

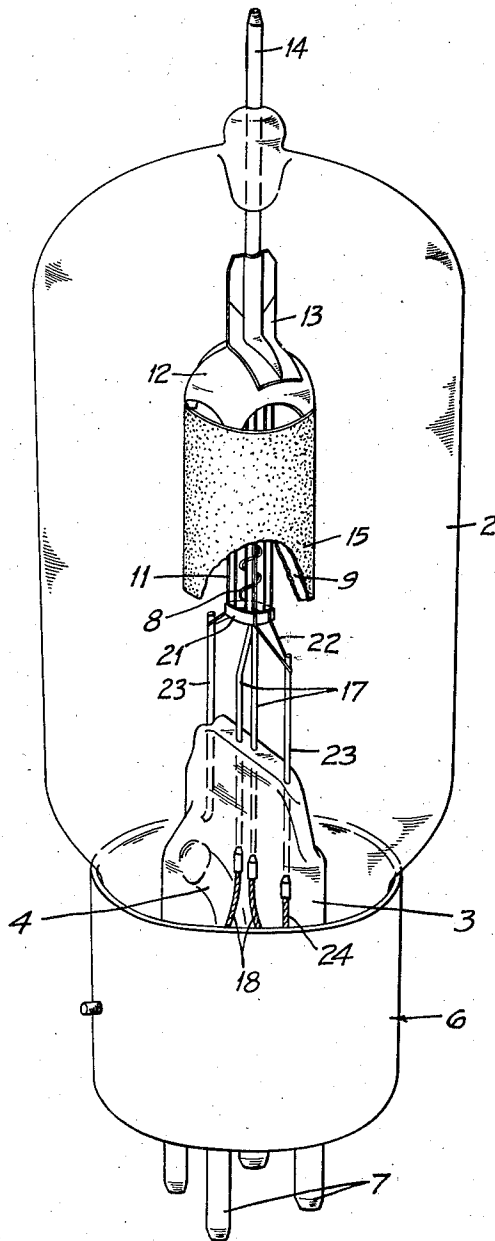
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COATED ANODE FOR ELECTRON DISCHARGE DEVICES

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COATED ANODE FOR ELECTRON
DISCHARGE DEVICES

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1 Claim. (Cl. 250—27.5)

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This is a division of my copending application
Serial No. 660,263, filed April 6, 1946.

My invention relates to electrodes for elec-
tron tubes.

It is among the objects of my invention to
improve the heat dissipation and gettering prop-
erties of electrodes such as anodes.

Another object is to provide an electrode hav-
ing a surface layer which is stable at high tem-
peratures.

The invention possesses other objects and fea-
tures of advantage, some of which, with the fore-
going, will be set forth in the following descrip-
tion 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 embodi-
ments thereof within the scope of the claim.

Referring to the drawing:

The figure of the drawing is an elevational
view of a tube embodying my improvements.

In terms of broad inclusion, my electrode for
an electron tube comprises a surface layer of me-
tallic particles bonded together and to the elec-
trode. The particles making up the surface
layer include carbon and a metal such as zir-
conium, tantalum or molybdenum, zirconium be-
ing preferred, the carbon being combined with
the metal to form a metallic carbide. In the
case of an anode the improved electrode prefer-
ably comprises a hollow body of sheet metal, such
as molybdenum, upon the outer surface of which
the carbide layer is applied. The surface layer
is preferably formed by coating the electrode
with a mixture of finely divided metal and car-
bon, the major proportion of which is metal, and
then heating the electrode to convert the car-
bon to the carbide and sinter the particles to-
gether and to the electrode.

In greater detail, and referring to the drawing,
a tube illustrating my improvements comprises
an envelope 2 having a reentrant stem 3 carry-
ing an exhaust tubulation 4. A base 6 with
prongs 7 is provided at the lower end of the tube.
The envelope encloses a cathode 8, grid 11 and
tubular anode 9, the anode having a cap 12 sup-
ported by bracket 13 on a lead 14 sealed to the
upper portion of the envelope.

