

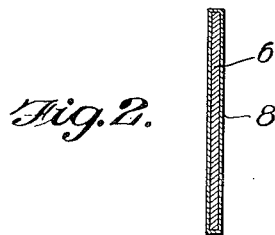
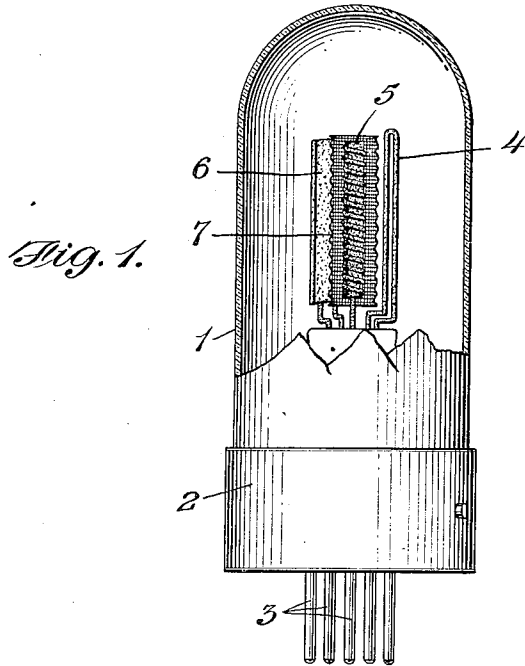
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THERMIONIC TUBE

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THERMIONIC TUBE

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4 Claims. (Cl. 250—27.5)

This invention relates to improvements in elec-
tronic elements and more particularly to im-
proved thermionic tubes, and is a continuation in
part of our prior application Serial No. 48,589,
5 filed November 6, 1935.

The desiderata in this particular field, that is
to say in vacuum tubes, includes such features as
high electronic emissivity, thermal resistivity and
longevity. The typical vacuum tube of today, as
10 is known, comprises an evacuated envelope con-
taining an electron emitting electrode, a plate
and a grid. Usually the electron emitting elec-
trode or filament comprises thoriated tungsten.
The elements tungsten and molybdenum are
15 likewise found to be efficacious in the operation of
vacuum tubes and, as is known, are employed
quite generally in the fabrication of the filament
and grid.

The choice of tungsten or thoriated tungsten
20 for the electron emission element is in effect a
compromise. It is known that certain substances,
such for example as calcium, barium, thorium and
the like are better thermionic emitters than
metals such as tungsten, molybdenum and so
25 forth. However, while calcium has a low work
function and is a good emitter, it has a relatively
high vapor pressure so that marked evaporation
occurs at low temperatures. The use of the
thoriated tungsten filament therefore involves a
30 combination of a material having a relatively
low emission but which is quite refractory and
an element having a high emission. This com-
bination is possible because of the fact that
thorium is strongly adsorbed on the surface of
35 tungsten even at the elevated operative tempera-
tures of the vacuum tube.

We have found that improved electronic ele-
ments, and particularly thermionic tubes, may be
produced by utilizing for the electrodes thereof
substances which are provided with a special
40 electrodeposited surface. According to the pres-
ent invention such surfaces may be widely varied
with respect to the components and hence with
respect to the electronic or electrical characteris-
tics so as to secure a wide range of desirable re-
45 sults.

More specifically considered, the invention
comprehends the utilization for the elements of
thermionic tubes of electrodeposited surfaces
50 which comprise alloys of tungsten, molybdenum,
tantalum, thorium and other similar refractory
metals having the electrical characteristics which
are desirable in this particular use.

As will be seen more fully hereinafter, the per-
55 centages of the respective components of the sur-

face may be changed or modified within a wide
permissive range to correspondingly modify the
electrical characteristics of the surface. It will
at once be seen that given the possibility of pro-
ducing a surface including such refractory metals
5 as tungsten, together with metals such as tanta-
lum, which are not only refractory but which
have a desirably low work function, electron
emitters of high efficiency are available.

In order more clearly to explain the invention 10
a typical embodiment is shown in the accompany-
ing drawing, in which:

Figure 1 is a conventionalized illustration of a
typical vacuum tube.

Fig. 2 is an enlarged detail section of the fila- 15
ment.

As shown in the drawing, the invention may be
embodied in a vacuum tube comprising an evacu-
ated envelope 1 which is formed with the usual
base or ferrule 2 and the contacts 3. The tube 20
may be a hard or soft tube and is producible by
methods well known in the art. The effective
operating elements of the tube include the fila-
ment 4, grid 5 and plate 6. The tube may also
25 be formed with the usual screen 7. Such ele-
ments may be connected through suitable insu-
lated leads to the contacts 3 in the manner well
known to those skilled in the art.

In accordance with the invention one or more
of these elements, such for example as the fila- 30
ment, plate or grid, may be formed with special
electrodeposited surfaces of tungsten in combina-
tion with other metals so as to produce the de-
sired electrical characteristics.

