Feb. 25, 1936. E. F. LOWRY 2,032,179

OXIDE COATED CATHODE FOR HEAVY DUTY SERVICE

Filed April 12, 1933

Fig. 1.

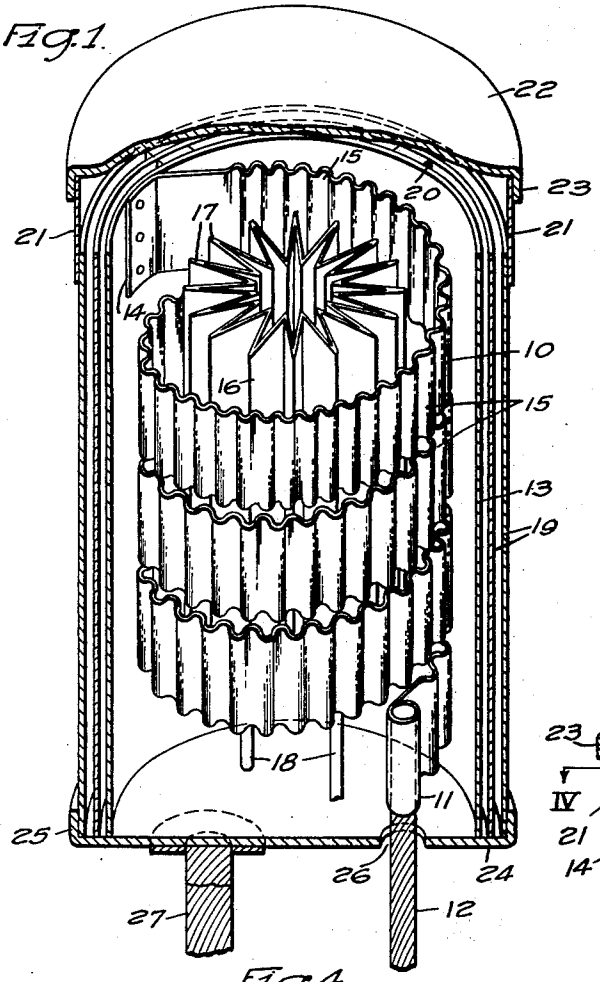


Fig. 2.

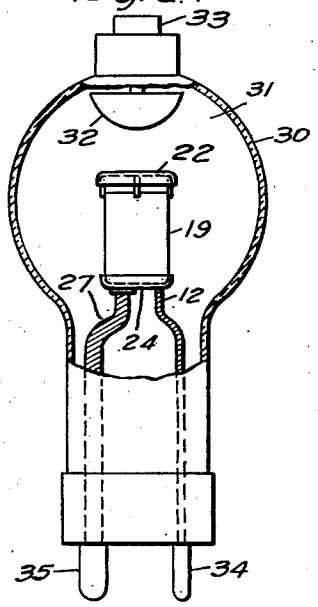


Fig. 3.

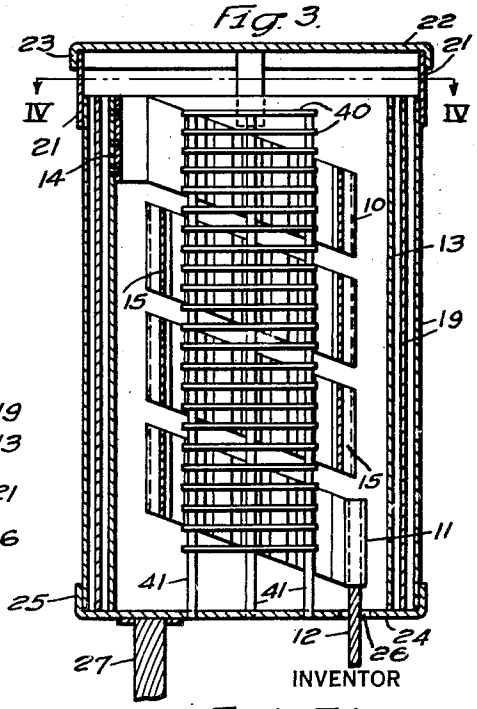
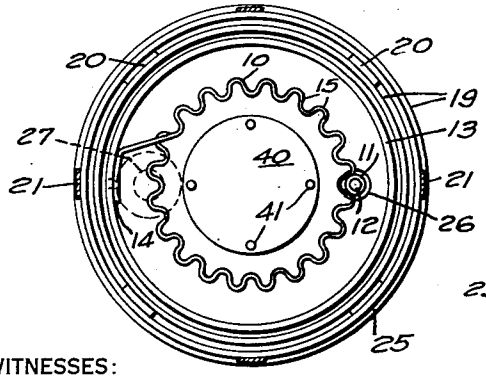


