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ELECTRON DISCHARGE DEVICE AND METHOD OF MAKING THE SAME.

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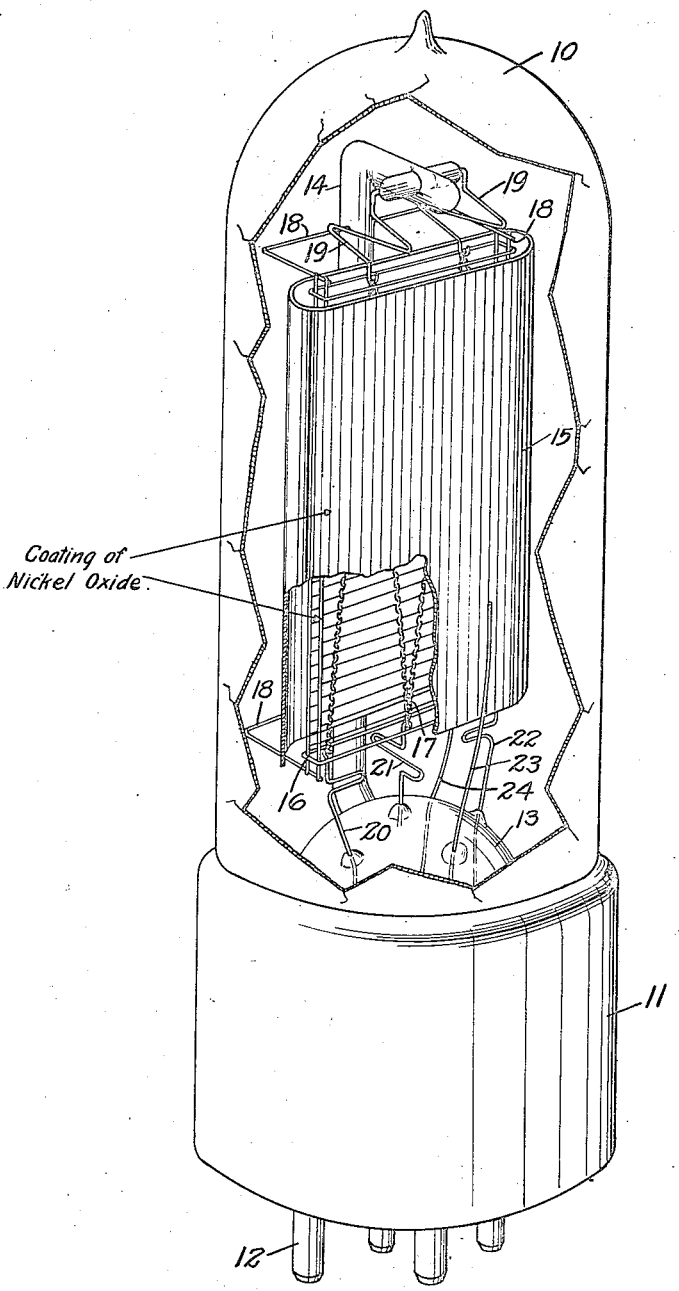

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UNITED STATES PATENT OFFICE.

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ELECTRON-DISCHARGE DEVICE AND METHOD OF MAKING THE SAME.

Application filed November 15, 1919. Serial No. 338,213.

To all whom it may concern:

Be it known that I, MERVIN J. KELLY, a citizen of the United States, residing at New York, in the county of Bronx, State of New York, have invented certain new and useful Improvements in Electron-Discharge Devices and Methods of Making the Same, of which the following is a full, clear, concise, and exact description.

This invention relates to electron discharge devices and to a method of manufacturing them.

One object of the invention is to increase the amount of power which may be applied to an electron discharge device while still keeping within the safe limits of temperature under which the electrodes can function.

Another object is the elimination of the objectionable effect which is sometimes produced in electron discharge devices, namely "blocking", which is caused partly, at least, by undesirable secondary emission from the grid.

Still another object is to eliminate the effects upon the operation of electron discharge devices which the lodgement of particles of the filament coating upon the grid have caused.

