Sept. 27, 1938. E. WALDSCHMIDT 2,131,204

INDIRECTLY HEATED THERMIONIC CATHODE

Filed Jan. 16, 1937

Fig. 1

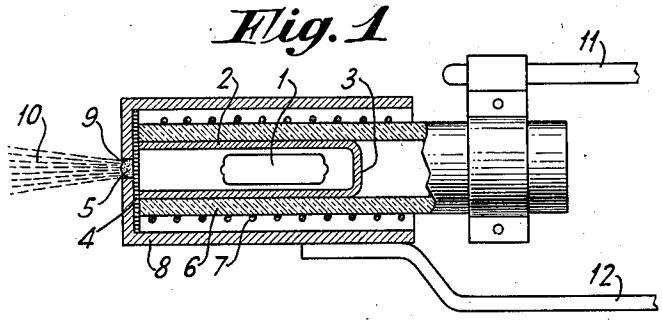


Fig. 2

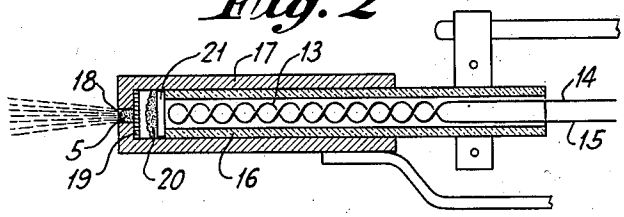
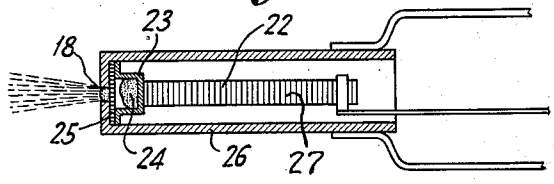


Fig. 3



INVENTOR
ERNST WALDSCHMIDT

BY Charles McClair
ATTORNEY

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INDIRECTLY HEATED THERMIONIC CATHODE

Ernst Waldschmidt, Berlin-Siemensstadt, Germany, assignor to Siemens & Halske, Aktiengesellschaft, Berlin-Siemensstadt, Germany, a corporation of Germany

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2 Claims. (Cl. 250—27.5)

My invention relates to indirectly heated thermionic cathodes and particularly to the construction of cathodes whereby the electron emissive material may be replenished during use.

In the construction and operation of indirectly heated cathodes with a punctiform emission surface for use in cathode ray tubes, the difficulty is encountered that on the one hand the emitting surface should be as small as possible, but on the other hand emissivity as great as possible should be distributed very uniformly over all the very small surface. This requirement is difficult to meet, particularly in view of the life of such a cathode, since very much smaller amounts of residual gas are able to destroy more readily the total emission of such a small cathode, with a surface of about ½ mm², than in the case of radio tube cathodes where the emitting surface is normally 200–300 times larger. Moreover, inert gases are often introduced into the tube, which are ionized by the electron discharge, and readily destroy the active emitting layer as a result of the positive ion bombardment.

It is known to use the heat supplied or produced when the cathode is in operation to evaporate to an electrode, such as the cathode for instance, a metal which has the property of maintaining at a constant value the emissivity of the cathode. However, the carrying of this principle into effect causes certain structural difficulties. The heat necessary for the evaporation must be supplied by the heating current, and therefore, the metal to be vaporized, such as barium for instance, must be deposited on or in the cathode. In doing this certain conditions must be observed; the emission surface must be uniformly coated; and furthermore, metal vapor must be prevented from depositing on other parts of the cathode, else these other parts become electron emitting at sufficiently high temperature, in which case a punctiform electron source as is necessary for many purposes, is no longer present. In cathode ray tubes for instance, it is also necessary to prevent the metal vapor produced within the tube depositing as a mirror, particularly in the vicinity of the cathode, which would vary the electrostatic conditions in the discharge space or even in the deflection chamber.

According to my invention a high emission thermionic cathode of long useful life is obtained by vaporizing during operation an activating metal, such as barium, lodged in a container so arranged that the metal vapor developed during operation can pass directly only to the real emitting surface of the cathode, which may be of very small area or punctiform. The real emitting surface is a part of an emitter which is permeable to the barium vapor.

Other objects, features, and advantages of my invention will appear from the following description taken in connection with the accompanying drawing in which Figure 1 is a longitudinal section of one example of a cathode embodying my invention, and Figures 2 and 3 are similar sections showing modifications.