Fig. 4.



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Patented Feb. 25, 1936

2,032,179

UNITED STATES PATENT OFFICE

2,032,179

OXIDE COATED CATHODE FOR HEAVY DUTY SERVICE

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Application April 12, 1933, Serial No. 665,754

9 Claims. (Cl. 250—27.5)

This application is a continuation in part of my copending application Serial No. 612,505, filed May 20, 1932, now Patent No. 1,968,608, issued July 31, 1934, for high efficiency oxide coated cathode and method of manufacture.

This invention relates to cathodes and particularly to cathodes for use in connection with gas-filled tubes such as rectifiers.

It is an object of this invention to obtain the desired quantity of electron emission with a smaller expenditure of heating energy than has heretofore been required.

It is a further object of my invention to provide a cathode comprising a heating member enclosing an indirectly heated member and both of these in turn enclosed by one or more radiation shields.

Other objects of my invention and preferred details of the construction will be apparent from the following description and the accompanying drawing to which reference is made.

In the drawing, Figure 1 is a longitudinal view partly in perspective and partly in section of a preferred form of cathode.

Fig. 2 is a view partly in section and partly in elevation of a tube in which the cathode structure is used.

Fig. 3 is a view in longitudinal section of a modification of the invention; and

Fig. 4 is a cross sectional view taken on the line IV—IV of Fig. 3.

Referring to the drawing and especially to Fig. 1 thereof, the compound cathode comprises a directly heated ribbon or strip 10 which is preferably of nickel, nickel-cobalt-ferro-titanium alloy such as described in my copending application Serial No. 144,911 for Thermionic cathodes, tungsten or other metal suitable for cathodes. This strip 10 is preferably wound helically around a central axis and is attached at the one end 11 to a lead 12 for the heating current.

Surrounding the heating strip or ribbon 10 is a radiation shield 13 preferably in the form of a cylinder concentric with the helical turns of the strip or ribbon 10. The upper end of the ribbon filament is attached to the radiation shield 13 at the upper portion thereof as at 14. The ribbon filament preferably has crosswise corrugations 15 therein and is also preferably coated on one or both sides with an electron emitting material such as the oxides of strontium and barium.

Within the ribbon filament is a surface 16 preferably in the form of a deeply corrugated cylinder of a material similar to the material used for the ribbon filament 10 and this surface 16 is also preferably coated on one or both sides with an electron emitting material such as the oxides of strontium and barium.

These corrugations 17 preferably form acute angles and the cross sectional contour of this central portion of the cathode is preferably annular as disclosed in Fig. 1. Any suitable supports 18 may be used for this portion of the cathode.

The shield 13 is the inner one of a plurality of cylinders 19, preferably concentric with the shield 13 and with the helical turns of the ribbon filament 10. The inner surface of the cylinder 13 is coated with an electron emissive material such as the oxides of barium and strontium. The inner cylinder 13 is rigidly connected to the other cylinders 19 by spacing and supporting devices 20 near the top and bottom of the shield.

At the top of the shield structure a plurality of supports 21 space an end shield 22 from the edges of the cylindrical shields 13 and 19, thereby leaving the space between the upper edge and the end shield 22 which is unobstructed except for the supports 21. The edge of the shield 22 is preferably turned downward forming a flange 23 and the supports 21 are secured to the outer surface of the outermost cylinder 19 and to the inner surface of the flange 23.