Grid 11 is of the cage type having a base ring
21 supported by brackets 22 on rods 23, one of
which serves as a grid lead connected to a base
prong 7 by a conductor 24. Cathode 8 is of the
filamentary type comprising a spiral of thori-
ated tungsten wire welded top and bottom to a
pair of leads 17 sealed to stem 3 and connected
to a pair of base prongs by conductors 18.

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The above described tube structure is merely
for purposes of illustration and may be varied
within wide limits.

My improvements, as embodied in anode 9,
comprise a surface layer 15 of carburized me-
tallic particles bonded or sintered together and
to the anode body. Body 9 is of a suitable refrac-
tory metal having a high melting point and low
vapor pressure, molybdenum being preferred be-
cause it can be fabricated in sheet form and is
relatively cheap compared to other metals in
this class.

The particles in surface layer 15 comprise car-
bon combined as a carbide with a refractory
metal or a combination of refractory metals,
such as zirconium, tantalum, molybdenum or
tungsten, zirconium being the preferred metal
for several reasons hereinafter recited. The sur-
face layer is preferably formed by preparing a
fluid mixture of the finely divided metal and
carbon, and applying this mixture to the elec-
trode by brushing or spraying. In the case of a
coating containing molybdenum, for example,
the proportions are preferably 80 parts by weight
of molybdenum powder to 10 parts of carbon
powder, it being noted that the major propor-
tion of the mixture is of the metal. In the case
of a coating containing zirconium the ratio is
preferably 91.2 parts by weight of zirconium pow-
der to 6 parts carbon. These proportions provide
about half the theoretical amount of carbon re-
quired to convert all of the metal in the coating
to the carbide. In either case the powders are
mixed with a suitable vehicle such as amyl ace-
tate to a consistency for brushing or spraying.

After coating, the electrode is heated to a tem-
perature sufficient to convert the carbon to a
carbide and to sinter the particles together and
to the electrode body. This heating is carried
out in an oxygen free atmosphere such as in
vacuum or in an inert gas such as argon or heli-
um. Heating in vacuum is preferred because the
coating is outgassed simultaneously with the
carburizing step. With a coating containing
molybdenum powder I have secured the desired
result by firing the electrode in a vacuum fur-
nace to about 1800° C. for about 5 minutes. With
the preferred coating containing zirconium pow-
der the firing is preferably done at a lower tem-
perature for a longer period, say at 1400° C. for
about 30 minutes. After firing, the anode struc-
ture is ready for sealing into the envelope, the
tube from this point on being processed and
evacuated in the usual manner.

My coated electrode has several advantages.

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One is that the final layer, being formed with metallic carbide particles, is of a rough granular texture in addition to being quite dark in color. This black body effect gives the electrode excellent heat dissipation properties. Another feature is that the metallic carbide layer is very stable at high temperatures, which stability is important during processing the tube on the pump and during subsequent operation. The fact that an excess of metal is provided in the coating, over and above that required to satisfy the carbon, means that the final coating contains some pure metal along with the metallic carbide, so that the surface layer 15 comprises an intimate admixture of metal carbide and uncombined metal. Some of the pure metal is probably present as uncombined metal in the core parts of the metallic carbide particles and some probably as metal particles between the carbide particles. In any event, the presence of this uncombined metal aids in binding the metallic carbide together in the coating, resulting in a very tightly cemented layer after the sintering operation. Such a firmly bonded layer is important to prevent the particles from being dislodged under the electrical and thermal stresses set up in the tube during operation.

While any of the metals mentioned in connec-

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tion with the coating composition will yield the above mentioned desirable characteristics in the surface layer, I prefer to use zirconium powder because it has additional advantages. For example, a layer composed of zirconium and carbon has good gettering (gas absorption) properties for cleaning up residual gases in the tube. Also, a surface layer containing zirconium carbide tends to suppress electron emission from the electrode. Both of these characteristics are desirable in an anode.

I claim:

An anode for an electron tube, comprising a metallic body and a surface layer comprising an intimate admixture of zirconium carbide and uncombined zirconium bonded together and to the anode body.

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REFERENCES CITED

The following references are of record in the file of this patent:

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