Feb. 16, 1937. C. S. BULL 2,070,968

ANODE FOR ELECTRON DISCHARGE DEVICES

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Fig. 2

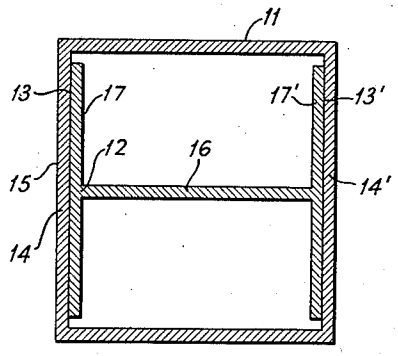
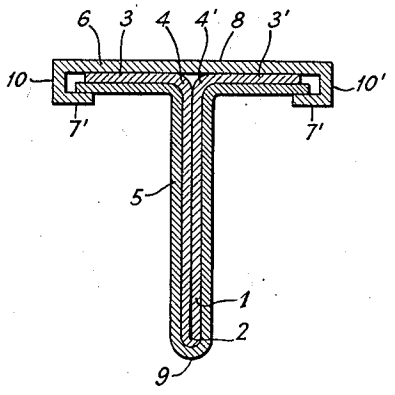


Fig. 1



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ANODE FOR ELECTRON DISCHARGE DEVICES

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9 Claims. (Cl. 250—27.5)

The present invention relates to anodes for electron discharge devices.

It is desirable that an anode for an electron discharge device should have the following properties. Firstly, when the anode is being degassed by heating, by means of a high frequency electromagnetic field, the whole anode should be heated to a temperature higher than it can reach during operation. Secondly it should be arranged that the surface of the anode which radiates heat during operation is of a substantially uniform temperature. Thirdly it should have a minimum of metal in it in order that degassing may be rapid.

The heating of an anode by means of a high frequency electromagnetic field may be produced in two different ways. Firstly a closed loop of suitable size and resistance may be provided in the anode, eddy currants flowing around the loop and generating heat. Secondly the anode may be wholly or in part of iron in which case heat is generated by hysteresis loss. Iron is the only metal which is suitable for hysteresis heating.

In the case of a thermionic valve with a cylindrical anode over the surface of which the electron stream is substantially uniformly distributed, the above conditions may easily be satisfied. However, in valves having small anodes, for example those employing focused beams of electrons, eddy current heating can only be carried out by forming the anodes into box-like structures and hysteresis heating can only be carried out by employing iron. Further owing to the poor thermal conductivity of iron and metal such as nickel which are suitable materials for forming closed loops for eddy current heating, electrodes constructed of these metals have a useful radiating area which is very little greater than the area over which heat is generated during operation by electron bombardment.

It is an object of the present invention to overcome or reduce these difficulties.

According to the present invention an anode for an electron discharge device comprises a first portion of a metal of relatively high thermal conductivity constructed and arranged to maintain said anode, in operation, at a substantially uniform temperature, and a second portion in thermal contact with said first portion and constructed and arranged so as to be capable of being heated to a substantially uniform temperature by means of a high frequency field.

The portion of higher thermal conductivity which will also have a high electrical conductivity should have such form that it does not provide a closed loop for currents induced by the high frequency electromagnetic field which is employed to heat the anode for degassing purposes.

The invention will now be described by way of example with reference to the accompanying drawing, wherein Figs. 1 and 2 show sectional views of two different anodes according to the invention.

