THERMIONIC CATHODE WITH HEAT SHIELD HAVING A HEATING CURRENT BY-PASS

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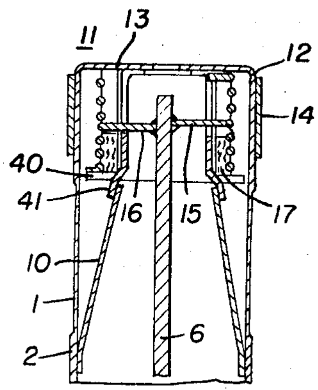

Fig. 4

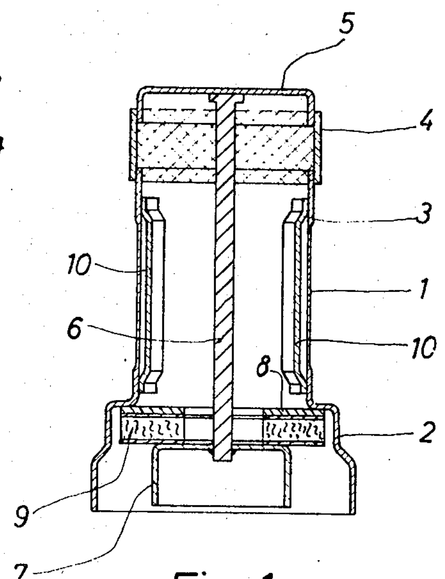

Fig. 1

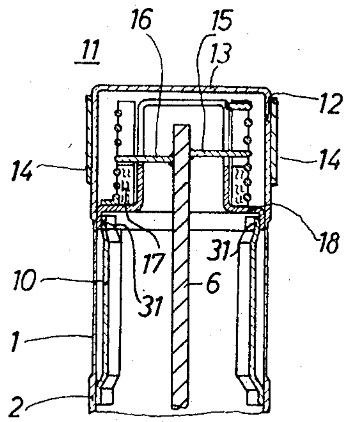

Fig. 2

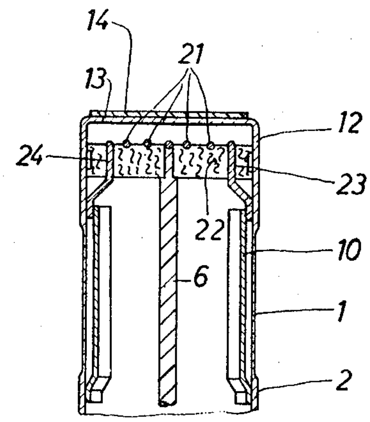

Fig. 3

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U.S. Cl. 313—270 7 Claims

ABSTRACT OF THE DISCLOSURE

A thermionic cathode for an electrical discharge tube is provided with a heat shield also serving as an electrical current connection to the cathode. The heat shield is bypassed by electrical conductors, e.g., wires or strips of conductive material which have a small cross-sectional area in a plane perpendicular to the heat flow in order to limit the thermal contact and minimize heat loss while their total cross-section is larger than the area of the shield being by-passed.

The invention relates to an incandescent cathode for use in an electric discharge tube having a plate-shaped thin-walled part having a great resistance for heat conduction, which at the same time serves as a current-supply conductor for the emissive part of the cathode and for the filament wire.

It is known to provide incandescent cathodes in electric discharge tubes, for example, electron or ion tubes, with a heat resistance part or heat barrier, that is to say, with an element of increased resistance to heat conduction which prevents the heat energy required for the cathode emission from being conducted away through supporting members and/or supply conductors for the filament current. Such a heat barrier is generally obtained by reducing the cross-sections of the supply conductors of the cathode and/or filament wire, viewed in the direction of flow of the heat, along a given length.

Such a heat resistance has for its object to reduce the power required for heating the cathode at the operating temperature, to render the temperature of the emissive surface as uniform as possible and to prevent the occurrence of excessively high temperatures at the areas at which the supply conductors are passed through the wall of the tube due to excessive heat conduction.

