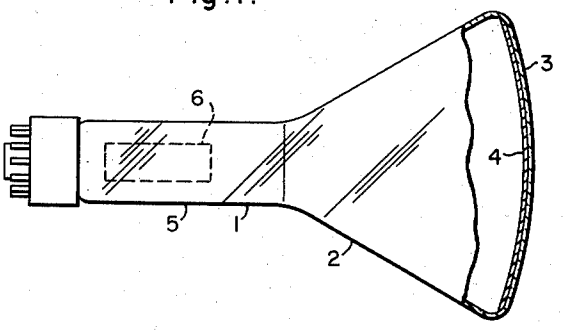
Dec. 20, 1960 G. R. FEASTER ET AL 2,965,793

ELECTRON DEVICE

Filed May 12, 1959

Fig. 1.



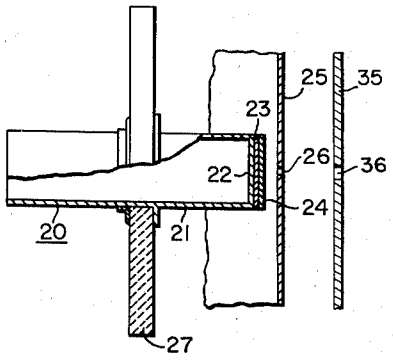




Fig. 2.

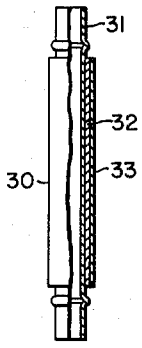



Fig. 3.

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# ELECTRON DEVICE

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This invention relates to electron discharge tubes and more particularly to an improved cathode therefor having increased life and stability.

The use of pure platinum cores in cathodes is well known in the tube art, and the use of platinum offers certain advantages in manufacturing long-like cathodes. Even through these advantages have been recognized, the use of solid platinum core cathodes has had a very limited use due to the high cost of platinum. Nickel core cathodes are widely used in electron tubes due to certain advantages, one of which is low cost. However, the nickel core cathodes have certain disadvantages which include susceptibility to oxygen poisoning and relatively short life.

It is, therefore, an object of this invention to provide an electron tube, the cathode of which possesses not only the combined advantages of a solid platinum core cathode and a nickel core cathode, but also possesses unique advantages resulting from the combination.

It is another object of this invention to provide a cathode having a metallic core which is coated with platinum.

It is a further object of this invention to provide beam forming means having a cathode with an active nickel core which is coated with platinum.

It is an additional object of this invention to provide a cathode having the combined advantages of long life and low cost.

It is an auxiliary object of this invention to provide a cathode having a means to replenish the supply of active metal within the electron-emitting coating.

It is a supplementary object of this invention to provide a cathode wherein the nickel core and its contained reducing agents are protected from undesired oxidation by a platinum coating, yet wherein the reducing agents can diffuse through the platinum during the life of the cathode to activate the oxide electron-emitting coating.

These and other objects of this invention will be apparent from the following description taken in accordance with the accompanying drawing, throughout which like reference characters indicate like parts and which drawing forms a part of this application, and in which:

Fig. 1 shows diagrammatically a cathode ray tube embodying the invention;

Fig. 2 shows the portion of the electron gun of the cathode ray tube shown in Fig. 1 adjacent the cathode;

Fig. 3 illustrates a cathode suitable for use in a receiving tube which embodies the invention.

Although the principles of this invention are broadly applicable to all electron tubes containing oxide cathodes, the invention is illustrated and described with particular reference to cathode ray tubes.

With specific reference to Fig. 1 there is shown a cathode ray tube embodying the invention. The cathode ray tube of Fig. 1 comprises an evacuated envelope **1** of suitable material, glass, for example, with an enlarged conical section **2** having a faceplate **3** and a target **4** at the end thereof and a narrow neckpiece **5** in which is located an electron gun **6**. In Fig. 2 that portion of the electron gun **6** immediately adjacent the cathode is shown in greater detail. The cathode **20** comprises a tubular cathode core of a suitable material such as a customary cathode nickel alloy which has an elongated body portion **21** and an end closure **22**. One suitable nickel alloy for the cathode core is the material known as active nickel. This nickel alloy contains controlled small percentages of various substances such as aluminum, titanium and magnesium which migrate to the surface of the cathode core and produce free alkaline earth metals due to the reduction of the alkaline earth oxides in the coating **24**. A continuous coating of metallic platinum **23** is provided which covers at least the end portion **22** of the cathode core. A coating **24** of electron emissive material, barium-strontium oxide for example, is provided on the platinum coating **23**. When the cathode is heated to a red heat, for example, by a heater, a cloud of electrons is thermionically emitted from the electron emissive surface **24**. The cathode **20** is positioned coaxially within a cylindrical control electrode by means of an insulating spacer ring **27**. The end of the cylinder nearest the electron emitting surface **24** of the cathode **20** is closed by a disc **25** which is positioned closely adjacent to the electron-emitting surface of the cathode . A small aperture **26** is provided opposite the cathode-emitting surface which has a considerably smaller area than the area of the electron-emitting coating **24**. An anode **35** is positioned adjacent the control electrode which has a small aperture **36** that is substantially coaxially aligned with the aperture **26** in the control electrode and the cathode. The anode is maintained at a positive potential with respect to the cathode, and a small diameter high density electron beam is produced by the coaction of the cathode **20**, control electrode and the anode. A more detailed explanation of the operation of an electron gun may be had by referring to U.S. Patent 2,773,212 issued to James A. Hall.

