

Dec. 13, 1932.

W. F. WINTER, JR

1,891,074

CATHODE FOR ELECTRIC DISCHARGE DEVICES

Filed Feb. 19, 1931

Fig. 1.

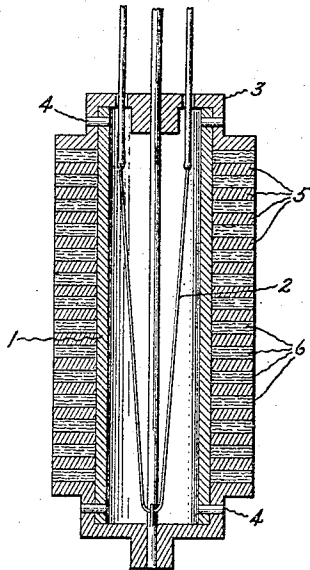


Fig. 2.

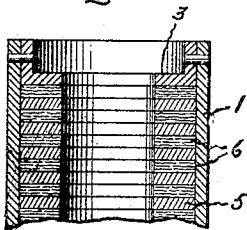


Fig. 3.

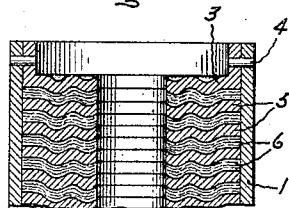
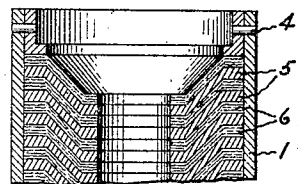


Fig. 4.



Inventor:
William F. Winter Jr.,
by *Charles E. Tuller*
His Attorney.

UNITED STATES PATENT OFFICE

WILLIAM F. WINTER, JR., OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

CATHODE FOR ELECTRIC DISCHARGE DEVICES

Application filed February 19, 1931. Serial No. 517,001.

The present invention relates to electric discharge devices and more especially to the cathode construction of such apparatus.

In order to increase the electron emission from a cathode, it has been proposed heretofore to coat the cathode surface with an alkaline earth material. Prior art cathodes may take the form of coated filaments in the smaller tubes, and in the larger devices, such as power rectifiers and the like, indirectly heated cathodes are employed to advantage. The latter usually constitute a cylinder containing a heater filament and in certain cases may be provided along its periphery with a series of radially extending vanes coated with a barium-containing compound, as is described and claimed in the Hull application, Serial No. 487,533, filed October 9, 1930, and entitled "Cathode structures for thermionic devices".

It has been found that when cathodes of this type are employed in gas tubes carrying large currents and subjected to intense positive ion bombardment, the coating tends to be knocked off and destroyed during prolonged operation. It will be understood that the coating normally is thin, hence, is not present in sufficient quantity to withstand much bombardment in addition to the normal wear caused by the production of electrons.

An object of the present invention is to improve the construction of cathodes suitable for use in gaseous discharge tubes with a view to offering a practically unlimited supply of electron emitting substance to withstand the eroding action of an electric arc. The operating life of a tube provided with the improved cathode is thus materially lengthened. Another object is to provide a cathode having a more intimate relation between the alkaline earth material and the metal member on which the material is deposited than that obtained in the prior art cathodes. The attainment of the last-mentioned object is beneficial from the standpoint of electron emission efficiency because the electrons may have as a part of their origin the compound or alloy formed between the foundation metal and the active substance so that the more intimate the mixture be-

tween these elements the greater will be the efficiency of emission. These objects are attained, in brief, by utilizing a cathode of the indirectly heated type and interleaving layers of alkaline earth material with layers of metal along the surface of the cathode. The construction of the improved cathode is such that the depth of the electron emitting substance is very substantial, in fact, this depth is limited, apart from the matter of design, only by the heat conductivity of the component metals. An intimate contact between the foundation metal and the alkaline earth material of the improved cathode is also maintained over the entire depth of the active material so that the amount of compound which is believed to be a most prolific source of electrons is substantially increased.

The invention will be better understood when reference is made to the following description of the accompanying drawing in which Fig. 1 represents a cross sectional enlarged view of a preferred embodiment of the invention, while Figs. 2, 3 and 4 show modifications of the cathode construction.