Referring to Fig. 1 of the drawing, a rectangular copper strip **1** is bent back upon itself along the perpendicular bisector of its longer pair of sides, thus forming a double strip. This perpendicular bisector intersects the plane of the drawing at point **2**. The two end portions **3**, **3'** of the strip are then bent away from one another about lines through points **4**, **4'**. Each end part **3**, **3'** is bent through 90° so that the section of the bent strip is T-shaped as shown, the vertical stroke of the T being constituted by two pieces of metal in contact with one another. An iron strip **5** of the same width as, but of length slightly greater than, that of the copper strip **1** is then bent to cover the bottom and sides of the vertical stroke of the T and the lower surfaces of the horizontal stroke. It is arranged that the ends of the iron strip project a short distance beyond the ends of the copper strip. A second iron strip **6** of the same width as the other strips is placed on the upper surface of the horizontal stroke of the T and then has its ends **7**, **7'** bent downwards and then horizontally towards the centre, so as to enclose the ends of the first iron strip **5**. The second iron strip **6** clamps the copper and the first iron strips together and the three strips together form a rigid structure. The copper T-piece thus has its major surfaces covered by iron which is pressed into as good contact as possible therewith.

The upper horizontal surface **8** of the T is arranged to receive electron bombardment and the heat produced is largely transferred to the copper strip **1** by which it is conducted down the vertical part or fin, and radiated therefrom. When an anode of this type is being degassed by eddy current heating, the whole of both iron strips **5** and **6** contributes to the heating and the copper does not conduct the heat generated away to waste. Further the copper is of such shape that it does not act as a closed loop which would interfere with the high frequency heating and

consequently rapid, uniform heating may be obtained.

In one example the width of the horizontal stroke of the T may be 7 millimetres, the length of the vertical stroke or fin 12 millimetres and the thickness of each of the copper and iron sheets 0.1 millimetre. The ability of the copper strip to conduct heat is such that with an anode of the above dimensions there may not be more than a difference of temperature of 100° C. between the edge 9 of the fin and the edges 10, 10' of the face even when the bombarded face 8 is at a bright red heat.

It is found that the copper in the fin is at a higher temperature than the surrounding iron on account of the relatively poor thermal contact (which is usually the best that can conveniently be provided) between the two metals. If the dissipation is small and the fin comparatively short, the iron sheath 5 around the fin may in some cases be omitted. The heat generated by high frequency heating is then limited by the maximum hysteresis loss that can be developed in the iron 6 of the bombarded face and this may be sufficient adequately to heat the copper fin.

In order to maintain a large area of contact between the two strips in the vertical stroke of the T, the inner strip 1 is preferably bent back upon itself as sharply as possible at point 2 and the bend back in the outer strip 5 is slightly rounded in the neighbourhood of the point 2 so that the two strips 1 and 5 remain in contact with one another over substantially the whole of the fin. In a modification of this arrangement the two metals may be interchanged. The anode then comprises a copper sheath enclosing an iron core. As before, the iron facilitates efficient high frequency heating and the copper serves to conduct heat generated by electron bombardment, from the face where it is generated, to the cooling fin. In this modified arrangement the copper sheath forms a closed loop around the iron core but the area enclosed by the loop is insufficient to interfere appreciably with the high frequency heating of the iron. Further, more than one fin may be provided and the fins need not be parallel but may be inclined at a suitable angle so that free radiation of heat can take place from both sides of each fin.

It has been found that an anode is less likely to become distorted if the bombarded surface is of nickel than if it is of iron. Since, however, an anode of the type described above relies on hysteresis loss for its high frequency heating, (there being no closed loop suitable for being heated by eddy currents) if the bombardment surface is of nickel, sufficient iron must be provided elsewhere so that the anode may be efficiently heated by hysteresis loss. In the construction described above satisfactory results may, however, be obtained with a bombarded surface of iron or copper.

In another arrangement shown in Fig. 2 a rectangular nickel box 11 which may be open at one or both ends has a copper member 12 of substantially H-shaped cross section inserted therein. The H-shaped copper member 12 comprises two sheets of metal 17, 17', having faces 13, 13' in as good thermal contact as possible with the inner surfaces of two sides 14, 14' of the box. The two sheets 17, 17' are thermally connected together by the portion 16 of the H. It will be seen that the H-shaped copper member is in contact with two areas 14, 14', spaced apart from one another, of the box 11. The outer surface 15 of side 14 is arranged to receive the electron bombardment, and heat generated is conducted not only around the box 11 itself but also through the portion 16 of the copper member 12 and is radiated from the outer surface of side 14'. In this way the whole box is maintained at a substantially uniform temperature. When the anode is being degassed by high frequency heating, eddy currents flow round the closed loops formed by the nickel box; the whole of the nickel box 11 becomes heated and satisfactory heating of the copper member 12 follows. In this case also the copper portion (the portion of higher thermal conductivity) is so shaped that it does not provide any closed loop which would interfere with the high frequency heating of the nickel box 11. A small amount of hysteresis loss will occur in the nickel but the heat generated by this loss is small compared with the eddy current heating.

