

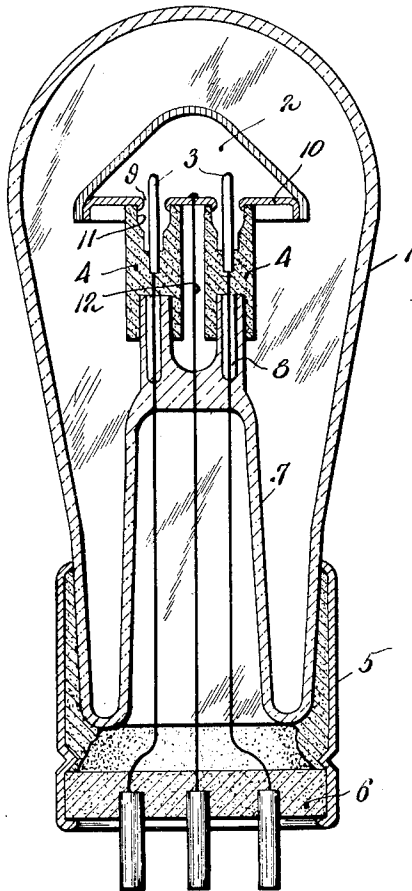
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1,679,449

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GASEOUS CONDUCTION APPARATUS

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GASEOUS-CONDUCTION APPARATUS.

Application filed June 13, 1927. Serial No. 198,398.

The present invention relates to electrical apparatus and in particular to unilateral conduction devices which employ a confined body of gas as carrier for the space current.

Notwithstanding the fact that the tube art in general has reached a high state of development, there still remains instances of tube failure and short life due frequently to disintegration of material forming the electrodes. Indeed, with the improvements heretofore offered in the art of evacuation and sealing, the problem of tube life now centers almost entirely about the stability of electrodes, particularly the anode. The erosion of this member is most pronounced in devices which depend upon gas, usually of the monatomic group for conduction, operating on the ionization principle, and is caused in part by reverse current tending to substitute the normal function of one electrode, specifically the cathode, for that of the other.

While there are many factors involved, of more or less importance, I found the greatest improvement in securing commercially long electrode life to reside in the relation of gas filling and anode material, more especially in a specific combination of these elements.

The primary object of my invention is to provide space current apparatus having relatively long life. A more specific object is to improve certain of the elements within the tube with a view towards minimizing erosion of electrode material under conditions of heavy ion bombardment and other deleterious effects. With these and other objects in view, reference should now be had to the following description which, when read in connection with the accompanying drawing, represents one embodiment of the present invention. While my invention has application to all space current apparatus, in the interests of clearness, I propose to exemplify the subject matter by referring to a specific form of rectifier; thus in the figure there is shown a space current device similar to that in the Smith Patent No. 1,617,179 and the Jenks application Serial No. 752,867.

This type of rectifier employs an envelope 1 which may be formed of glass, a hollow cathode 2 of tantalum or other refractory material, anode 3, insulating thimbles 4 preferably of lavite and a base comprising metallic cylinder 5, secured by suitable compound

to the envelope in the usual manner. The bottom of the cylinder is closed by insulating disk 6 into which the connector plugs project. The envelope 1 has re-entrant stem 7 provided with two tubular projections 8 which extend in the bottom of insulation thimbles 4, the latter being slipped over the projections and held in position by cathode 2. The anodes are mounted in openings in members 4 concentrically with projections 8 and openings 9 in the cathode. The cathode is preferably formed in two parts, the upper part comprising a conically shaped element and the lower part 10 a cover fitting the open end of the cone. A portion of each thimble 4 is spaced from the anodes a distance materially less than the mean free path of the electrons present and serves to prevent the passage of current between either anode and the outer surface of the cathode. Ionization is thus confined to the space enclosed by the cone, i. e. the region adjacent to the inner surface of the cathode. In order to minimize the internal losses of the device I may coat the active portion of the cathode with a substance as alkali, earth alkali or combination of the two, to increase emission. If desired, the substance may be conveniently applied in the form of a nitrate, successively heating the cathode, e. g. by a hydrogen flame, to high temperature (e. g. above 1000° centigrade) and spraying the solution onto the cathode as disclosed and claimed in the application of P. L. Spencer, Serial No. 183,045. A number of coats may be applied in this manner until the alkali substance permeates and alloys with the metal of the cathode giving a lasting effect by way of low work function. The cylindrical members 4 contain circular recesses 11 adjacent to the openings 9 to prevent or reduce to a negligible factor the tendency of current to flow between cathode and either anode along the surface of insulation. The openings 9 are of such size as to provide space between the cathode and operating anodes, comparable to or slightly less than the mean free path of electrons within the region of the cathode. While the cathode may be supported solely by cylindrical members 4, I prefer partly to depend for support on the centrally located cathode lead 12 which is joined electrically to one of the connector plugs.

Now, whereas in the patent and applica-

tion supra, it was stated that the preferred gas of the monatomic group was helium under the pressure of several millimeters and that the anodes could be satisfactorily made of many refractory conductors, it was found in practice that when immersed in helium, these metals offer a wide variation of disintegrational effects at the anode under similar conditions of operation. In this connection I have discovered one outstanding example giving an electrode life nearly ten times that of the nearest combination; I have reference to the use of tantalum for anode material in a helium filling such as mentioned which arrangement appears to cooperate in an unusual, unforeseen and inexplicable manner to minimize electrical disassociation at the positive member. It was further verified that the remarkable behavior between these substances is quite independent of the shape, size and type of apparatus, the superiority of operation being accentuated under low gas pressure and high voltage, a condition particularly harmful to other combinations. When utilizing tantalum for anode material in an atmosphere of helium one may substantially decrease the gas pressure and increase applied potential over the orders of magnitude now commonly employed in the art without fear of materially shortening the life of the apparatus through electrode failure. The preferred pressure of gas may be of the

order of one or more centimeters of Hg. In order to conserve tantalum, which is expensive, I may provide nickel pins with a thin band of the metal at the end operating as anode. Moreover, if desired, an alloy of tantalum may be employed having an electrode life dependent upon the tantalum component of the metal.

I am aware that electrodes of tantalum have been proposed in connection with certain inert gases; however, the enumeration of elements has either failed to mention or has specifically excluded helium as the other element of the combination. Hence, no limitations are to be imposed on my invention as defined by the following claims except as may be necessary in view of prior art.

I claim:

1. In a gaseous discharge apparatus of the type described containing helium, an anode, a cathode operatively associated therewith, said anode comprising tantalum.

2. A gaseous discharge rectifier containing helium, a hollow cathode having an opening therein, another electrode presented to the interior of the cathode through said opening, said other electrode comprising tantalum.

Signed by me at Cambridge, Massachusetts, this 6th day of June, 1927.

CHARLES G. SMITH.