emission of electrons that is sufficient for the operation of the tube at a materially lower temperature than that of an incandescent tungsten filament.

According to the invention the discharge tube comprises such a cathode and in addition one or more heating units which conduct an electric current and are to be heated by said current, said heating units being locally in direct contact with the cathode but for a considerable part clear of it, said cathode being heated essentially by the conduction of the heat developed in the heating units to the cathode across the place of contact.

This method has the advantage that the heating current does not flow through the cathode itself, and alternating current can be used for heating the heating units without the aforesaid disadvantages.

It is of course, obvious that it is not possible to heat the cathode by heat conduction to such a temperature as would be necessary for a sufficiently intensive emission of electrons of tungsten. It is moreover unnecessary if the surface of the cathode has applied thereto material which at a low temperature easily emits electrons. It is also obvious that the cathode may be constructed entirely of the said material. It is essential only that the surface of the cathode contains material having the aforesaid favorable property. Such materials which at a comparatively low temperature emit electrons to a marked extent and neither fuse at this temperature nor obtain an inadmissably high tension of vapour are known. As an example the oxides of the alkaline earth metals, for example barium oxide may be mentioned.

It must be remarked that the heating of the cathode which according to the invention principally takes place by heat conduction is partly effected in another way, that is to say, by radiation of heat.

According to the invention a particularly simple construction is obtained if the heating units also supports the cathode.

Furthermore it is advantageous to make the cathode principally of a metal that conducts heat well, and the heating units are preferably constructed of material such for example as chrome iron, nickel-chromium, or similar material having a high resistance.

The choice of a material having a high specific resistance is advantageous because the heating wires if they also support the cathode, must for this reason have a relatively large diameter.

When applying the invention to a discharge tube in which the electrodes are arranged concentrically, the cathode may at each end be carried by a heating wire.

Furthermore it is advisable to supply the heating units and the incandescent cathode with separate leading-in wires, so that the incandescent current circuits are quite independent of the cathode grid circuit and the cathode anode circuit.

For heating the heating units, a transformer may be used, the primary winding of which

is capable of being connected to a voltage of alternating current of the usual value for example to the lighting system of a town.

Obviously it is detrimental if the cathode leads current from one heating unit to the other. In order to prevent this, one may either heat the heating units in entirely separated circuits for example by using separate secondary coils or care may be taken that the cathode makes contact with those points of the heating units which have practically the same potential.

In the latter case the lead-in wires for the heating units may also be branched within the lamp, so that less leading-in wires need be sealed in and one secondary winding is sufficient. Moreover all the points of the cathode have the same potential, so that it is possible to maintain the advantages of the known equipotential cathode.

The accompanying drawing represents an embodiment of a discharge tube according to the invention.

The tube shown has an incandescent cathode, a grid and an anode, and is particularly adapted for use as a detector or receiving tube of small power such as are used for example by amateurs.

In addition a different construction of an incandescent cathode with heating units according to the invention is shown. In the said drawing:

Figure 1 is a front elevation of a discharge tube with three electrodes according to the invention together with its circuit arrangement.

Figure 2 is a side view of the tube shown in Figure 1.

Figure 3 represents in perspective the stem of the tube shown in Figure 1, said stem having fixed thereto the cathode. The other electrodes are omitted in this figure.

Figure 4 shows a different construction of an electron emitting cathode with heating units.

The tube shown on the drawing comprises an exhausted vessel 1 of glass for example having hermetically sealed thereto a glass stem 2, leading-in wires for the various parts of the discharge tube being hermetically sealed in the clamped portion of the stem.

Within the envelope 1 are enclosed an anode 3, a grid 4 and an electron emitting cathode 5. The anode 3 consists of a cylindrically bent plate, which may be of some suitable electrode material such for example as nickel, and is carried at the two ends by supporting wires 6 and 7, the latter of which also serves as a leading-in wire.

The grid 4 consists of a helically bent wire for example of nickel, molybdenum, tungsten, or other suitable material, and is carried at the two ends by supporting wires 8 and 9, the latter of which also serves as leading-in wire.

In the axis of the electrodes 3 and 4, which are arranged concentrically in relation to each other is found the cathode 5 which is preferably of material that conducts heat well, for example of copper and which is coated at its surface with material that easily emits electrons at a comparatively low temperature such for example as an alkaline earth metal oxide.

