June 23, 1936. C. J. SMITHELLS 2,045,561

EVACUATED ELECTRIC DISCHARGE VESSEL

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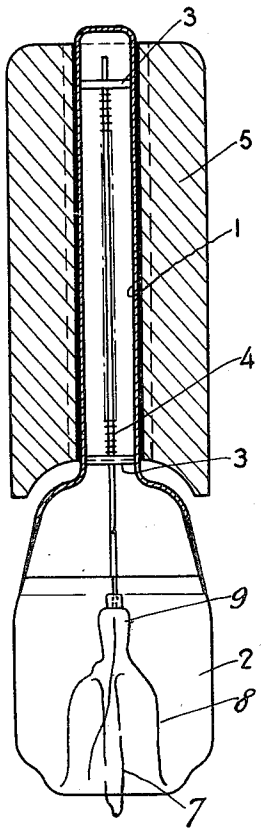

Fig. 1

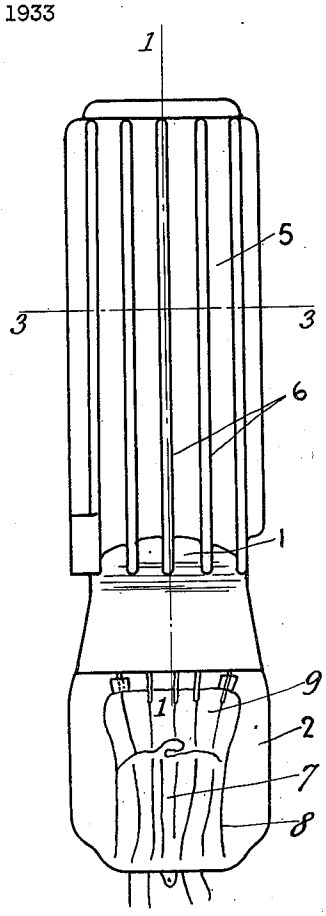

Fig. 2

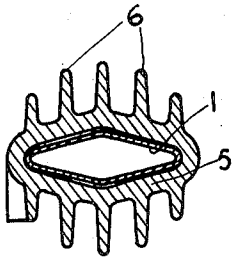

Fig. 3

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EVACUATED ELECTRIC DISCHARGE VESSEL

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3 Claims. (Cl. 250—27.5)

This invention relates to evacuated electric discharge vessels of the type in which one electrode (hereinafter called the anode) forms part of the envelope.

In the larger vessels of this type, consuming more than 1,000 watts, the anode is usually cooled by the forced circulation of fluid. In the smaller vessels of the type, consuming less than 20 watts, no special cooling means is usually provided. Between these extremes are intermediate vessels, consuming power of the order of 50 watts, in which the anode may be cooled suitably by the attachment of fins without forced circulation of fluid. The invention relates more particularly to vessels of this intermediate class.

The anodes of such vessels, like those of the smaller class but unlike those of the larger class, are often cylinders whose cross section departs widely from the circular form, being for example lozenge-shaped. Anodes of non-circular cross section will here be termed flattened. In order to prevent the collapse of a flattened anode when evacuated, the material of which it is made has generally to be thicker than would be necessary if the cross-section were circular and often thicker than is desirable on other grounds. The object of this invention is to combine the provision of cooling means with the provision of supporting means that enables thinner material to be used.

In the accompanying drawing, Figure 1 shows diagrammatically a side elevation of an electric discharge device provided according to the invention, with a cooling sheath, the anode and sheath in this elevation being shown as a section on the line 1—1 of Figure 2; Figure 2 shows a front elevation of the electric discharge device and cooling sheath shown in Figure 1; and Figure 3 shows a transverse section on the line 3—3 in Figure 2 of the cooling sheath and anode only, showing the form of the cooling fins in this particular example and the approximate relative positions of the anode and the interior surface of the cooling sheath.

In the drawing, the flattened anode 1 and the glass portion 2 form the envelope of the discharge device, which is evacuated in known manner through an evacuating tube 7 sealed into the pinch tube 8. The electrodes are supported by the pinch 9 and by insulating plates 3 bearing against the electrodes and the interior surface of the anode. The grid electrode 4 is shown in Figure 1.

According to the invention, a sheath 5 is provided for the anode and this sheath is provided, as shown, with cooling fins 6. The sheath is shown in Figure 3 as being tight against the anode at the ends of its maximum diameter of its cross-section and exerts pressure on the anode, that is, it grips the anode, along this line, while the sheath is shown as closely approaching the anode at other parts of its surface.

