

July 3, 1934.

R. A. JACOBUS

1,964,761

GRID ELECTRODE

Filed Oct. 25, 1933

FIG. 1

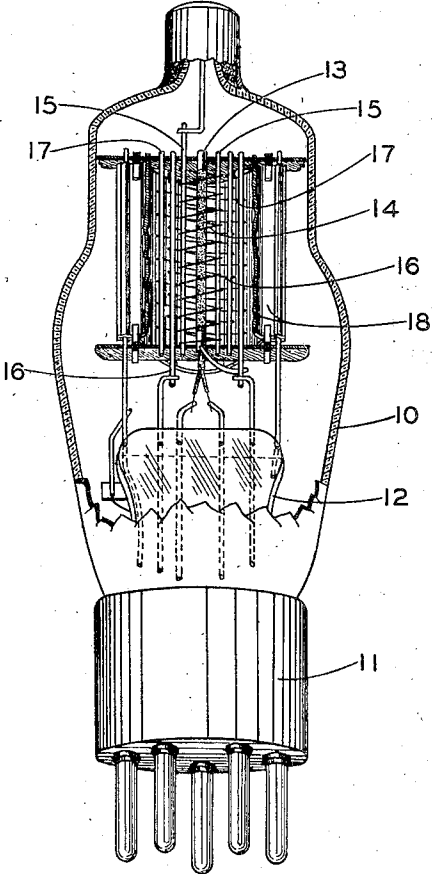
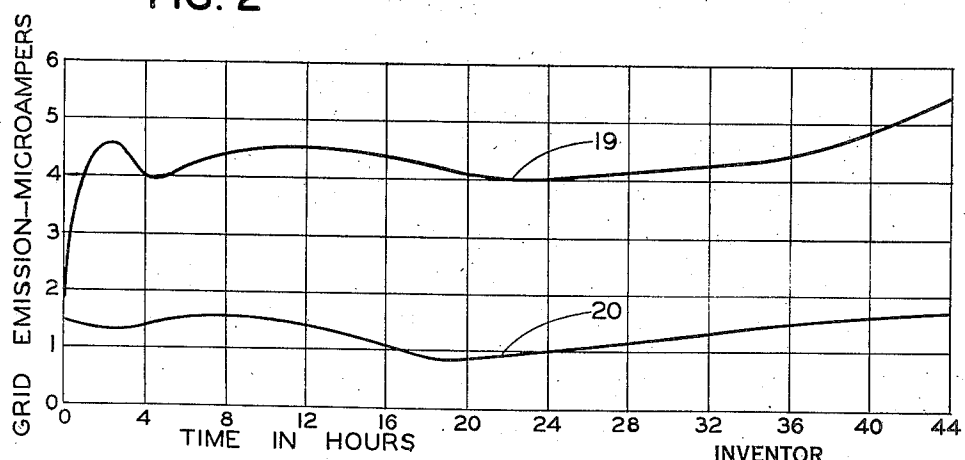


FIG. 2



INVENTOR
RICHARD A. JACOBUS.

BY
Charles M. C. Carr
ATTORNEY

UNITED STATES PATENT OFFICE

1,964,761

GRID ELECTRODE

Richard A. Jacobus, Upper Montclair, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application October 25, 1933, Serial No. 695,061

4 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices of the type having a thermionic cathode coated with oxides of the alkaline earth metals and one or more cooperating grid electrodes adjacent the cathode and more particularly to the structure of the cooperating grid electrode adjacent the cathode.

In such tubes as heretofore made difficulty has been encountered in some cases during operation of the tube due to electron emission from the grid electrode adjacent the thermionic cathode. This grid emission, which probably depends on the deposition on the grid of alkaline earth oxides driven off from the oxide coating on the cathode, depends on the temperature of the grid and may become objectionably high in tubes in which the grid becomes quite hot during operation. This grid emission may produce objectionable effects; for example, in a resistance coupled amplifier a vicious cycle occurs, as grid emission causes a drop in the grid bias, which increases the plate current; the increased plate current heats the plate, and heat radiated from the plate heats the grid and thus further increases the grid emission. If the amplifier is transformer coupled the effects of grid emission are not so noticeable, but transformer coupling is more expensive than resistance coupling. In resistance coupled amplifiers the voltage amplification depends largely upon the resistance in the grid circuit and where grid emission is present the grid resistor is necessarily small. In the radio frequency types of tubes grid emission will lower the impedance of the input grid circuit, resulting in a loss in sensitivity and selectivity of the radio receiver in which the tube is used. Grid emission will also prevent the desired sharp plate current cut-off characteristic of the tube because the electrons emitted by the grid will go to the plate and produce some plate current after the flow of the electrons from the cathode has been entirely cut off by the negative field of the grid.

Grid electrodes which, under normal operation, run rather hot have usually been made of molybdenum wire, which has desirable physical characteristics, but is expensive, and has a rather high and undesirable emission when used as grid wire near an oxide coated cathode. Nickel wire is much cheaper, but does not have the necessary hot strength and produces a grid of rather high grid emission.

One of the objects of my invention is to provide an electron discharge device employing an oxide coated cathode, in which electron emission from

the grid will be substantially less than that in these devices as heretofore made.