The cathode is carried at its end by two wire loops 11 and 12 (see also Figure 3), which serve as heating wires and preferably consist of material having a high resistance such for example as chrome-iron or nickel-chromium. The loop 11 is carried at its ends by supporting wires 13 and 14, the latter of which serves as a leading-in wire, whereas the loop 12 is carried by supporting wires 15 and 16, the wire 15 being used as a leading-in wire.

Within the tube the ends of the heating wires are in conductive connection by wires 17 and 18 so that for feeding the current to the said heating wires it is only necessary that two wires are sealed in the clamped portion of the stem.

The drawing shows that the cathode 5 makes contact with those points of the heating wires that practically have the same potential, so that no current flows through the cathode 5. In addition the cathode 5 is provided with a separate leading-in wire 10, which has the aforementioned advantages.

A high vacuum may be provided in known manner within the bulb 1 and for this purpose the glass wall and the surface of the electrodes may in known manner be deprived of the occluded gases. For obtaining a three electrode tube of the so-called soft type, a gaseous filling of low pressure may be resorted to.

By reference to Figure 1 the circuit arrangement of the discharge tube shown on the drawing will be briefly described.

For heating the heating wires 11 and 12 a transformer 20, 19 is provided, the primary winding 20 of which may be connected by means of a switch 21 to an alternating current circuit of the usual voltage, for example to the lighting system of a town. The transformer which need transmit only a very low power may be of simple construction.

In the anode circuit are interposed a battery 23 and a telephone 25, whereas in the grid circuit are provided a regulating condenser 26 and parallel thereto a regulating inductance 24, the latter of which may be used for intercepting variations of voltage.

In a construction shown in Figure 4, a cathode 30 is carried by heating coils 31 and 32, a thin layer of insulating material 33 being applied between the cathode and the wire coils.

What I claim is:—

1. In an electron discharge tube, a cathode unit including a thermally conductive cath-

ode member adapted to emit electrons when heated, a plurality of independent electric heaters each in thermally conductive relation to said member, a plurality of pairs of branch conductors, the branch conductors in each of said pairs being respectively connected at their adjacent ends to one of said heaters to supply current thereto, and two main conductors each connected respectively to the free end of one branch conductor in each of said pairs whereby currents alike in phase are delivered to said heaters simultaneously, and whereby said cathode member is established in relation to said heaters at equi-potential points in said heater and branch conductor circuits.

2. In an electron discharge tube, an elongated thermally and electrically conductive cathode adapted to emit electrons when heated, a grid and an anode, a plurality of electric heaters thermally and conductively connected to said cathode, and conductors to supply currents to said heaters, said cathode being electrically connected to equipotential points of said heaters.

3. In an electron discharge tube, an electrically and thermally conductive cathode of substantial heat capacity adapted to emit electrons when heated, a grid and an anode, a conductor including branches to supply heating current, an electric heater in each of said branches, said cathode being connected in thermally and electrically conductive relation to said heaters at equipotential points on said branches.

4. A cathode comprising an electron-emitting member and a plurality of heating units, each of the heating units being adapted to conduct an electric current and to be heated by said current, the electron-emitting member contacting with each of the heating units at only one point, the electron-emitting member being supported by the heating units at those points at which the electron-emitting member is in contact with the heating units.

5. A cathode comprising an electron-emitting member and a plurality of heating units, each of the heating units being adapted to conduct an electric current and to be heated by said current, the electron-emitting member contacting with each of the heating units at only one point, the electron-emitting member being supported by the heating units.

6. A cathode comprising an electron-emitting member and a plurality of heating units, each of the heating units being adapted to conduct an electric current and to be heated by said current, the electron-emitting member contacting with each of the heating units at only one point, the electron-emitting member contacting with those points of the heating units which have substantially the same potential.

7. In an electron discharge tube an elongated thermally conductive cathode adapted to emit electrons when heated, a grid, an anode, and a plurality of electric heaters in thermally conductive relation to said cathode, said heaters being spaced apart and surrounding opposite ends of said cathode.

8. An electron discharge tube comprising an anode, a grid, and an elongated thermally conductive cathode capable when heated of emitting electrons from its middle portion, and a pair of electric heaters positioned adjacent the end portions only of said cathode and spaced apart sufficiently to permit an unobstructed emission of electrons from the outer surface of the middle portion of said cathode, each of said heaters comprising a wire loop outside of and in thermally conductive relation to the cathode end adjacent said loop.

In testimony whereof I affix my signature, at the city of Eindhoven, this 25th February 1924.

DR. GILLES HOLST.