April 10, 1934. W. ESPE ET AL 1,954,474

GLOW CATHODE

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Fig. 1.

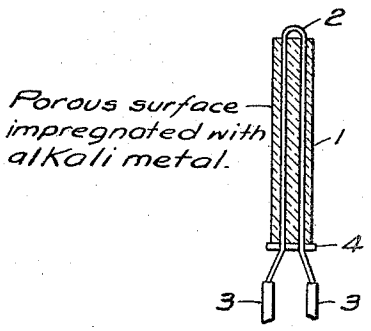


Fig. 2.

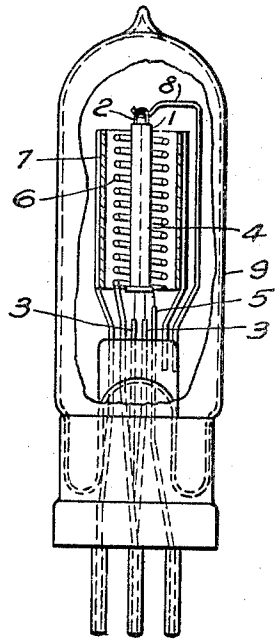
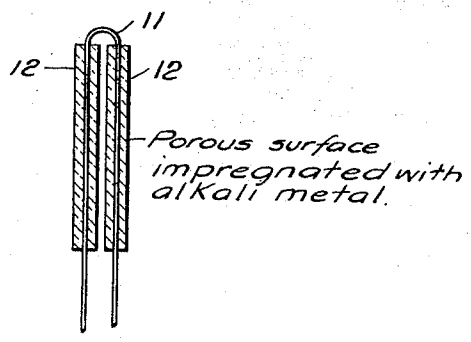


Fig. 3.



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GLOW CATHODE

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2 Claims. (Cl. 250—27.5)

Our invention relates to electron-emissive cathodes for electrical-discharge devices and particularly to cathodes in which the electron-emissive surface is insulated from the heater which maintains it at its operating temperature.

One object of our invention is to provide means for employing electron-emissive materials, such as the alkali metals, which vaporize at relatively moderate temperatures.

Another object of our invention is to provide means for preventing the vaporization of the alkali metals at temperatures above those at which they sublime freely when in a massive free state.

A further object of our invention is to provide an electron-emissive cathode in which an insulating refractory body is provided with a single surface layer which is both an electron emitter and a good metallic conductor.

Further objects of our invention will be apparent upon reading the following specification, taken in connection with the drawing in which:

Figure 1 is an elevational view showing one form of cathode structure embodying my invention;

Figure 2 is a view partly in elevation and partly in section showing an electrode electrical discharge tube employing a cathode of the type illustrated in Figure 1.

Figure 3 is a view similar to Figure 1 and showing an alternative form of cathode structure embodying my invention.

Amplifier and detector tubes have recently been developed in the radio art which employ cathodes, all portions of the surface of which are at the same electrical potential. Such tubes are particularly useful where it is desired to employ alternating current to supply the energy necessary to maintain the cathode at its proper operating temperature. In one of the best known forms of such tubes, the cathode consists of a refractory insulating core which encloses a tungsten heater energized by alternating current. The surface of the refractory core is covered by a metallic sheath which, in turn, is coated with well known electron-emissive oxides. This electron-emissive surface is maintained at its operating temperature by heat flowing to it through the refractory core, and all parts of it remain at the electrical potential of the metallic sheath underlying it.

It is known that the specific electron-emissivity of the alkali metals is much higher than that of almost any other material at relatively low temperatures. However, the sublimation point of these materials, in the free state, is relatively low. It is, in fact, so low that at temperatures giving an electron-emissivity of the order of magnitude required in practice, the alkali metals vaporize so rapidly that their employment for this purpose is not feasible. In consequence, it has heretofore been necessary, in order to obtain the desired magnitude of electron emission, to employ the refractory oxides above mentioned at the elevated temperatures at which they are capable of operating, although the much higher temperatures involved in this procedure resulted in the necessity of wasting undesirably much larger amounts of power in cathode heating.

In accordance with our invention, it is possible to employ the alkali metals at relatively low temperatures required to render them sufficiently emissive and still to prevent their rapid sublimation. When they are made to impregnate a porous refractory support, it has been found that the presence of the refractory enclosing material in immediate proximity to the small areas of surface in which the alkali metals are exposed reduces the rate of vaporization of the latter to practicable values while their very high electron-emissivity remains unimpaired. In consequence, it is possible to operate these metals at temperatures giving the required specific electron-emissivity without vaporization thereof; and such temperatures are far lower than those necessary to produce the same specific emissivity in the case of the emissive oxides heretofore employed for the same purpose.