One feature of my invention comprises the provision of a black coating on the electrodes of electron discharge devices, particularly the plate and grid. In a preferred form of my invention using electrodes composed of nickel, a coating of oxide of nickel is produced on the surface by oxidation at a suitable temperature, preferably about 900° C. in an electric furnace in the presence of air. Using other metals for electrodes, such as molybdenum, other suitable black coatings may be formed within the spirit of my invention.

Electron discharge devices have been deficient in their operation in one respect because only a limited amount of power could be handled by them without heating the electrodes beyond a safe temperature. By increasing the capacity of the electrodes to radiate heat faster, we can increase the power applied and still keep the temperature within safe limits.

Furthermore, electron discharge devices, particularly when considerable amounts of power are handled, have been subject to a "blocking" phenomenon which has paralyzed the tube operation. When strong electron currents are passing, the bombardment of the grid sometimes produces a secondary emission from the grid, the flow of which secondary current is opposed in direction to the normal operating electron or space current. In some cases, this secondary current has completely neutralized the normal current, and thus "blocked" the proper functioning of the device.

A second feature of my invention involves the coating of the grid or control electrode with a substance which acts to substantially eliminate electron emission therefrom. It has been found that nickel oxide, or molybdenum oxide on the grid surface produce this result. Other substances which are semi-insulating in their properties may be used. It is not here necessary to develop the theory as to why such a coating on the grid reduces the electron emission therefrom and is sufficient to state that these coatings do so reduce it.

My invention is illustrated in the drawing which shows a form of device to which my invention is applied.

As illustrated, the device involving my invention comprises a preferably evacuated bulb 10 to which the usual base portion 11 is attached. This base portion provides a support for suitable terminals 12. Within the bulb 10 is a stem portion 13 from which an arbor or post 14 arises. This arbor 14 provides means for supporting an anode 15, a grid 16 and a filament 17. The anode as shown is in the form of a hollow cylinder having an oval cross section and is supported by suitable wires extending from post 14, these wires not being shown. The anode 15 surrounds the grid 16 and the filament 17. The grid 16 is supported from the arbor 14 by means of wires, such as 18, and the filament 17 is supported from the arbor 14 by means of wires 19 connected to the top of the filament. The filament is supported at its bottom by means of wires 20, 21 and 22. The wires 20 and 22 also serve as lead-in wires for the current applied to the filament. Wires 23 and 24 are lead-in wires connecting respectively to the plate and the grid. While I have described the mechanical arrangement of the electrodes within the tubes shown, my invention should not be supposed to be limited to this particular type of tube which is shown merely

for the purpose of illustrating one form of tube to which my invention is applicable.

In the manufacture and preparation of the electrodes for assembly within the tube, the plate 15 and the grid 16, which are in the form shown, of nickel, are preferably subjected for a suitable time in an electric furnace to a temperature of about 900° C., in the presence of air or oxygen. This treatment produces on the surfaces of these electrodes a coating of black nickel oxide. This coating, possessing as it does the characteristics of a black body radiator, provides a means whereby the electrodes more efficiently radiate heat so that greater amounts of power can be supplied to them at a given temperature of operation.

In the case of the coating applied to the control or grid electrode 16, it is found that secondary emission from the grid is practically eliminated and that thermionic emission from the grid, due to the presence thereon of particles of coating from the filament, is likewise substantially reduced.

In some cases, particularly where the device is to be used for a detector of minute currents or as a detector or amplifier which operates intermittently, it is found that the device will operate more efficiently if the coating is removed from the surface of the plate which lies in the path of the electron stream. The coating may be removed in any suitable manner and a preferred method of so removing the coating comprises the subjection of this face to the action of a jet of hydrogen or other reducing agent while the face is heated. Another method of removing the coating is to subject the electrode face to the action of a blast of abrasive material which efficiently removes the coating.

By thus coating the electrodes in the manner above described, I not only substantially eliminate secondary and thermionic emission from the grid, but I also increase the radiating efficiency of the device to such an extent that approximately at least twice as much power can be handled by a device constructed in accordance with my invention.