In the particular form of cathode shown in Figure 1, a pellet 1, containing barium which is slowly evolved as a vapor when the pellet is heated, is placed in a metal cup 2 with a solid bottom 3 and a perforated cover, such as a grating 4, preferably of nickel, on which is deposited a mass 5 of active or electron emitting material, such as barium oxide, so that one side of the mass 5 is exposed to barium vapor evolved in the cup 2, and electrons are emitted from the opposite side or surface. The cup 2 is mounted within a tubular ceramic insulator 6 surrounded by a heater coil 7. The heater coil is in turn surrounded by a metal sleeve or shield 8 to minimize the effect upon the cathode ray of the static or magnetic field generated by current in the heater coil. The sleeve or shield 8, which is preferably of nickel, is shaped to form over the grating 4 a cup with an aperture 9 containing the mass 5 of active material from which the cathode ray 10 is emitted. Preferably the mass of active material 5 is in good contact with the metal walls of the aperture 9 and with the nickel grating 4, and produces a copious flow of electrons when the sleeve 8 is heated to electron emitting temperature. The heater coil 7 has one end connected to the sleeve 8, and is supplied from a source of heating current by a lead 11 connected to the sleeve 8 and a lead 12 connected to the other end of the coil. When the pellet 1 is heated the barium vapor evolved from it is absorbed by the mass 5, which is in effect a stopper for the only vent from the cup 2 and is permeable by the barium vapor. The heater coil 7 is so proportioned that it brings the mass 5 and surrounding parts to the proper temperature for good electron emission and also heats the pellet 1 to the temperature at which evolution or evaporation of the active metal occurs at a rate which maintains the electron emission.

In the modification shown in Figure 2, the heater 13, together with its supply leads 14 and 15, is within a ceramic tube 16 which fits snugly in a cylindrical metal sleeve 17, preferably of nickel, which forms a cap over the open end of tube 16 with an opening or aperture 18 holding the mass

5. A nickel sieve or grating 19 at the end of tube 16 adjacent the cup extends across the aperture 18 and forms a perforated bottom for the aperture 18 which holds the mass 5 of active material, such as barium oxide. The ceramic tube 16 has on its end toward the aperture a metal cover or disc 21 coated with or supporting a quantity of material 20 from which the active metal such as barium may be evaporated during the life of the cathode. The vaporized active metal passes through the grating or oxide carrier 19 and permeates the mass 5 within the aperture 18 and serves to maintain and to stimulate the electron emission. The metallic disc 21 also serves as a shield between the heating element and the material 20, the heater 13 preferably being a heater wire insulated in a known manner, for instance by an aluminum oxide coating.

Figure 3 shows a modification in which a heat conductor is utilized as a heating element. This conductor provides at its front surface a uniformly heated area and in addition possesses certain economical and structural advantages. The conductor 22 has at one of its ends a cup-shaped current carrying connector 23 of metal in which the material 24 from which it is desired to evaporate a metal such as barium is placed. The cup 23 is covered by a grating 25, preferably of nickel, serving as a support for active material, such as barium oxide, deposited on it. A metal cylinder 26 serves as an electrostatic and electromagnetic shield and also as a conductor for the heating current to the cup 23 and a heater coil 27 for the conductor 22. This structure requires a minimum of material so that the heating time is only a fraction of that of the previous modifications.

It has been found that instead of using as a source of metal vapor a compact piece of active metal which, as experience has shown, may evaporate very suddenly and rapidly, it is advantageous to have the metal absorbed in a porous body. It was found, for instance, that the metal vapor will be delivered slowly and uniformly from porous ceramic bodies with the pores filled with the metal to be vaporized. Suitable ceramic bodies are those which do not react with the active metal to be evaporated. Bodies of such materials as magnesium oxide or aluminum oxide may be treated by immersion in a solution of barium azide, followed by drying and heating in vacuum at a temperature of 300° to 350° C. to drive off the nitrogen. A porous ceramic so treated has been found to provide a source of barium which will be vaporized at the desired rate. A source of active metal vapor may also be provided from pressed masses of a reaction mixture containing barium oxide, for example, and a reducing agent, such as tantalum, magnesium, or aluminum and some inert material, if necessary, to bring about a slow reaction when the mass is heated.

Cathodes of the type above described can be used in all discharge vessels, particularly in those in which the most punctiform emission source possible is required, and are especially well suited for cathode ray tubes which find use for measuring or television purposes.

While I have indicated the preferred embodiments of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims.

I claim:

1. A thermionic cathode comprising a metal sleeve having an opening at one end, a ceramic tube fitted into said sleeve, a metal disc fitted into said sleeve adjacent the end of said ceramic tube, a metal mesh within said sleeve and between the open end of said sleeve and said disc, alkaline earth metal oxide in the open end of said sleeve and on said metal mesh, a compound which when heated evolves vapor of an alkaline earth metal on the side of said metal disc facing said metal mesh and a heater mounted within said ceramic tube adjacent said disc for heating said disc and said sleeve to operating temperature.

2. A thermionic cathode of high electron emissivity comprising a metal chamber with a single aperture in its wall, a metallic mesh chamber within said metal chamber adjacent and covering said aperture, said metal chamber enclosing a porous refractory mass impregnated with a material which evolves barium when heated, electron emitting material of a compound of barium within said aperture and on said metallic mesh member, and means for heating said material to electron emitting temperature and said porous mass to a temperature at which barium is slowly vaporized.

ERNST WALDSCHMIDT.