In accordance with the foregoing principles, Fig. 1 shows an embodiment of my invention comprising an insulating porous refractory core 1 having two longitudinal holes therein. This refractory core may be composed of unglazed porcelain molded and fired by processes too well known in the art to require description here. Alternatively, it may be formed by molding silica-gel and heating the latter to reduce it to the anhydrous state. If this is done, there will result a finely porous refractory body. In accordance with yet another modification the core 1 may be of carbon; and in such case, the heater filament 2 may or may not be dispensed with and the heating current sent through the carbon core itself.

A U-shaped heating filament 2 of tungsten or other refractory resistance material, may be threaded into the holes of this core and mounted on leads 3 extending through the press of a vacuum tube. By spacing the said holes as closely as possible the magnetic field due to the heating current may be made substantially zero. The lower end of the refractory may then be sur-

rounded by a band 4 of nickel or other suitable metal which will serve to make contact with a cathode lead 5 sealed through the press aforesaid, in the manner shown in Fig. 2. The structure assembled, as thus far indicated, may then be placed inside a container adapted to be exhausted and so positioned as to be surrounded by a helix of tungsten or other refractory metal having a heavy coating of potassium thereon. The container may then be exhausted, and the potassium-coated spiral heated to such a degree that the alkali metal deposits within the pores of the silica core.

While the foregoing is one method by which the alkali metal may be deposited within the pores of the refractory base, other methods of effecting the same result will be apparent to those skilled in the art. It will also be recognized that alkali metals other than potassium may be deposited in a similar way. The penetration of the alkali metal into the interior pores of the refractory may be facilitated if the latter is maintained at an elevated temperature by energizing the heater which it encloses.

The cathode formed in the foregoing manner may then be provided with a control electrode 6 and an anode 7 of forms well known in the art, as illustrated in Fig. 2. Its upper end may be welded to a rod 8 to additionally support it. The whole may be enclosed in the usual glass tube 9 and exhausted by the standard processes now well known in the radio tube art.

As an alternative form to the foregoing, the cathode embodying my invention may be formed by coating a heater wire of tungsten or other suitable refractory conductor of the form indicated by the reference character 11 in Fig. 3 with silica-gel and then heating the latter to dehydrate the gel and form a porous silica refractory coating 12. To obtain a desirable thickness of the latter, the heater may be dipped and heated repeatedly to effect dehydration. The desired thickness of the refractory coating 12 having been obtained, it may be impregnated with the alkali metal in the manner already described for the embodiment shown in Fig. 1. It may then be provided with control electrode anode and sealed into an evacuated container by methods similar to those described in connection with Figs. 1 and 2 and now standard in the radio art.

It will be found that cathodes made in accordance with the foregoing principles will operate with the same specific electron-emissivity as oxide-coated cathodes of the conventional type but at temperatures far below those required by the latter; and that no appreciable vaporization of the absorbed alkali metals occurs at such temperatures. As a result of their lower operating temperature, cathodes of the form herein disclosed cause less drain on the stored energy of batteries if the latter are employed to maintain the necessary operating temperature. Where alternating currents are used to supply heating energy, not only is there economy in the power required, but the size of the wires which is necessary to seal through the glass walls of the enclosing tube is reduced. The foregoing are features of no inconsiderable importance in the case of tubes of larger power output.

Our invention also provides a very simple and inexpensive structure for the uni-potential cathodes desired for alternating current operation inasmuch as a single coating provides the electron-emissivity and the high electrical conductivity necessary to attain uni-potential operation.

Wherever in the claims and description herein the term "alkali metal" has been used, it will be understood to include also the alkaline earth metals.

While in accordance with the patent statutes we have described practical embodiments of our invention, it will be appreciated that the principles thereof may be embodied in numerous alternative forms of structure which will be apparent to those skilled in the art. We desire, therefore, that the following claims be limited only insofar as required by their express terms and by the limitations imposed by the prior art.

We claim as our invention:

1. An electron-emissive cathode comprising a heater element and a refractory enclosing means therefor comprising dehydrated silica-gel impregnated with an alkali metal.

2. The method of forming an electron-emissive cathode which comprises molding a core from silica-gel, dehydrating said silica-gel, and impregnating the surface thereof with an alkali metal.

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