In Fig. 3 is shown a cathode suitable for use in a receiving tube. This cathode comprises a core **31** of a customary cathode nickel alloy, a continuous coating of metallic platinum **32** and an electron emissive coating **33**. The coating of platinum is provided at least in the area to which the electron emissive coating **33** is applied to the cathode core. The platinum coating may be applied to the active nickel core by any suitable method which gives intimate thermal and electrical contact between the core and the platinum coating, such as a cladding or electroplating operation, for example.

A suitable plating process can be found in "Metal Finishing Guidebook," 1958 edition, published by Finishing Publications, Inc., Westwood, New Jersey. A suitable plating solution that has been used and gives satisfactory results is as follows:

| | | |
|---|---|---|
| Water | liter | 1 |
| Ammonium nitrate | gms | 100 |
| Sodium nitrate | gms | 10 |
| Platinum P-salt (61%) | gms | 10 |
| Ammonia (conc.) | cc | 50 |
| Current density | amp./sq. ft | 55–120 |
| Temperature | ° C | 95 |

The Platinum P-salt referred to is a platinum diammino nitrite of the formula $Pt''(NH_3)_2(NO_2)_2$ and can be purchased from Baker & Company, Inc., Newark, New Jersey.

The conventional type electron gun currently used in cathode ray tubes as, for example, television picture tubes generally comprises a cylindrical cathode with a flat electron emissive surface, an apertured modulating electrode in close proximity to the cathode emissive surface and an anode in close proximity to the control electrode on the

side opposite the cathode. Further accelerating and focusing anodes may be located after the first anode.

The principal disadvantage of this type of arrangement is that the area of the cathode from which the electron beam is derived is relatively small due to the small aperture in the control electrode through which an electric field set up by the first anode may be effective to form an electron beam from electrons thermally emitted from the cathode. To maintain emission the cathode must possess a sufficiency of the active metal, barium, for example, within its oxide matrix. Due to the fact that the active metals diffuse laterally through the alkaline earth oxide to some extent but do not diffuse through or over nickel at all, the tube life is largely determined by the life of the central portion of the cathode-emitting surface. By coating the cathode core with patinum metal, a metal into and on which alkaline earth metals diffuse easily, a supplementary diffusion path is offered to assist the diffusion of the active metal to the central emitting area of the oxide matrix. Thus, by this invention the peripheral, unused, electron emitting area of alkaline earth metal oxides is caused to act as a supply area of alkaline earth metals as they are depleted, by the action of gas ions for example, from the central electron emitting area of the oxide coating and thereby achieve much longer cathode life.

To maintain the high current levels that are needed and used in ordinary tubes, this invention provides a nickel core under the platinum coating to provide activating material i.e., reducing agents, by diffusion through the platinum to the barium strontium oxide coating. As is customary, within the nickel core, reducing agents are provided which give direct chemical production of barium from the matrix by reduction of the barium oxide layer. The reducing agents are dispensed gradually throughout the life of the cathode to the coating by diffusion through the platinum. Furthermore, the platinum acts as a barium reservoir due to the fact that barium is absorbed in the platinum layer and then released to the oxide coating later when the content of barium within the oxide layer falls. To obtain this reservoir action it is generally necessary for the depth of the platinum layer to be at least one percent of the total cathode core thickness or 25 microinches, whichever is smaller. This reservoir property also enables the cathode to recover from transient oxygen attacks such as occur during the processing of a tube. The platinum coating also functions to protect the nickel core and its reducing agents from oxidation, and furthermore to provide a reduction of nickel sublimation within the tube since nickel sublimation presents a substantial contribution to interelement leakage in tubes.

It will be recognized that the objects of the invention have been achieved by providing a cathode for an electron tube having a greatly increased life. This cathode possesses the advantages of both a nickel core cathode and a platinum core cathode and possesses additional advantages due to the dispensing action of the nickel core activating impurities through the platinum coating. This cathode also allows lateral migration of the active metal



which replenishes the supply of active metal in the central electron emitting area of the cathode as it is depleted. In addition the cathode is not susceptible to poisoning due to oxidation of the reducing agents contained in the nickel core during processing.

While the present invention has been shown and described in one form only, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various changes and modifications without departing from the spirit and scope thereof.

We claim as our invention:

1. A cathode comprising a nickel core, a coating of platinum thereon, and a coating of electron emissive material thereupon.

2. In a cathode ray tube including an evacuated envelope, a target at one end thereof, and an electron gun for forming and focusing a beam of electrons upon said target, a cathode for supplying electrons for said beam comprising a nickel core, a coating of platinum thereon and a coating of electron emissive material provided over said platinum coating.

3. An electron beam forming means comprising a cathode, a control electrode and an anode, said cathode comprising a nickel core having a coating of platinum thereon and a coating of electron emissive material provided over said platinum coating, said electrodes having an aperture therein coaxial with said cathode, said anode maintained at a positive potential with respect to said cathode, said cathode, said control electrode, and said anode cooperating to form an electron beam.

4. A cathode comprising a tubular nickel core having one end closed, a coating of platinum on at least said end of said core, and a coating of electron emissive material applied upon said platinum coating.

5. A cathode comprising a tubular nickel core, a layer of platinum clad on said core, and a coating of barium-strontium oxides upon said platinum coating.

6. A cathode comprising a tubular nickel core, a layer of platinum in intimate electrical and thermal contact with said core, said platinum layer having a thickness of at least one percent of the thickness of said core, and a coating of barium-strontium oxide upon said platinum layer.

7. A cathode comprising a tubular nickel core, a layer of platinum in intimate electrical and thermal contact with said core, said platinum layer having a thickness of at least 25 microinches, and a coating of barium-strontium oxide upon said platinum layer.

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