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ELECTRON TUBE AND METHOD OF MAKING THE SAME

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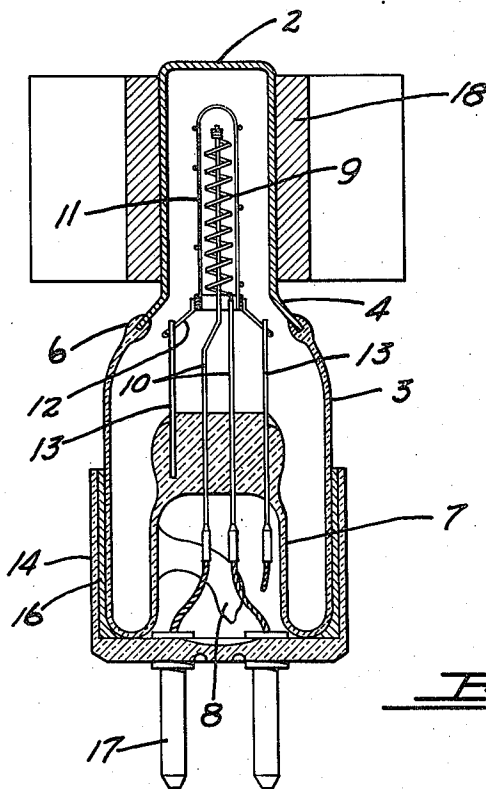


Fig. 1

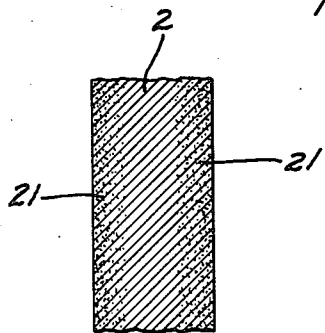


Fig. 2

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ELECTRON TUBE AND METHOD OF
MAKING THE SAME

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2 Claims. (Cl. 250—27.5)

My invention relates to electron tubes, and more particularly to a vacuum tube having an external anode.

It is among the objects of my invention to provide an improved external anode.

Another object is to provide a tube of the character described in which a thoriated tungsten filament may be successfully used.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of my invention. It is to be understood that I do not limit myself to this disclosure of species of my invention as I may adopt variant embodiments thereof within the scope of the claims.

Referring to the drawing:

Figure 1 is a vertical sectional view of a tube embodying the improvements of my invention; and

Figure 2 is an enlarged sectional view of the anode wall after steam treatment.

In terms of broad inclusion, my tube comprises an envelope enclosing a cathode and having an external electrode or anode forming part of the envelope wall. The cathode is preferably of the thoriated tungsten type, and the anode is given a special treatment to insure maintenance of a good vacuum and prevent premature failure of emission from the cathode.

In greater detail, and referring to the drawing, my tube comprises an external electrode or anode 2 which is a hollow metallic body forming part of the tube envelope. The anode of the tube shown is cup-shaped but this is merely for purposes of illustration. The remainder of the envelope comprises a vitreous or glass portion 3 fused to flare 4 of the anode at seal 6. Portion 3 preferably has a reentrant stem 7 for carrying the other electrodes in the tube. An exhaust tubulation 8 on the stem provides means for evacuating the envelope.

A cathode 9 is provided in the envelope projecting upwardly into anode 2. This is preferably of the filamentary type comprising a helix of thoriated tungsten wire secured top and bottom to a pair of cathode leads 10 sealed to stem 7. The filament wire is preferably carbonized in the usual manner. The triode type of tube chosen for purposes of illustration includes a grid 11 of suitable shape and material supported by a bracket 12 on rods 13 sealed to stem 7, one of these rods functioning as a grid lead.

A suitable base 14 is secured to the glass portion of the envelope by cement 16. This base

carries terminal prongs 17 to which flexible extensions on the grid and cathode leads are connected. A cooler 18 is preferably provided on the anode. This may be of any suitable metal having good heat conductivity, such as copper or aluminum, and preferably has longitudinal fins. The cooler may be secured to the anode in any suitable manner.

