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ELECTRIC DISCHARGE DEVICE

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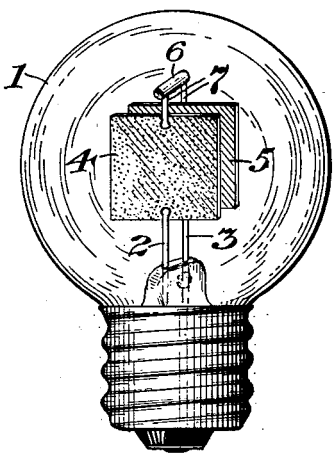

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ELECTRIC DISCHARGE DEVICE

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3 Claims. (Cl. 250—27.5)

The present invention relates to electric discharge devices, and to electrodes therefor. The particular object of the invention is to provide a gaseous discharge device which will have a long useful life, will start upon the application of a relatively low potential, will operate at a correspondingly low voltage, and will maintain these characteristics throughout its life. A further object of the invention is to provide a method of producing such a device. Other objects and advantages of the invention will appear from the following particular description of a device embodying my invention and the method of manufacture thereof.

The invention consist of certain new and novel features of construction and combinations of parts and also the new and novel steps in the process of manufacture of gaseous discharge devices, as hereinafter set forth and claimed.

Considerable difficulty has been encountered heretofore in the production of gaseous discharge devices which would function at normal commercial potentials. It has been particularly desired to produce a device of this character which would consistently operate on 100–120 volts D. C. Various expedients have been tried in order to accomplish this, but these have resulted in short life of the device. By the present invention it has been found possible to produce a device which will start on the application of a direct current potential of the order of 80 volts and which will have a useful life of several thousand hours. This has been accomplished by a modification of the activation heretofore used in devices of this type, as fully set forth in the following specification.

For purposes of illustration a perspective view of an electric discharge device produced according to my invention is shown in the accompanying drawing.

In this drawing a sealed envelope 1 of glass, fused silica, or other suitable material has sealed thereinto in a conventional manner the inleads 2 and 3 which respectively support the electrodes 4 and 5. Said electrodes have thereon a coating of material of low work function which is produced in a manner which will be set forth in detail hereinafter. An insulating bead 6, in which terminate the ends of wires 7 which are welded to the electrodes 4 and 5 near the upper edges thereof, serves to maintain the proper spacing of said electrodes. The envelope 1 contains any suitable gaseous atmosphere, such as neon, helium, argon or mercury vapor, or combinations thereof.

A preferred method of preparing the device is as follows. The electrodes 4 and 5 of iron or nickel are first carefully cleaned to remove any foreign substances adhering thereto, after which they are raised to a high temperature either in a vacuum or, preferably, in an atmosphere of hydrogen. In the latter case the electrodes become saturated with hydrogen to the exclusion of all other gases, and electrodes so treated are found to be more easily freed of occluded gas in the later stages of the treatment. When cool the electrodes are coated with a compound of potassium, caesium, barium, strontium, or other alkali or alkaline earth metal, or a combination thereof. This compound is preferably one, such as the carbonate, which readily decomposes to the oxide when heated in a vacuum. This material is conveniently applied to the electrodes 4 and 5 by mixing it with a vehicle and either painting or spraying it thereon, or the electrodes may be dipped therein. It has been found that the presence of sufficient carbon on the electrodes to reduce a portion of the alkaline oxide is desirable at a later stage in the treatment, hence a vehicle such as collodion, the residue of which readily decomposes to carbon when heated in a vacuum, is preferred although other vehicles such as alcohol or water may be used with good resutls.