In Fig. 1, numeral 1 designates a metallic cylindrical casing within which a tungsten filamentary heater 2 is supported in any suitable manner. The ends of the casing are closed by caps 3 which carry flanges and are secured to the casing by rivets 4. The space between the oppositely disposed flanges on the member 3 is filled with a plurality of metal discs 5 preferably of nickel, between each of which is disposed a quantity of alkaline earth material 6, for example a compound of barium. The latter conveniently is formed as a coating on both sides of each disc by alternately dipping the metal member in an aqueous solution of barium carbonate and drying the same until the desired thickness of coating is obtained. The treated discs are assembled on the metal cylinder 1 and pressed together with the coating in physical contact, thereafter held securely in place by the flanged cap members which are riveted to the cylinders. The cathode may be mounted in an envelope to cooperate with other electrodes in the rectification and amplification of electric currents, as is well understood in the art. It

is evident that when the filament 2 is heated by an external source (not shown), the heat radiated thereby is communicated across the space to the cylinder 1 and conducted through
 5 the composite material to produce electron emission from the outer periphery of the cathode. As the outer surface of the composite cylinder becomes worn, due either to the
 10 normal erosion caused by electron emission or to the knocking off of particles by positive ion bombardment, there is an abundance of material to present fresh electron emitting
 15 surfaces. The bombarding effect of the arc is confined to the outermost surface of the cathode and is precluded from following the radial line of contact between the respective
 20 coated discs by the intimate relation between the members, caused by the pressure. There also appears to be a certain amount of alloying effect at the place of contact, which effect
 25 further serves to combine the members into a unitary mass. The intimate contact between the nickel and barium compound extends the full depth of the composite material so that
 the mixture which is believed to be favorable to the profuse production of electrons extends entirely through the active composite body as far as the foundation cylinder.

Fig. 2 shows the application of the invention to a cathode in which the alternate or interleaved layers of nickel and alkaline earth metal are arranged within the metal cylinder instead of being exterior thereto as in Fig. 1. The cap members 3 are provided with internally
 35 extending flanges to clamp the layers into a unitary member. A heater may be positioned within the bore of the cathode and the electrons produced at the inner peripheral surface constrained to pass through
 40 the end of the cathode and caused to impinge on an anode (not shown) as is well known in the art.

Fig. 3 exemplifies a modification of the structure shown in Fig. 2 in that the discs contain
 45 circular concentric grooves within which to impound more active material than in the case of the flat discs. Fig. 4 shows another modified shape of disc in which the dished spaces accommodate still more active material and allow a greater depth or length of
 50 mixture. Other shapes of discs to suit special conditions of operation will readily occur to those skilled in the art. As in the case of the structures described in detail in connection with Fig. 1, the discs shown in Figs. 2, 3 and
 55 4 are coated on one or both sides of the active material and may be rigidly clamped between two end plates secured to a metal cylinder 1 or formed in any other manner into a solid
 60 mass whose temperature conveniently may be raised to produce electrons.

In the foregoing embodiments, any desired thickness of disc and coating may be
 65 used so that by varying the respective thicknesses, any predetermined mixture of the

component metals as a whole, may be employed. There may be as many as 150 discs per inch length of cathode and the latter made in suitable length with any set of diameters. It is apparent that the approved cathode construction is rugged and mechanically solid and makes use only of the simplest of machine operations. If desired, in place of the coatings, there may be utilized self-supporting discs of alkaline earth material or other active substance, although at present I consider it preferable to use thin discs and thin thermionically-active coatings so as to increase the optimum number of recurring mixtures. While I have referred to the use of nickel and a compound of barium as constituting the component members of the active mixture, it is evident that any other well known combination of metals may be used, either in the form of a coating of one metal on another or as individual layers as explained above.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. A cathode for an electric discharge device comprising a metal cylinder, a plurality of spaced metallic members extending radially from the periphery of the cylinder, the spaces between said members being completely filled with electron emitting material so as to present a smooth peripheral surface over the entire length of cathode, and a heater positioned within said cylinder.

2. A cathode for an electric discharge device comprising a plurality of metal discs coated with an electron emitting material and pressed together with the coated surfaces in contact, and means for heating the assembly to an electron emitting temperature.

3. A cathode for an electric discharge device comprising a plurality of nickel discs arranged on a supporting member, said discs being coated with barium carbonate and pressed together until the discs contact with each other, and means for heating the discs to an electron emitting temperature.

4. A cathode for an electric discharge device comprising a plurality of metal discs coated on both sides with electron-emitting material, said coatings being in direct physical contact with one another.

In witness whereof I have hereunto set my hand.

WILLIAM F. WINTER, JR.