According to the invention in an electric discharge vessel of the type described having a flattened anode, the anode is supported against collapse under external pressure by being gripped in a cooling sheath.

A little explanation is necessary to explain what is implied here by the word "gripped". When a flattened anode collapses under pressure, the decrease of one of the dimensions of its cross-section is generally accompanied by the increase of some other dimension. In general, the dimension that increases will be the maximum dimension. There may possibly be exceptions to this statement, especially if the cross section has several equal maximum dimensions (for example if it is a square), but if there are exceptions, they are excluded from the scope of the invention, which applies only to anodes such that collapse under pressure is accompanied by increase in one at least of the maximum dimensions. Collapse can then be prevented by preventing increase of this maximum dimension. The sheath is said to grip the anode when it exerts a pressure on the anode along the maximum dimensions of its cross-section and thus prevents its increase.

The sheath has not only to support the anode but it has also to cool it; accordingly it must be in effective thermal contact with the anode. For this purpose, it must just touch or approach very closely to the anode over the greater part of its cross-section, while exerting pressure on it only along lines in the neighbourhood of its maximum dimension. These conditions can be fulfilled at the same time by giving to the internal cross-section of the sheath a perimeter slightly greater than the perimeter of the cross-section of the anode, but making that dimension of the cross-section of the sheath which is to coincide with the maximum dimension of the anode slightly less than this dimension. If the most perfect thermal contact and the least distortion of the anode are required, the differences implied by the word "slightly" in the preceding sentence may be of the order of one mil; but of course either of them may be greater if the corresponding quality is sacrificed.

In order that a sheath should be a cooling

sheath within the meaning of this specification, it is necessary only that with a given temperature difference it should transfer to any fluid in which it is immersed substantially more heat than would be transferred by the unsheathed anode under the same temperature difference. Thus, being made of metal, it might be similar to the anode in external form, but have thick walls and a larger surface. But generally it will be convenient to make the sheath as thin as is consistent with the rigidity necessary to avoid distortion by its reaction with the anode, and to provide its exterior surface with fins. Aluminium is a suitable material for the cooling sheath; a convenient method of making large numbers of sheaths to the close dimensions required is to extrude a long length of the desired cross-section and then cut it into the lengths appropriate for the individual anodes; the fins must then, of course, be longitudinal.

The sheath may be placed round the anode by heating it and shrinking it on; if the anode is supported on a glass seal, this method is usually preferable to forcing the sheath on. The anode is most likely to collapse when it is hot, for then the metal is weakest. It will be necessary therefore to provide the anode with support during baking. This may be achieved by fitting the sheath on the anode before baking. This course is inconvenient, because the sheath has a large capacity for heat and its presence prolongs the time necessary for baking and for cooling after baking; but if the anode is so weak that it will collapse when cold, if unsupported, it cannot be avoided. Often, however, the anode will not collapse when cold, but only when it is heated in operation. If this is so, it is preferable to support the anode during baking with a temporary sheath of low heat capacity, easily attached and detached, for example by means of bolts and thumbscrews. This temporary sheath need not, of course, provide cooling means. The temporary sheath is detached after baking, when the anode is quite cold, and replaced by the permanent cooling sheath.

I claim:—

1. In the manufacture of an evacuated electric discharge tube in which part of the envelope comprises a thin walled metal tube having long and short axes and subject to collapse with elongation of its long axis under external atmospheric pressure, the process which comprises temporarily applying pressure at the ends of the long axis of the tube only for preventing elongation thereof during evacuation and then permanently applying continuous pressure at the ends of the long axis of the tube only after evacuation.

2. An evacuated electric discharge tube comprising a flattened tubular thin walled metal anode forming part of the envelope of the tube, said anode being oval in cross section with transverse long and short axes and having walls so thin that the anode is subject to collapse under atmospheric pressure with elongation of said long axis, and a cooling sheath closely surrounding said metal anode and in pressure engagement therewith at opposite ends of said long axis for preventing collapse of the anode and elongation of said long axis under atmospheric pressure.

3. An evacuated electric discharge tube comprising a flattened tubular thin walled metal anode forming part of the envelope of the tube, said anode being oval in cross section with transverse long and short axes and having walls so thin that the anode is subject to collapse under atmospheric pressure with elongation of said long axis, and a cooling sheath surrounding said anode in heat conducting contact therewith and in pressure engagement therewith at opposite ends of said long axis for preventing collapse of the anode and elongation of said long axis under atmospheric pressure.

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