An important feature of the invention resides in the treatment of external electrode 2 so as to maintain a good vacuum in the tube and insure adequate and dependable emission from the filament. In the past it has been considered difficult if not impossible to use a carbonized thoriated tungsten filament in an external anode tube on account of premature failure of emission due to filament contamination or otherwise. As a result it has been the practice to use the less efficient plain tungsten filaments in such tubes. In my improved tube a carbonized thoriated tungsten filament is used with excellent results. Not only is contamination of the filament prevented, but I also find that loss of carbon from the filament is largely prevented.

Anode 2 is of a metal having a relatively high melting point such as iron. Iron base alloys such as those containing nickel are satisfactory. Kovar is an alloy of this character and is preferably used because this metal has the proper expansion properties for sealing to glass. Kovar is an alloy comprising 30% Ni, 15% Co, 0.2% Mn, and balance Fe.

Since the external anode forms part of the wall of the evacuated envelope it is necessary that the anode be gas impervious. Otherwise a vacuum cannot be maintained. Any gas bleeding into the envelope is a source of contamination for the filament and in part is responsible for premature emission failure, particularly in the case of a thoriated tungsten filament which is especially sensitive to contaminating influences. Most metals are somewhat pervious to gas, particularly at the elevated temperature an anode operates in a vacuum tube. I overcome the difficulties involved by special processing of the anode.

Before anode 2 is sealed to glass 3 the anode is heat treated. The anode is preferably first cleaned by heating to about 1000° C. for about thirty minutes in an atmosphere of hydrogen. This time and temperature is not critical and may be varied within wide limits. After hydrogen firing the anode is then heated to about 400° to 700° C. for say about one hour in an atmosphere of steam. This is done in a tube furnace

capable of bringing the anode up to the desired temperature, into which furnace steam is admitted at atmospheric pressure. The steam penetrates the intercommunicating pores within the wall of the anode, forming a metallic oxide layer over the surface and extending an appreciable depth within the body of the metal as indicated at 21 in Figure 2. With an anode of iron the impregnating material is iron oxide. This oxide layer at the surface and impregnating the metal seals the pores, making the anode substantially impermeable to gas.

After the envelope has been sealed together with the internal electrodes in place, and before base 14 and cooler 18 are applied, the tube is evacuated. Any suitable vacuum pump may be used, connected to exhaust tubulation 8. While the tube is on the vacuum pump the grid and anode are heated to outgas them. This is preferably done by energizing the cathode and applying positive potentials to the grid and anode so that the latter are heated by electron bombardment. Heating the anode under vacuum probably reduces the oxide at the inner surface of the anode body back to metal, or at least stabilizes the inner surface so that no undesirable gas is released during subsequent operation of the tube. Reduction of the oxide within the pores also has a sealing action. Of course the oxide at the outer surface, which is not under vacuum, remains as an impregnating oxide in the pores.

While I have particularly described my improvements in conjunction with tubes having an anode of iron or an iron base alloy, it is understood that other suitable metals may be used. A nickel anode sealed with nickel oxide gives good results. It is also understood that, while I prefer to form the oxide sealing layer by a steam treating process, the oxide layer may be formed by

other means as by heating the anode in air. The important thing is that a dense layer of metallic oxide is formed at or near the surface of the anode under cooler 18 making the anode impervious to gas so as to maintain a good vacuum in the envelope; an oxidizing process which gives depth to penetration of the oxide, such as the steam treating process, being preferred because it gives best assurance of a gas tight anode.

Another advantage of an oxide layer which penetrates into the body of the anode is that the surface oxide on the anode may later be removed to expose the metal so that cooler 18 may be subsequently united to the anode. Thus, removing the surface oxide makes it possible to solder or otherwise bond the cooler directly to the anode metal, and, if the oxide penetration is sufficient, the sealing properties are not destroyed. If a surface layer only of the oxide is depended upon to seal the pores this cleaning of the surface is not possible. For deeper penetration of the oxide, steam pressures higher than atmospheric may be used.

I claim:

1. The method of making an electron tube having an envelope including a metallic anode section, which comprises impregnating the anode with a metallic oxide to seal its pores, evacuating the envelope, removing the surface oxide from the anode, and then attaching a cooler to the anode.

2. An electron tube comprising a metallic external anode impregnated with a metallic oxide providing a sealing layer below the outer surface of said anode, said outer surface being substantially oxide free, and a cooler on the anode bonded to said surface.

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