In carrying out the invention, for example, a 35
tungsten nickel alloy may be electrodeposited
upon a suitable base, such as ferruginous or non-
ferruginous wires or plates in accordance with the
process described in our copending application
Serial No. 744,566, filed September 18, 1934. 40
Similarly the invention comprehends the employ-
ment as electron emitting surfaces of special elec-
trodeposited alloys containing such refractory
and effective electron emitting metals as tung-
sten, tantalum, molybdenum and thorium. De- 45
sirable combinations of these metals may be elec-
trodeposited in the form of an alloy upon a suit-
able base metal and utilized as filaments, grids or
plates in electronic tubes. Such alloys may be
employed either in binary form, such for exam- 50
ple as an alloy of tungsten and tantalum, or in
polynary alloy form in combination with other
desirable metal components, such as thorium,
nickel and the like.

An effective method of producing elements of a 55

thermionic tube comprises the utilization of an electrolyte, such for example as described in copending application Serial No. 14,372, filed April 2, 1935, or copending application Serial No. 28,187, filed June 24, 1935. Similarly, improved results, especially where the elements treated are desired to be used as filaments, may be secured by adding to the electrolytic bath a compound having a potentially available thorium ion so as to coplate or codeposit thorium in association with tungsten, tantalum or nickel or combinations thereof. This may be done, for example, by adding a predetermined quantity of thorium to the bifluorid bath as described in copending application Serial No. 28,187. When an electric current is passed through such a bath it is found that there is plated out on the cathode a metallic surface containing an appreciable quantity of metallic thorium, in combination or alloyed with tungsten, nickel and tantalum.

It will be appreciated, as has been explained in the copending applications referred to, that by the proper adjustment of temperature, hydrogen ion concentration and current density, the respective quantities of the several metals which are codeposited may be varied so as to secure any desired combination and thus insure a wide permissive range of electronic characteristics in the resultant plate. It is particularly to be observed that with this method of electrodeposition such refractory metals as tungsten, together with highly emissive metals, such as thorium and such metals as tantalum which are not only refractory but which also present a low work function, the electronic characteristics of an element may be advantageously modified or varied so as to secure a novel composite electrode having the characteristics desired for any particular use.

As intimated hereinbefore, the elements produced according to the present invention may be employed for the several elements of a hard or soft tube, such as the filament, grid, or plate. Depending upon the particular use to which the element is to be put, the electrolytic bath or the plating conditions may be modified so as to increase or decrease the respective quantity of any particular component. By this process of coplating nickel, for example, with tungsten and tantalum, or of an alloy of nickel, tungsten, tantalum and thorium, and by the potentially variable composition of the plate, the physical characteristics of the elements may be controlled within a relatively wide range to thus impart to the element such features as improved ductility, tensile strength, thermal refractory characteristics and the like. Similarly the physical character of the resultant plate may be further modified by codepositing other metals, such as iron and cobalt, together with the refractory metals described.

It will likewise be appreciated that the special surfaces herein defined may be electrodeposited upon any suitable metal, such as ferrous or non-ferrous bases. If desired the special surfaces may be plated upon pure tungsten or tungsten alloys, molybdenum or molybdenum alloys, or in fact upon any metal or alloy which functions effectively as a cathode in the electrolytic bath.

Likewise it is within the contemplation of the invention to specially treat the plated cathode

prior to use as an element in a thermionic tube. For example a filament produced according to the present invention and which presents a surface containing such metals as tungsten, thorium or tantalum may be flashed and heat treated at elevated temperatures so as to improve the emissive characteristics of the surface. It is to be observed that since the effective surface of the electrodes described herein comprise alloyed elements, offsetting is materially diminished.

It is to be observed that special electrodes, of differential cross-sectional characteristics, may be readily produced under the operations herein-described. As has been pointed out in the prior applications referred to, the respective quantities of the several components of the alloys may be varied, during a given plating operation, by modifying the temperature or current density or by modifying both the current density and temperature. In this manner electrodes may be made up having a differential composition in cross-section. Thus, for example, electrodes may be produced by electro-codepositing nickel, thorium or tantalum upon a suitable base, such as tungsten base plate, and thereafter there may be electrodeposited on the plate an alloy of tungsten, tantalum and nickel. The element may be thereafter heat treated to insure the controlled diffusion of thorium through the element.

As noted above, operating under the principles of the present invention, elements for electronic tubes may be produced having a wide variety of thermal or electrical characteristics fitting them especially effective for use as emitters, plates or grids.

While the invention has been described with respect to the special surface of the elements of a tube per se, that is to say the filament, grid, plate and the like, it is to be understood that if desired special surfaces may be electrodeposited upon the envelope itself, where such envelope is constructed of metal.

While preferred modifications of the invention have been described, it is to be understood that these are given didactically merely for the purpose of explaining the underlying principles of the invention and not as limiting the invention to the specific illustrations set forth.

We claim:

1. A grid for thermionic tubes which comprises a suitable metal base having electrodeposited thereon a surface including tungsten and tantalum together with a metal of the iron group.

2. A control grid for thermionic tubes comprising a conductive base member having an adherent electrodeposited surface of an alloy of tungsten and nickel.

3. A control grid for thermionic tubes comprising a conductive base member having an adherent electrodeposited surface containing tungsten, tantalum and nickel.

4. A method of producing improved electronic filaments of tubes which comprises electrodepositing on a conductive base a surface containing thorium in association with tungsten and nickel, overplating on said surface a co-deposit of tungsten, tantalum and nickel, and heat treating the filament to effect diffusion of the thorium contained in the first plate.

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