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ELECTRODE FOR VACUUM TUBES

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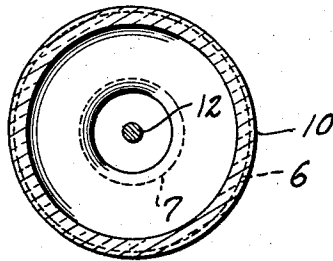


Fig. 2.

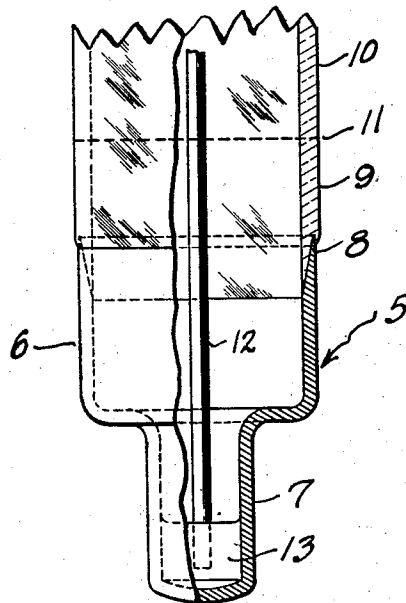


Fig. 1.

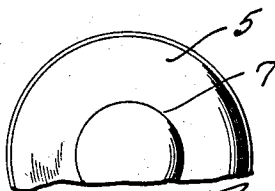


Fig. 3.

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ELECTRODE FOR VACUUM TUBES

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6 Claims. (Cl. 176—50)

This invention relates to vacuum tubes and particularly to electrodes for such tubes, including anodes for vacuum tubes such as X-ray tubes, broadcasting tubes, lighting tubes, especially large flood lighting tubes, and the like, and has for an object to provide such an electrode as will properly and tightly seal with the glass and will not become gassed or porous under manufacturing operations so that it will effectively maintain the vacuum in the tube.

In the drawing there is illustrated by way of example a metal anode according to our invention sealed to the glass of a vacuum tube. The anode may take different forms but the form shown is commonly used.

In this drawing:

Fig. 1 is a side elevation and partial section of the anode and a connected portion of a glass tube;

Fig. 2 is a transverse section through the glass tube looking toward the anode; and

Fig. 3 is a bottom plan view.

This copper electrode or anode 5 is shown as having a cylindrical body portion 6 of more or less cup-shape with a plug or extension 7 drawn from the bottom wall thereof for insertion in a socket to give the desired electrical contact to a source of current supply. Ordinarily the upper free edge of the body portion 6 is feathered or reduced to a thin knife edge as indicated at 8 for properly sealing to the glass, the edge being cut down to approximately .006 inches thick. The glass seal 9 is applied to both the outside and inside of this thin edge by means of a gas torch, and then when the tube is ready to be assembled the body or an extension tube from the body indicated at 10 is fastened to this glass seal by fusing as indicated at 11. The electrode illustrated has been cupped and drawn and the extension 7 drawn from the end wall thereof. A lead or conductor indicated at 12 leading to any of the electrical elements of the tube may be soldered to the extension 7 as shown at 13 or may be soldered to any convenient part of the anode.

These anodes must therefore be capable of properly fusing or welding to the glass seal, which connection must be gas tight, and the metal also must be such as not to become gassed or rendered porous by the reducing flame of the gas torch used in fusing or welding the anode to the glass. The metal therefore must be free from oxygen or at least the oxygen content must be very small. If the copper anode for example contains cuprous oxide in material amounts

this oxide will be reduced by the flame of the torch and the metal will become what is termed "gassed" in the trade, which would cause it to become porous so that it will not properly maintain the vacuum in the tube. The anode also must have high electrical conductivity, ordinarily over 75% of the International Annealed Copper Standard, particularly when it is used as an anode for X-ray and broadcasting tubes, although when used for large flood lighting tubes high electrical conductivity is not so important. The metal of the anode must also be capable of withstanding cupping and drawing operations without cracking.

After a large number of tests with a large number of copper and copper alloys we found that practically all of them, with the exception of copper containing a small amount of silicon, either failed to properly seal to the glass or became gassed or porous so would not maintain the vacuum, as well as failed to have the desired electrical conductivity. We have found that copper containing from approximately 0.01 to about 0.10 percent silicon would meet these tests although the preferred range is from approximately 0.03 percent to approximately 0.075 percent of silicon in the copper. We have found that copper with this amount of silicon fuses or welds satisfactorily to the glass giving a good gas tight seal, and it is not gassed and does not become porous under the action of the gas torch flame used in making the seal. This metal also has high electrical conductivity and is capable of withstanding cupping and drawing operations without cracking.

In order to be accepted for this type of work, particularly X-ray and broadcasting tube anodes the samples must be able to withstand very rigid tests. In the usual test the samples are oxidized for about 15 minutes in a muffle furnace heated to 900° C., they are then cooled in air and then reduced for 15 minutes in a hydrogen furnace heated at 800° C., and allowed to cool in hydrogen. After this oxidation reduction cycle the sample is polished for microscopical examination, and to be satisfactory the penetration as indicated by the depth of oxygen line should not be greater than .003 inches and open grain boundaries not exceed .003 inches.

It will be evident from the above that for best and most satisfactory results the amount of silicon should be very accurately controlled as the amounts used are very small and are within relatively narrow limits.

In the above description by the term "vacu-

um tube" we mean such tubes as X-ray tubes, broadcasting tubes, lighting tubes, particularly large flood lighting tubes, etc. In fact this anode can be used in any tube where vacuum must be maintained and there is a copper to glass seal.

Having thus set forth the nature of our invention, what we claim is:

1. In combination, an electrode for vacuum tubes including a tubular portion terminating in a thin edge, and a glass tube welded to said edge portion, said electrode being composed of copper containing approximately from 0.01% to 0.1% silicon.

2. In combination, an electrode for vacuum tubes including a tubular portion terminating in a thin edge, said electrode being composed of copper containing approximately 0.03% to 0.075% silicon, and a glass tube welded to said edge portion.

3. In a vacuum tube, an electrode having free edge portions and composed of copper containing approximately 0.01% to 0.1% silicon, and

a glass tube welded to the free edge portions of the electrode.

4. In a vacuum tube, an electrode having free edge portions and composed of copper containing approximately 0.03% to 0.075% silicon, and a glass tube welded to the free edge portions of the electrode.

5. In combination, an electrode for vacuum tubes comprising a tubular portion having a free edge and an end wall and an extension of less diameter drawn from said wall, said electrode being composed of copper containing approximately 0.01% to 0.1% silicon, and a glass tube welded to the free edge portion.

6. In combination, an electrode for vacuum tubes comprising a tubular portion having a free edge and an end wall and an extension of less diameter drawn from said wall, said electrode being composed of copper containing approximately 0.03% to 0.075% silicon, and a glass tube welded to the free edge portion.

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