In tubes having coaxially arranged tubular electrodes which are used especially with medium and higher powers in the higher frequency ranges, for example, of up to 1 gc./s. and higher, use is frequently made of heat resistances consisting of thin-walled sheet material, generally having a cylindrical shape, and joining the electron-emissive part of the cathode. This part of the cathode may consist, for example, of a meshed grid (mesh cathode) or may be applied in the form of a layer to an intermediate support (matrix) on a tubular body which is integral with the heat barrier. The heat barrier may be constituted by part of the cathode support the diameter of which is reduced by turning. The heat barrier forms at least part of the cathode support and serves at the same time as one of the supply conductors for the filament current, the cathode direct current and the cathode high-frequency current. Thus, a separate insulated through-connection through the vacuum envelope is eliminated. The return conductor for the heating current and, in the case of indirectly heated cathodes also the filament wire, are disposed inside the tubular outer part. A similar cylindrical heat barrier is also used in cathodes having a flat emissive part in which the heat barrier is closed by the cathode surface at the end lying inside the tube.

In order to obtain a simple construction capable of withstanding shocks, in indirectly heated tubes, one end of the filament wire of the heater body already mounted may be connected with the metal supports of the heater body which are in turn joined, for example, by welding, to the outer metal part during the continued building-up of the system.

Such heat barriers consisting of sheet material have the disadvantage that not only the temperature but also the voltage decreases so that in the case of alternating-current heating the heating current flowing through the heat barrier produces an alternating voltage between the emissive part of the cathode and the reference point of the external circuit arrangement to which the connecting member of the cathode is secured. As a result, a hum voltage is produced in the output signal of the tube which originates from the cathode and which is amplified in the tube due to the grid cathode control.

If attempts should be made to achieve an improvement in this respect by enlarging the current-conducting cross-section of the heat barrier, the heat-conducting cross-section would also become larger and the effect of the heat resistance would decrease or would be completely eliminated so that this solution is not serviceable.

The object of the invention is to reduce in a cathode of the aforementioned kind the electrical resistance of the heat barrier without essentially varying the degree of heat dissipation. According to the invention, this is achieved in that at least one current bridge whose dimension at right angles to the plane of the direction of flow of the heat is small and whose overall cross-section is larger than that of the bridged section of the heat barrier, which current bridge bridges the heat barrier in the direction of flow of the heat in an electrically good conducting manner. The current bridge or current bridges convey the major part of the filament current in accordance with their cross-section, while on the other hand they derive only a small quantity of heat from the emissive cathode part due to the small transitional face, that is to say small as compared with the total range in which heat is developed. Consequently, with unchanged filament-current power the cathode temperature does not vary, but the voltage drop across the heat barrier is smaller so that the hum voltage in the output signal decreases.

Small ranges having a slightly lower temperature may occur at the areas at which the current bridges are secured to the hot side of the heat barrier. It is therefore advisable to provide the emissive cathode part at a sufficiently large distance from the securing area of the current bridge due to the heat exchange.

The heat barrier preferably consists of a cylindrical sheath which is bridged at a plurality of points regularly distributed along the periphery, for example, at three points, by a wire-, rod-, or strip-shaped current bridge. It is advantageous with a view to the current distribution if the end or ends of the filament wire conductively connected with the heat barrier are located at or in the proximity of the securing point or points of the current bridges. The cross-section of the current bridges is preferably at least ten times that of the bridge section of the heat barrier. This section is constituted by the strip-shaped section of the heat barrier, viewed in the direction of the flow of heat, which has the same dimension at right angles to the direction of the flow of heat as the current bridge.

The heat barrier and the current bridge may be made of the same material, for example, of cathode nickel, so that processing is simplified.

In a favorable embodiment, the current bridge is arranged in an electrically good conducting manner between the colder end of the heat barrier and the heated part of the cathode system. It is advantageous if the current bridge is connected to the point of the heated part of the lowest absolute temperature.