The electrodes 4 and 5 are then sealed into the envelope 1 in the usual manner, and the device placed in an oven and baked out at approximately 450° C. for ten minutes, during which time the envelope 1 is exhausted. By this treatment the envelope walls are made to give off any occluded gas and moisture. Then, the vacuum being maintained, the device is placed within the influence of a high frequency magnetic field, the electrodes 4 and 5 being heated thereby to a temperature of approximately 1000° C., driving all occluded gases out of said electrodes, reducing the carbonaceous vehicle to carbon, and reducing the alkaline or alkaline earth compound to the oxide. A suitable gaseous atmosphere, such as a mixture of neon with about .5% argon, at a pressure of about 5 m. m. of mercury is then admitted to the device. Then the electrodes 4 and 5 are again placed within a high frequency magnetic field and raised to approximately 1000° C. While at this temperature a high voltage discharge with a current density of the order of .5 ampere per square inch of electrode surface is established between said electrodes. As a result of the bombardment to which the electrodes are subjected by this discharge the surface of the alkaline or alkaline earth oxide is reduced

to the metallic form, the liberated oxygen combining with the carbon present on the electrodes. In the absence of carbon somewhat the same result seems to be obtained by mechanical absorption of the free oxygen atoms by the glass wall or other parts of the device, under the low pressure of the gaseous atmosphere within the device. Due to the high temperature of the electrodes during this bombardment there is a low cathode drop so that there is little sputtering of the electrode material onto the walls of the envelope.

The gas mixture used during this treatment is then removed from the device, and the operating atmosphere admitted. The latter atmosphere may be any of the usual vapors or monatomic gases, but is preferably a mixture of either neon, or neon and helium, with from .1% to 5% of argon, and is admitted at a pressure of the order of 15–25 m. m. of mercury. The device is then sealed off, after which a high frequency discharge of several amperes, or sufficient to raise the electrodes to a red heat, is maintained between the electrodes 4 and 5 until the surface of said electrodes is uniformly activated as evidenced by the uniform distribution of the glow thereon. This will take on the order of 30 seconds. The device is then burned on alternating current of commercial frequency for several minutes, a discharge of the order of 100–200 milliamperes per square inch of electrode surface being maintained during this period, the object of this treatment being to age the activated surface in order to stabilize its operating characteristics. After this treatment a device so produced will have a breakdown potential in the neighborhood of 80–100 volts D. C.

Where the electrodes 4 and 5 are separated by a distance less than the means free path of the ions of the gas utilized for the discharge, the discharge is substantially confined to the outer faces of said electrodes. I have found that this same result may also be obtained, regardless of electrode separation, by coating only the outer face of each electrode with the alkaline compound, since the discharge maintaining potential between the prepared surfaces is insufficient to produce a discharge between the uncoated portions of said electrodes.

In practice both of the electrodes 4 and 5 are coated in the above described manner, even though the device is to be used on direct current, since the device will then operate regardless of polarity, and by reversing the polarity after the coating on one electrode has been exhausted the coating on the other electrode can be utilized, thereby increasing the useful life of the device.

The terms "alkaline metal" or "alkaline oxide" as used in the claims are intended to cover metals of either the alkali or alkaline earth groups, or their oxides, respectively.

It is to be understood that while the above process is preferred for the production of my improved gaseous discharge device various changes may be made in the process or in the separate steps thereof without modifying or changing the essential features and characteristics of the device produced thereby, and that variations within the scope of the appended claims may be made in the device without departing from the spirit of my invention.

What is claimed is:

1. The method of producing electrodes for a gaseous discharge device which comprises creating a coating of an alkaline oxide on said electrodes and then producing a layer of the alkaline metal on the surface of said oxide coating by bombarding said oxide with a high frequency discharge while said electrode is maintained at a high temperature.

2. The method of producing a gaseous discharge device which consists in coating the electrodes with an alkaline compound which is reducible to the oxide, sealing said electrodes into an envelope, evacuating said envelope while heating said envelope and said electrodes to a temperature sufficient to drive off occluded gases, continuing to heat said electrodes in a vacuum to reduce said alkaline compound to the oxide, admitting a gaseous atmosphere to said envelope, raising said electrodes to a high temperature and producing a discharge therebetween to reduce the surface of said oxide to the metallic form, evacuating said envelope, refilling said envelope with a desired gaseous atmosphere, and bombarding said electrodes with a high frequency discharge.

3. The method of treating an electrode having a coating of an alkaline earth metal over a layer of the oxide of said metal which consists in bombarding said metal with a high frequency discharge to activate said coating and to reduce the work function thereof.

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