Jan. 16, 1945. R. J. BONDLEY 2,367,332

CATHODE

Filed June 26, 1942

Fig. 1.

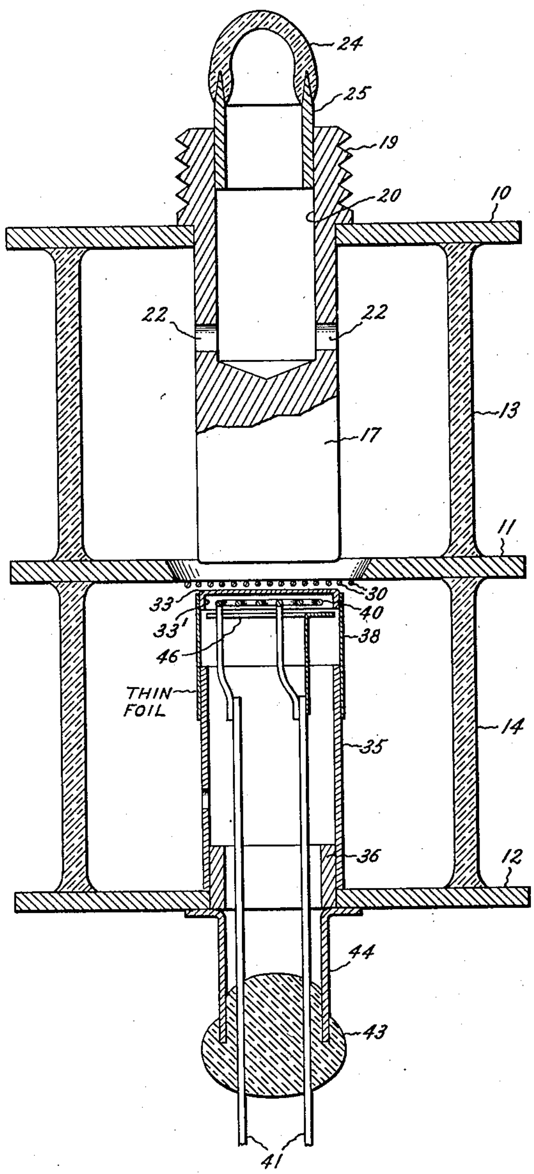


Fig. 2.

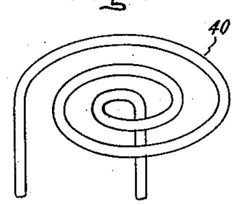
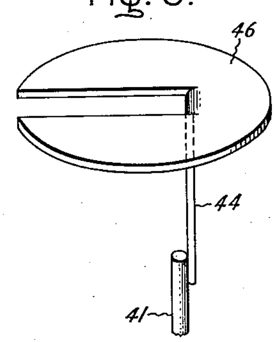


Fig. 3.



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2,367,332

CATHODE

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5 Claims. (Cl. 250—27.5)

The present invention relates to an improved form of cathode especially adapted for use in ultra high frequency discharge tubes.

Certain high frequency tubes of a type described in E. D. McArthur Patent No. 2,353,743, dated July 18, 1944, employ a cathode structure comprising an elongated hollow cylinder having an emissive part which forms an end wall for the cylinder. This construction has numerous advantages as used in a high frequency system, but presents certain difficulties in maintaining the emissive part at an emitting temperature, these difficulties being largely attributable to heat loss from the emissive part to the structure by which it is supported.

It is an object of the present invention to provide an improved cathode having the advantages of the structure referred to in the foregoing but characterized by a low rate of heat loss from the emissive component of the cathode. In the attainment of this object an important feature of the invention comprises the use of a piece of thin metal foil as a principal element of the structure by which the emissive cathode part is supported. As will appear more fully in the following, the low thermal conductivity of such an element tends to minimize conductive heat loss to the supporting parts while at the same time making it possible to provide a continuous imperforate structure with the advantages which accrue from such a structure when used in a high frequency system.

The features of the invention desired to be protected herein are pointed out with particularity in the appended claims. The invention itself, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the drawing in which Fig. 1 is a longitudinal sectional view of a discharge tube suitably embodying the invention and Figs. 2 and 3 are detail views of certain parts of the cathode structure shown in Fig. 1.

Referring particularly to Fig. 1, there is shown a high frequency discharge tube formed of a series of three similar metal disks **10**, **11** and **12** which are insulatingly separated by glass cylinders **13** and **14** sealed between them. The upper disk **10** supports a cylindrical anode structure which extends centrally through the disk and which terminates externally in a threaded portion **19** adapted for connection to a current supply terminal. The anode has a central bore **20** which connects with the main discharge space through openings **22** and through which evacuation of the discharge envelope can be carried out. After evacuation, the envelope is sealed by means of a body of glass **24** fused to the extremity of a metal tubulation **25** which is brazed into the anode bore **20**.