The invention will now be described more fully with reference to four embodiments shown in the accompanying drawing, in which:

FIG. 1 shows a directly heated cylindrical mesh-cathode,

FIG. 2 shows a cylindrical cathode indirectly heated by heat radiation and having an emissive layer,

FIG. 3 is a cross-sectional view of a flat cathode indirectly heated by heat radiation, and

FIG. 4 shows an alternative embodiment of the cathode shown in FIG. 2.

For the sake of clarity, the parts are not shown on the correct scale in the figures.

The mesh-cathode shown in FIG. 1 has a heat barrier **1** in the form of a thin cylindrical sheath which is integral with an annular cathode connection **2** having a wall which is considerably thicker than that of the heat barrier **1**. At its upper end, the heat barrier **1** terminates in an annular likewise thick-walled part **3** to which the emissive part of the cathode in the form of a meshed grid **4** of thorium-plated tungsten is secured in an electrically good conducting manner, for example, by welding or soldering. The meshed grid **4** is likewise joined at its upper end in an electrically good conducting manner to the edge of the metal hood **5**. The center of the hood **5** is joined to a rod-shaped supply conductor **6** for the heating current in an electrically good conducting manner. The lower end of the current supply conductor **6** is connected to a second hood-shaped cathode connection **7** in an electrically good conducting and vacuum-tight manner. The conductor **6** also supports the hood **5** and consequently the mesh-cathode **4** of the cathode system.

The outer cathode connecting ring **2** is connected through a metal intermediate ring **8** to one metal-plated end face of a ceramic ring **9** in a vacuum-tight manner by soldering, while the inner cathode connecting ring **7** is connected to the other metal-plated end face of this ring. After being mounted, the cathode system shown in FIG. 1 is connected by soldering to another metal-plated ceramic part in a high-vacuum-tight manner.

There are arranged inside the heat barrier **1** four current bridges **10** which are regularly distributed along the periphery, which interconnect the thick-walled parts **2** and **3** in an electrically good conducting manner and which bridge the thin-walled heat barrier **1** for the filament current. The current bridges **10** have a smaller dimension at right angles to the direction of flow of the heat, which direction of flow extends parallel to the longitudinal axis of the cathode. Consequently, they cover only a small securing surface on the thick-walled parts **2** and **3**. Their cross-section is larger, however, with respect to that of the individually bridged parts of the heat barrier, for example ten times larger.

In operation, the heating current flows from the cathode connection **7** through the rod **6** and the hood **5** in the meshed cathode **4** to be heated at the emission temperature and in the cathode in accordance with the invention, this current is conducted back to the outer cathode connection not exclusively through the heat barrier **1** but for the major part through the current bridges **10**.

In the system shown in FIG. 2, the heat barrier **1** terminates in a dish-shaped part **11** having a cylindrical wall **12** and a flat bottom **13**. Along the major part of its length the cylindrical wall **12** is coated with an emissive layer **14**. The wall **12** and hence the layer **14** are heated by radiation of the filament wire consisting of two wires **15** and **16** which are wound in known manner on a ceramic cylinder **17** with a winding sense such that the magnetic fields compensate each other to the optimum and do not induce hum in the tube. The inner ends of the filament wires **15** and **16** are connected in an electrically good conducting manner to the current-supply rod **6**, while the outer ends are connected to another cup-shaped metal support **18**. The lower collar-shaped part of the support **18** supporting the ceramic body **17** is secured to the cylindrical wall **12**, for example, by welding. The upper part of the ceramic body **17** and the support **18** are provided with a slot passing through the axis for passing the filament wires **15** and **16** to the outside.

Like in the system of FIG. 1, the heat barrier **1** is bridged by means of current bridges **10** the upper ends **31** of which are welded to the lower collar-shaped part of the support **18**.

In the system of FIG. 2, the lower edge of the emissive layer **14** is located at a small distance from the securing areas of the upper ends **31** of the current bridges **10**. This distance is sufficient to ensure that the emissive layer **14** is not located in the ranges of slightly lower temperature that may be formed around the securing areas. Local disturbances of the temperature of the layer and hence of the emission are thus avoided.

