

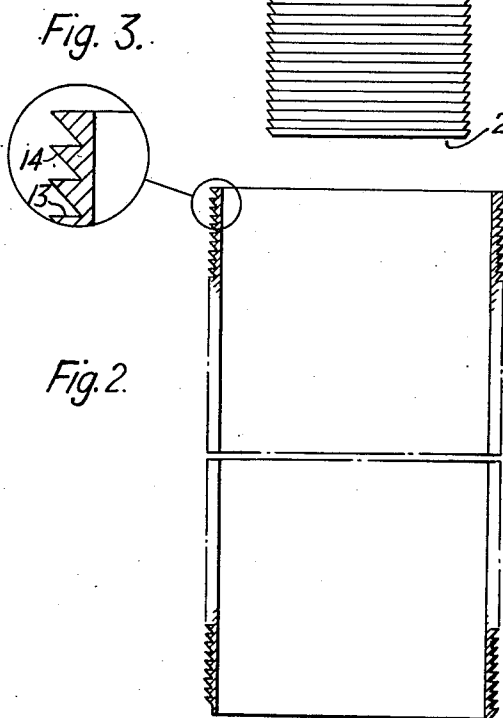
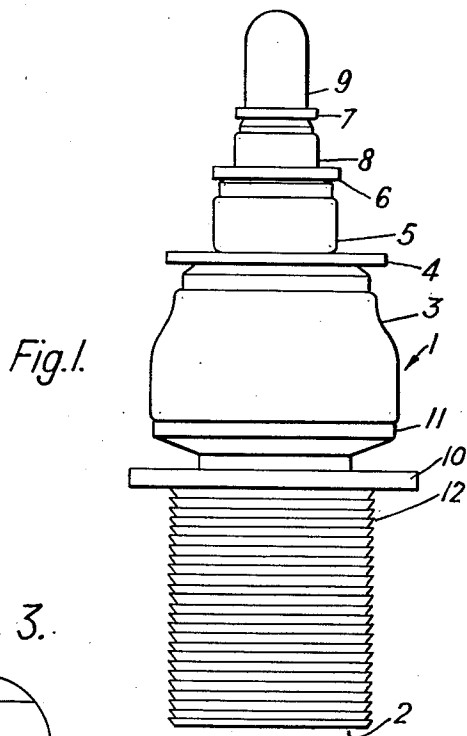
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ELECTRIC DISCHARGE TUBES

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1

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ELECTRIC DISCHARGE TUBES

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The present invention relates to electron discharge tubes cooled by the latent heat of evaporation of a cooling liquid.

It has previously been proposed to cool the anodes of high power thermionic valves having external anodes by supporting the valve with the anode immersed in cooling liquid contained within a boiler, the temperature of the coolant liquid being allowed to rise to boiling point so that the dissipation of heat is largely accomplished by utilising the latent heat of evaporation of the liquid. In general it is known that it is not satisfactory merely to place the smooth anode of the conventional water-cooled valve in the cooling liquid, but steps have to be taken to ensure that bubbles of gas do not collect on the anode surface, thereby giving rise to hot spots, while it is also desirable to provide a large surface in contact with the coolant. It has therefore been proposed to utilise an anode structure in which the surface is covered by a number of protuberances which serve not only to increase the effective surface area but also to mitigate against the likelihood of bubbles of vapour becoming lodged in contact with the anode.

We have found that satisfactory latent heat cooling can be achieved with anode surfaces of comparatively simple configuration, and, in accordance with the present invention, we provide an electron discharge tube having an external anode whose external surface carries grooves which extend substantially continuously around the circumference of the anode. Although the groove shaping does not appear to be unduly critical it must, of course, be such as not to encourage the trapping of vapour bubbles; preferably the groove shape is of semi-V formation with one bounding wall substantially horizontal when the discharge tube is in its operating position and the other groove bounding wall inclined at an acute angle to and above the first mentioned groove bounding wall. The grooves may be provided very simply by turning a screw thread in the anode wall or, if desired, a comparatively thin wall sleeve in which such grooves are turned can be fitted over and secured to the smooth anode of a conventional water-cooled valve.

An embodiment of the invention will be described with reference to the accompanying drawings in which:

FIG. 1 is an outline drawing of an electron discharge tube according to the invention;

FIG. 2 shows a longitudinal cross-section through a sleeve to be fitted to a standard smooth-walled anode; and

FIG. 3 is an enlarged view of part of the sleeve wall.

In the embodiment of FIG. 1 the tube 1 comprises an external anode 2 joined by means of glass envelope portion 3 to a grid ring 4 which supports a control grid coaxially inside the anode 2. Another length of glass envelope portion 5 separates the grid ring 4 from a filament ring 6 which similarly supports one end of a directly heated cathode within the grid and anode electrodes. The other end of the cathode is taken out to a further ring 7 separated by a glass collar 8 from the ring 6. The

2

discharge tube is terminated at this end by a cap 9 secured to ring 7 and covering an exhaust tubulation.

In operation the discharge tube is supported with the anode projecting vertically downwards into a water-filled boiler. A flange 10 provides a seating for the tube to rest on the lip of the boiler. Since the anode is normally of copper it will be sealed to the glass envelope portion 3 by means of a Housekeeper seal. Consequently the flange 10 has to be spaced somewhat away from the glass-to-metal seal, as is indicated in the drawing.

Between the flange 10 and the lower end of the anode 2 the anode surface 12 is grooved. The form of the grooves is similar to that shown in FIG. 3, in which each lower groove-bounding-wall 13 is substantially horizontal and each upper groove-bounding-wall 14 is inclined at an acute angle to the adjacent bounding wall 13 below it. Furthermore, in its preferred form each slant groove-bounding-wall surface intersects the adjacent horizontal groove-bounding wall surface above it so that the cross-section as shown in FIG. 3 has a saw-tooth boundary.

The grooves in the anode surface can conveniently be formed by turning a screw thread on a lathe. Alternatively, if it is desired to modify a standard water-cooled valve for latent heat cooling a sleeve such as shown in FIG. 2 can be fitted over the anode.

The sleeve of FIG. 2 comprises a thin walled copper tube in which grooves are cut. In a typical embodiment the sleeve wall thickness was 0.150", the depth of the grooves (surface 13, FIG. 3) was 0.100" and the spacing between adjacent grooves was 0.143". A discharge tube provided with such grooves covering 180 sq. cms. of cylindrical anode surface was shown to be able to dissipate comfortably 17 kilowatts, whereas a similar tube having the normal smooth anode surface was only able to dissipate just over half this power.

While the principles of the invention have been described above in connection with specific embodiments, and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

What I claim is:

1. An anode structure for an electron discharge tube adapted to be immersed in a liquid coolant and to be cooled by the latent heat of evaporation thereof, said structure comprising a cylindrically shaped anode having a series of annular grooves extending around the outside circumference of said anode, each of said grooves being defined by a lower surface which is substantially normal to the vertical axis of the tube when in its operating position, and an upper surface inclined at an acute angle to said lower surface.

2. An anode structure according to claim 1 in which the distance between adjacent horizontal grooves are between one and one and one-half times the radial depth of said grooves.

3. An anode structure according to claim 1, wherein said series of annular grooves are interconnected to form a substantially continuous screw thread.

References Cited in the file of this patent

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