Below the anode and at a distance of a few mils from it there is provided a grid which comprises a series of conductive rods **30** placed at regularly spaced intervals across a circular opening formed centrally in the disk **11**, the outer periphery of the disk thus providing a terminal for the grid.

The cathode of the tube comprises an emissive part **33** which is in the form of a disk of refractory material, such as nickel or molybdenum, and which is provided peripherally with a depending flange **33'**. This disk may be coated on its upper surface with an emission enhancing material, such as alkaline earth oxide. A support or mount for the disk is provided by a metal cylinder **35** which is supported centrally with respect to the part **12**, being secured to it by being welded or brazed to a heavy metal sleeve **36** which is set into an opening formed in the part referred to. The connection between the supporting cylinder **35** and the disk **33** comprises a sleeve **38** which is constituted of thin metal foil, preferably a foil having a thickness between a fraction of a mil (e. g. 0.3 mil) and a few (3 or 4) mils. The function and utility of this sleeve will be explained in detail at a later point.

Within the hollow cathode structure formed by the combination of the cylinder **35** and the foil sleeve **38** there is provided a radiation heater comprising a multiply bent filament **40** (see Fig. 2). This is arranged in close proximity to the emissive part **33** and during the operation of the device serves to maintain the latter part at an elevated temperature. Heating current is supplied to the filament **40** through lead-in wires **41** which extend downwardly through the disk **12**, being insulatingly supported with respect to the disk by means of a body of glass **43** fused into a flanged eyelet **44**.

In order to assure efficient operation of the cathode as a whole it is desirable to prevent the heat generated by the filament **40** from being dissipated by radiation or conduction to the non-emissive parts of the cathode structure. Radiation in unwanted directions is minimized by the use of a shield **46** which comprises a metal plate or reflector supported by one of the lead-in conductors **41** at a location just below the plane of the filamentary heater **40**. Loss of heat by conduction, on the other hand, is reduced to a low value due to the high resistance presented by the foil sleeve **38** to heat flow along it. In other words, the very small cross-section of the heat transfer path provided through and along the foil makes it certain that heat losses by this means will be extremely small.

From the standpoint of using the tube in a high frequency system, the cathode structure has the advantage that the heater **40** and its associated leads are wholly enclosed by a conductive structure so that no coupling exists between these parts and the high frequency fields developed in the space near the outer electrode surfaces. Morover, the foil **38** provides a wholly symmetrical conductive path for the flow of high frequency currents to and from the emissive disk **33** to the cathode terminal provided by the disk **12**, this being a highly advantageous circumstance from the standpoint of assuring minimum inductance for the cathode circuit.

In applying the foil **38** to the cathode structure a sleeve of appropriate dimensions may first be formed by wrapping foil ribbon about a cylindrical mandrel of the correct diameter and then welding the overlapping edges. The cylindrical sleeve thus provided is next manipulated into the proper relationship with the emissive part **33** and the supporting cylinder **35** and is spot-welded at its extremities to these parts to form an assembly such as that illustrated.

The foil **38** may be formed of any reasonably heat-resistant material, such as nickel or molybdenum. In a particular case it has been found advantageous to use a foil which is constituted of nickel-iron-cobalt alloy (fernico) because of the extremely low heat conductivity of this metal. Due to its cylindrical form the foil part is characterized by a much higher degree of mechanical strength than its physical dimensions would indicate. Even when a very thin foil is employed, there is no particular tendency for the foil to sag or to permit displacement of the emissive part **33**.

While the invention has been described by reference to a particular embodiment of it, it will be understood that numerous modifications may be made by those skilled in the art without departing from the invention. I therefore aim in the appended claims to cover all such equivalent variations as come within the true spirit and scope of the foregoing disclosure.

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

1. A cathode comprising an emissive part, a support for said cathode and a piece of metal foil providing a connection between said emissive part and said support for minimizing heat transfer from said emissive part to said support.

2. A cathode including an emissive part desired to be maintained at an elevated temperature, a support for said cathode, and a metallic connection of low thermal conductivity between said part and said support, said connection comprising a piece of metal foil having a thickness between a fraction of a mil and a few mils.

3. A cathode including an emissive disk desired to be maintained at an elevated temperature and means for supplying current symmetrically to the disk while minimizing conductive heat loss from the disk, said means comprising metal foil attached to the periphery of the disk.

4. A cathode including an emissive part, a hollow mounting structure for said part, a heater within said structure for maintaining said part at a temperature of thermionic emission, and means for minimizing conductive heat loss from said part, said means comprising a sleeve of thin metal foil forming an element of said mounting structure.

5. A cathode including an emissive disk, a filamentary heater positioned in effective heat exchanging relation to said disk, a metal cylinder providing a support for said disk, and a sleeve of thin metal foil providing a connection between an extremity of said cylinder and the peripheral edge of said disk, said cylinder and sleeve in combination with said disk forming an enclosure for said heater and said sleeve serving to minimize conductive heat transfer between said disk and said cylinder.

RALPH J. BONDLEY