At the bottom, the cylinders 13 and 19 are closed by a bottom shield 24 which is fitted to the outermost cylinder 19 by an up-turned flange 25. An opening 26 is provided in the bottom shield 24 for the passage of the lead 12 to the end 11 of the ribbon filament. If desired, electrical insulation may be utilized to cover this opening or to insulate the lead 12 from the shield 24. A lead 27 is connected to the bottom shield member 24 and preferably well spaced from the lead 12.

In Fig. 2 is disclosed an electron discharge device in the form of a rectifier in which my compound cathode is utilized. This discharge device includes a gas-tight container 30 preferably filled with a gaseous medium 31 of the noble gases or a metallic vapor such as that of mercury. The anode 32 is preferably of carbon and has a lead passing through the gas-tight container to an external anode connection 33. If desired, a grid may be used either around the cathode or around the anode or otherwise partitioning the space between the two main electrodes with a suitable external lead. The cathode leads 12 and 27 may act as supports for the compound cathode and are connected to external leads 34 and 35, respectively.

The lead 35 has been labeled "anode return"

for a reason that will be hereinafter pointed out.

The material for the shields 13, 19 must have good reflecting properties and, with the exception of the inner surface of the shield 13, these shields must be highly polished. The inner surface of the shield 13 must not react with the material with which it is coated even at high temperatures in such a way as to diminish its thermionic activity. Nickel is found to answer these requirements very well.

When the device is in operation, the electrons which constitute the space current emerge from the strip 10, the inner surface of the shield 13 and from the structure 16 and move to the anode 32. The space current circuit is over the lead 27 and the electrons which emerge from the cathode are returned to it over this lead. The electrons emitted from the cylinder 13 and the structure 16 constitute a major portion of the space current and the strip 10 is thus relieved from conducting that portion of the space current.

Since the combined area of the coated surface of the cylinder 13 and the structure 16 is of much greater magnitude than the area of the coated strip 10, the space current carried by the strip 10 is reduced by a large amount, namely, that corresponding to the emission of the coated surfaces of the cylinder 13 and the structure 16. The heating effect of the space current in the strip 10 is thus reduced to an amount such that undesirable overheating is unlikely even at the end 14 where the strip carries the most current.

The heat radiated by the strip 10 is absorbed by the coated portion of the shield 13 and the coated structure 16 and re-radiated into the space containing the strip 10. Comparatively little radiation occurs from the outer surface of the cylinder 13 because of its bright surface. It tends, therefore, to reflect any heat reaching it from the strip 10 back towards said strip 10 and structure 16. Similar reflections occur at each surface of each of the shields 19. The combined effect of all the shields is to minimize loss of heat by radiation from the cathode.

It will, therefore, be seen that practically all of the electron emissive coating is within the space which is shielded from radiation. The amount of heating required for a given amount of electron emission is materially diminished. By this arrangement, I find it possible to obtain the necessary temperature of the whole structure with the temperature of the strip 10 exceeding the temperature of the inner surface of the cylinder 13 by less than 100° C., while the temperature of the structure 16 will be practically the same as that of the strip 10. This similarity of temperatures of the ribbon 10 and the structure 16 follows from the fact that the major portion of the electron emitting surface of 16 is practically enclosed by the ribbon.

The device is adapted to be used with a very heavy anode current from 100 to 1000 amperes. The cathode is adapted for this large current by reason of the large electron emissive surface composed of the indirectly heated surface 16, the directly heated electron emitting surface 10 and the indirectly heated inner surface of the shield 13. Due to the small heat radiation surface, because of the deep corrugations in the surfaces 16 and 10, and also due to the surrounding radiation shields 13 and 19, the heating current may be very small. Efficiencies of one and one-half amperes or more of plate current per watt heating energy may be obtained. The anode current may be five or more times the heating current applied to the ribbon filament 10. The passage of this large heating current from the anode 32 will be across the ionized gas of the tube to the cylinders 13 and 19 to the bottom shield 24 and hence to the lead 27 connected to the anode return lead 35. The heating current will pass through the external lead 34 through the internal lead 12, through the ribbon filament 10, down the cylinders 13 and 19 to the internal lead 27 and external lead 35. It is important that, if alternating current is used for the heating current, the passage of the current will be as described during the half cycle the tube is conducting current. The lead 27 must be negative with respect to the lead 12 during the time that space current is flowing.