In the system shown in FIG. 3, the dish-shaped part **11** is lower than in the system shown in FIG. 2 and the emissive layer **14** is applied to the flat outer surface **13**. The filament wire **21** is provided on a ceramic plate **22** and is fed at its center through the current-supply conductor **6**. The ends **23** and **24** are separately connected in an electrically good conducting manner to the upper ends of one of the current bridges **10** and the filament current is conducted back through these bridges to the outer cathode connection **2**.

In the system shown in FIG. 4, the cup-shaped support **18** is secured to the base **13** of the part **11**, for example, by welding. A collar **40** of the support **18** supporting the ceramic body **17** has four tags **41** which are regularly distributed along the periphery and only two of which are shown in the figure for the sake of clarity. Current bridges **10** are secured in an electrically good conducting manner to the tags **41**, for example, by welding. The lower ends of the current bridges **10** are secured in an electrically good conducting manner to the upper part of the outer thick-walled cathode connection **2**, for example, by welding.

Between the source of heat, that is to say the filament wires **15** and **16** and the connecting tags **41** for the current bridges **10** there is disposed a ceramic thermally insulating body **17** so that a thermal resistance is obtained between the source of heat and the connecting tags **41**. Moreover, the dimension of the current bridges **10** at right angles to the direction of the flow of the heat is small, which direction of flow extends parallel to the longitudinal axis **6** of the cathode system. Consequently, they cover only a small surface of the securing area on the parts **2** and **41** so that they can conduct only a small quantity of heat from the support **18** to the cathode connection. However, the cross-section is large with respect to that of the individually bridged part of the heat barrier, that is to say large in the meaning of the aforementioned definition, for example, ten times larger, so that they convey an essential part of this filament current.

The temperature distribution on the cathode is not influenced by the separate heat paths.

In an embodiment of the cathode shown in FIG. 4, the diameter of the cathode is 16.5 mms., the wall thickness of the nickel parts **2**, **3** and **11** is 0.5 mm. and that of the heat barrier is 0.05 mm. At three points regularly distributed along the periphery the connection between the parts **11** and **2** was established by means of bridges in the form of three nickel strips having a cross-section of 0.5 mm. x 2 mms. and a free length of approximately 10 mms.

The voltage drop across the heat barrier **1** was reduced from 34 mv. to 20 mv. so that the hum level of the output signal, i.e. the ratio between the disturbing hum voltage and the useful signal voltage, measured under given conditions, was reduced by approximately 5 db. With unchanged filament-current energy, a variation of the cathode temperature could not be found.

What is claimed is:

1. A thermionic cathode comprising a support constituting one terminal of an electrical supply, an electron-emissive member, a heat barrier of thin-walled sheet material between said support and said electron-emissive member and constituting an electrical connection to said emissive member, and at least one electrically conductive member connected across a portion of said barrier for supplying an electrical current to said cathode, said member having a dimension at right angles to the plane of heat flow which is small relative to the heat barrier to provide limited thermal contact therewith and a total cross-section larger than the cross-section of the bridged portion of the barrier whereby said member bridging the barrier effectively limits the flow of heat therethrough while providing an electrical connection to the cathode.

2. A thermionic cathode as claimed in claim 1 in which the heat barrier is a cylindrical sheath which is bridged at points regularly distributed along the periphery by strip-shaped members serving as current bridges.

3. A thermionic cathode as claimed in claim 2, in which the cross-section of the current bridge is at least ten times that of the individually bridged section of the heat barrier.

4. A thermionic cathode as claimed in claim 1 in which the heat barrier and the current bridge consist of the same material.

5. A thermionic cathode as claimed in claim 1 in which an end of a filament is provided which is conductively connected with the heat barrier and is located in the proximity of the securing point of the current bridge.

6. A thermionic cathode as claimed in claim 1 in which the current bridge is connected to the point of the heated part having the lowest absolute temperature.

7. A thermionic cathode as claimed in claim 4 in which the heat barrier and current bridge consist of cathode nickel.

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