What is claimed is:—

1. The method of manufacturing electron discharge devices which comprises producing a black coating on the surfaces of an electrode and then removing the black coating from one of said surfaces.

2. The method of manufacturing electron discharge devices which comprises producing a black coating on the surfaces of an electrode and then removing the coating from one of said surfaces by means of a reducing agent.

3. The method of manufacturing electron discharge devices which comprises producing a black oxide coating on the surfaces of an electrode and then removing the coating from one of said surfaces by means of a reducing agent.

4. The method of manufacturing electron discharge devices which comprises producing a coating on the surfaces of an electrode by means of subjecting it to high temperature in the presence of air and then removing the coating from one of said surfaces by means of a reducing agent.

5. The method of manufacturing electron discharge devices which comprises producing a coating on the surfaces of an electrode by means of subjecting it to high temperature in the presence of air and then removing the coating from one of said surfaces by means of a blast of abrasive material.

6. An electron discharge device comprising a cathode, an anode and a grid electrode, said grid electrode being interposed between said cathode and anode, and a coating for said grid electrode capable of substantially eliminating electron emission therefrom.

7. An electron discharge device comprising a cathode, an anode, and a grid electrode, said grid electrode being interposed between said cathode and anode, and a semi-insulating coating for said grid electrode capable of substantially eliminating electron emission therefrom.

8. An electron discharge device comprising a cathode and anode, said anode having one side lying outside the path of electron current, and a black coating for that side of said electrode.

9. An electron discharge device comprising a cathode and an anode, and a black coating on said anode.

10. An electron discharge device comprising a cathode and a control electrode spaced apart from said cathode, and a black coating on said control electrode.

11. An electron discharge device comprising a cathode, anode and control electrode, said control electrode and said cathode being spaced apart and a black coating on said anode and control electrode.

12. An electron discharge device comprising a cathode and an anode, said anode having a surface faced away from said cathode and a black coating for that surface of said anode.

13. An electron discharge device comprising a cathode, anode and control electrode, said control electrode and said cathode being spaced apart, a black coating for said control electrode and a black coating for all parts of the anode which do not lie in the path of the electron current.

14. An electron discharge device comprising a cathode, a control electrode of nickel spaced apart from said cathode, and a coating of nickel oxide on said control electrode.

15. An electron discharge device comprising a cathode, an anode of nickel and a coating of nickel oxide on said anode,

16. An electron discharge device comprising a cathode, an anode of nickel and a control electrode of nickel, and a coating of nickel oxide for said anode and said control electrode.

17. An electron discharge device comprising a cathode, a grid electrode surrounding said cathode and spaced apart from the same, and a black coating for said grid electrode.

18. An electron discharge device comprising a cathode, a grid electrode surrounding said cathode, an anode surrounding said cathode and said grid electrode, and a black coating on said anode and grid electrode.

19. An electron discharge device comprising a cathode, a control electrode surrounding said cathode, an anode surrounding said control electrode and said cathode, a black coating for said control electrode and for the side of the anode facing away from the cathode.

20. An electron discharge device comprising a cathode, a control electrode surrounding said cathode, an anode of nickel surrounding said control electrode and said cathode, and a coating of nickel oxide for said control electrode and said anode.

21. An electron discharge device comprising a cathode, a control electrode of nickel surrounding said cathode, an anode of nickel surrounding said control electrode and said cathode, and a coating of nickel oxide for said control electrode and for that part of the anode which faces away from the cathode.

22. An amplifier comprising a cathode and anode, and a coating having good heat radiating qualities on said anode.

23. An electron discharge device comprising cathode, anode and control electrodes, said control electrode and said cathode being spaced apart, and a secondary electron suppressing coating on said control electrode.

24. An electron discharge device comprising a cathode, an anode and a control electrode, said control electrode and said cathode being spaced apart, a secondary electron suppressing coating on said control electrode, and a heat radiating coating on said anode.

In witness whereof, I hereunto subscribe my name this 11th day of November, A. D. 1919.

MERVIN J. KELLY.