The cathode lead 12 is accordingly designed merely for the heating current. Due to the large cross sectional area of the radiation shields, the heating current and anode current will not unduly heat these shields 13, 19, 24 by the passage of the current therethrough. The lead 27, however, is made of greater cross sectional area than the lead 12 because it will carry the large anode current as well as the heating current. It will thus be noted that my invention contemplates protecting the heater from the large anode current of the device and yet using the heater to provide electrons for the passage of such anode current.

Figs. 3 and 4 illustrate another modification of the invention to illustrate one of the many changes that may be made within the spirit of my invention.

The compound cathode of Figs. 3 and 4 is similar to that of Fig. 1 except that the corrugated annular surface 16 of Fig. 1 has been replaced by a stack of discs 40 supported and spaced on any convenient type of supports 41. These discs are coated with electron emissive material such as the oxides of barium and strontium. In other respects the Figs. 3 and 4 are similar to that of Fig. 1.

In accordance with the patent statutes I have described particular embodiments of my invention, but it will be recognized that these are intended to be illustrative only and that the broad principle thereof will be capable of alternative embodiments which will be evident to those skilled in the art. I desire accordingly that the claims shall be given the broadest construction of which their terms are susceptible in view of the prior art.

I claim as my invention:

1. A compound cathode comprising a directly heated surface, an electron emissive surface enclosed by said directly heated surface and indirectly heated therefrom and a radiation shield enclosing said directly and indirectly heated surfaces and supporting said indirectly heated surface.

2. A compound cathode comprising a shield and a ribbon filament, a coating of electron emissive material on said filament and on the shield adjacent thereto and an electron emissive surface enclosed by said ribbon filament and indirectly heated therefrom, said shield and said filament being electrically connected.

3. A compound cathode comprising a filament, an electron emissive surface enclosed by said filament and a radiation shield enclosing said filament and said surface, said shield having an electron emissive coating on a wall adjacent said filament and shield and said surface being indirectly heated by said filament.

4. A compound cathode comprising a ribbon

filament, a surface enclosed by said ribbon filament and a radiation shield enclosing said filament and said surface, said filament, said surface and the inner surface of said shield being coated with electron emissive material.

5. A cathode comprising a surface adapted to emit electrons freely when heated, and a heater therefor comprising a metallic ribbon having its small thickness relative to its breadth disposed to substantially enclose the major electron emitting portion of said surface so that the thickness of said ribbon has a general radial direction relative to said surface, the major portion of the said surface being exposed to direct radiation from said ribbon.

6. A cathode comprising a surface adapted to emit electrons freely when heated, and a heater therefor comprising a metallic corrugated ribbon having its small thickness relative to its breadth disposed to substantially enclose the major electron emitting portion of said surface so that the thickness of said ribbon has a general radial direction relative to said surface, the major portion of the said surface being exposed to direct radiation from said ribbon.

7. A cathode comprising a surface adapted to emit electrons freely when heated, and a heater therefor comprising a metallic ribbon having its small thickness relative to its breadth disposed to substantially surround said surface so that the thickness of said ribbon has a general radial direction relative to said surface, the major portion of the said surface being exposed to direct radiation from said ribbon, and a radiation shield substantially surrounding said heater.

8. A compound cathode comprising a shield and a directly heated surface, an electron emissive surface enclosed by said directly heated surface and indirectly heated therefrom, said shield having an electron emissive coating facing said directly heated surface, said shield conserving the heat from said directly heated surface.

9. A compound cathode comprising a radiation shield and a ribbon filament, an electron emissive surface enclosed by said ribbon filament and indirectly heated therefrom, said shield having an electron emissive coating adjacent said filament, said shield supporting said surface therefrom.

ERWIN F. LOWRY.