The structure does not buckle, since differential expansion of the two metals is possible. On the pump the structure can be thoroughly degassed, since the whole surface contributes to the heating energy, and the copper does not conduct the heat generated away to waste.

I claim:

1. In an electron discharge device, an anode comprising a copper sheet with insulatingly spaced edges to impede circulating eddy currents and constructed and arranged to maintain said anode, in operation, at a substantially uniform temperature, and a second sheet of metal of the iron class in thermal contact with said first sheet, said second sheet encompassing said first sheet with its edges in good electrical contact to facilitate the circulation of eddy currents induced by a high frequency field.

2. In an electron discharge device, an anode comprising a first portion of a metal of relatively high thermal conductivity and an iron portion in the form of a sheet, said first portion being in the form of a fin in contact with and extending outwardly from one surface of said sheet and the other surface of said sheet being arranged to be bombarded by electrons.

3. In an electron discharge device, an anode comprising a first portion of a metal of relatively high thermal conductivity and an iron portion in the form of a sheet, said first portion being in the form of a fin in contact with, extending outwardly from and substantially at right angles to one surface of said sheet and the other surface of said sheet being arranged to be bombarded by electrons.

4. In an electron discharge device an anode comprising an iron portion in the form of a sheet, a fin portion of a metal of relatively high thermal conductivity and an iron coating on said fin portion, said fin portion being in contact with and extending outwardly from one surface of said sheet and the other surface of said sheet being arranged to be bombarded by electrons.

5. In an electron discharge device an anode comprising a hollow member of a metal of relatively low thermal conductivity and a member of relatively high thermal conductivity arranged within said hollow member and in contact with areas spaced apart upon the inner surface thereof, the arrangement being such that, when one part of the surface of said hollow member is heated by electron bombardment, heat is conducted through said member of relatively high thermal conductivity to another part of the surface of said hollow member, said hollow member

being thereby maintained at a substantially uniform temperature.

6. In an electron discharge device an anode comprising a hollow member of nickel and a member of relatively high thermal conductivity arranged within said hollow member and in contact with areas spaced apart upon the inner surface thereof, the arrangement being such that, when one part of the surface of said hollow member is heated by electron bombardment, heat is conducted through said member of relatively high thermal conductivity to another part of the surface of said hollow member, said hollow member being thereby maintained at a substantially uniform temperature.

7. In an electron discharge device an anode comprising a member in the form of a hollow rectangular box, two sheet-like members of a metal of relatively high thermal conductivity in contact respectively with the inner surfaces of two opposite faces of said box and a connecting member also of a metal of relatively high thermal conductivity connecting said two sheet-like members, said hollow rectangular box being of a metal of relatively low thermal conductivity and the arrangement being such that when one of said opposite faces is heated by electron bombardment, heat is conducted through said sheet-like members and said connecting member to the other of said opposite faces, said hollow rectangular box being thereby maintained at a substantially uniform temperature.

8. A planar anode comprising a sheet of ferrous metal adapted to receive electrons upon one surface, means to uniformly distribute heat throughout the anode comprising a second sheet of metal of good heat conducting material placed in good heat conducting contact with the other surface of the ferrous sheet, and means to the rear of the anode electrically joining the edges of said ferrous sheet to lower the impedance in said ferrous sheet to the flow of circulating eddy currents induced by alternating currents.

9. An anode comprising a copper plate, an integral arm extending laterally from one side of said plate and a continuous sheet of metal of the iron class secured in good heat conducting contact with the faces of the plate and its arm.

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