Another object is to provide an improved material for the grid electrodes of electron discharge devices. In accordance with my invention I make a grid electrode of an alloy which is predominately nickel and also contains an effective amount of manganese. I have obtained good results with an alloy consisting of 95% nickel and 5% manganese. Such an alloy has a hot strength considerably greater than nickel, and can be used for grids in a number of tubes in which nickel would not be satisfactory. A greater advantage than the hot strength of the alloy is the marked reduction in grid emission which is observed with grids made of this alloy and used in radio tubes with oxide coated thermionic cathodes. This reduction in grid emission may be due to the manganese, and it is possible that the manganese in the alloy grid wire reacts with the alkaline earth oxides deposited on the grid wire and converts these oxides into thermionically inactive compounds.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, will be best understood by reference to the following description taken in connection with the accompanying drawing in which:

Figure 1 is a perspective view with parts broken away of a representative type of tube made in accordance with this invention;

Figure 2 shows the comparative grid emission characteristics of two tubes, one with a control grid made of molybdenum wire and the other with a control grid made of manganese nickel wire.

The tube shown in Figure 1 as representative of the types of tubes in which my invention may be employed comprises a sealed evacuated bulb enclosing the tube electrodes and having the usual base 11 and reentrant stem 12 which carries the electrode assembly. This electrode assembly comprises an oxide coated indirectly heated cathode 13, a control grid in the form of a helix 14 wound on the usual side rods 15, a grid 16, a suppressor grid 17, and a plate 18, the grid and plate being coaxial with the cathode 13 and successively surrounding it in the order named. The suppressor grid is connected to the cathode 13 by the usual jumper or connector between the cathode and the suppressor grid lead. The control grid helix 14 surrounding and adjacent the cathode 13 is of manganese nickel wire, and the side rods 15 may be of manganese nickel or of nickel or other suitable metal. When the thermionic cathode 13 is heated during exhaust and subse-

quent operation of the tube, some of the electron emitting coating is driven off the cathode sleeve and deposits upon the grid wire of the control grid 14 and to a lesser extent upon the grids 15 and 16. During operation of the tube the control grid and particularly the grid helix 14 may attain a temperature at which considerable electron emission occurs if the grid helix 14 is of molybdenum, nickel, or nichrome wire. The electron emission from the grid prevents the desired sharp plate current cut off characteristic, as this stray emission produces some plate current even after the electron stream from the cathode is cut off by negative bias on the control grid. The grid emission also causes the grid to become less negative or more positive and in cases where there is a grid resistor and a grid biasing voltage source in the grid circuit the grid's emission may cause enough reduction of the bias on the grid 14 to permit an increase in plate current. The current flowing to the grid 14 through the grid resistor in the external grid circuit produces across the grid resistor a voltage drop opposed to the biasing voltage and thus reduces the normal grid bias by the amount of this opposing voltage drop. For example, if the grid resistor has a value of 1 megohm and the grid current flowing is one microampere, the voltage drop is one volt and a normal negative grid bias of three volts will be reduced to two volts.

When the grid helix is made of manganese nickel wire in accordance with my invention, as represented in Figure 1, the electron emission from particles of cathode coating on the helix will be very much less than when the helix is made of the commonly used metals, as shown by the curves of Figure 2.

Referring now to Figure 2 the curves 19 and 20 show the grid emission in microamperes over a period of 48 hours in two tubes constructed as shown in Figure 1 and with the helix of the control grid of the tube which gave curve 19 made of molybdenum wire, and of the one made of manganese nickel alloy in accordance with my invention. The curve 19 shows that the average grid emission is comparatively high and that there is a general increase of the grid emission during

the operation of the tube with the molybdenum wire grid. The curve 20 shows that the average grid emission in the same type of tube with the helix 14 of the control grid made of manganese nickel is substantially less, and also that the average grid emission does not increase during operation of the tube for the same length of time. The screen grid, the suppressor grid, and any other grid in the tube may also be made of manganese nickel wire to minimize grid emission from these grids. Grid emission from the grid next the cathode is usually greater than from any of the other grids because it receives more of the cathode coating and is heated more than any of the other grids by heat radiated from the cathode.

This invention is not limited to pentode types of tubes such as illustrated and described above, but may equally well be employed in triode, tetrode or other multigrid types of tubes. The scope of this invention is limited only by the appended claims.

What is claimed as new is,—

1. An electron discharge tube comprising an oxide coated cathode, a cooperating anode, and a cooperating grid electrode of an alloy of manganese and nickel which is predominately nickel interposed between said cathode and said anode.

2. An electron discharge tube comprising an oxide coated cathode, a cooperating anode, and a grid electrode interposed between said cathode and said anode and made of an alloy of approximately 95% nickel and approximately 5% manganese.

3. An electron discharge tube comprising an indirectly heated oxide coated cathode, a plurality of cooperating grid electrodes surrounding said cathode, one of said grid electrodes having a helix made of a wire of an alloy of manganese and nickel which is predominately nickel, and a cooperating anode surrounding said grid electrodes.

4. A grid electrode for use in an electron discharge tube, said grid comprising a helix of an alloy of manganese and nickel which is predominantly nickel and having a relatively low electron emissivity.

RICHARD A. JACOBUS.

50

125

55

130

60

135

65

140

70

145

75

150