UNITED STATES PATENT OFFICE.

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ELECTRON-DISCHARGE APPARATUS AND METHOD OF PREPARATION.

1,244,216. Specification of Letters Patent. Patented Oct. 23, 1917.

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To all whom it may concern:

Be it known that I, IRVING LANGMUIR, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Electron-Discharge Apparatus and Methods of Preparation, of which the following is a specification.

The present invention relates to electrical devices operating with a pure electron discharge and comprises a novel cathode material and the method of its preparation.

In a previous application, Serial No. 795,610, filed October 16, 1913, I have described and claimed a new type of electrical discharge apparatus comprising an envelop containing electrodes one of which emits electrons and being so highly evacuated that positive ionization is negligible. Some of the characteristics of this "pure electron discharge" are absence of conductivity in the space between independent unheated electrodes, a variation of the current over a certain range with the 3/2 power of the voltage, the absence of blue glow in the space, the absence of gas fluorescence and the lack of cathodic disintegration.

Various refractory materials, platinum, carbon, tungsten and molybdenum, have been used as cathode materials and it has been found that the emissivity of electrons of these various materials while differing to some degree is of the same order of magnitude.

I have discovered that the electron emissivity of pure thorium is of an entirely different order of magnitude than the emissivity of refractory materials heretofore used in electron discharge devices. It is not necessary that the electrode should consist entirely of thorium. When, for example, a thorium compound, such as the oxid, has been added during the process of production to one of the highly refractory metals, for example, tungsten, and the metal subjected to a preliminary heat treatment in a high vacuum, the electron emission in a high vacuum is enormously increased. This increased emissivity is not due to the presence of thorium oxid in the manner of the Wehnelt cathode for various reasons hereinafter explained, but according to all indications is a property of metallic thorium on the surface of the cathode.

Apparatus suitable for preparing and utilizing a thoriated cathode in an electron discharge apparatus is somewhat diagrammatically shown in the accompanying drawings, in which Figure 1 shows a simple type of apparatus in which the anode consists of a film of refractory metal on the inside wall of the envelop produced by vaporizing a refractory metal at high temperature; Fig. 2 is a device operable as a rectifier having a thoriated cathode and plate-shaped anodes; and Fig. 3 illustrates a modification in which active thorium material may be transferred to the cathode from an independent thoriated conductor.

The device shown in Fig. 1 comprising an envelop 1 consisting of glass, quartz or the like provided with two filamentary conductors 2, 3, of highly refractory metal, such for example as tungsten, at least one of which, say filament 2, is thoriated. They are connected to leading-in wires 4, 5, sealed into a stem 6 in the well-known manner. The envelop is connected to a vacuum system by a tube 7, containing a trap 8 which may be surrounded by a freezing bath, such as liquid air, contained in a Dewar flask 9 or even an ice and salt mixture. It is the function of the freezing bath to prevent mercury, or other vapors, from the vacuum pumps from reaching the envelop 1.

The preliminary evacuation of the envelop is carried out by the usual methods of producing high vacuum, which includes baking out the envelop to remove water vapor. The final stage of the evacuation is preferably but not necessarily carried out by a Gaede molecular pump to the highest possible vacuum obtainable by this means,—that is, to about .001 micron. While the apparatus is still on the pump the filaments 2, 3, are heated to a temperature of about 2900° K. (absolute) for a short time and the envelop 1 is baked out in an oven at a temperature of about 360 to 450° K. The apparatus may then be sealed from the vacuum system at the contraction 10. It is then preferably immersed in liquid air and both filaments 2, 3 aged by heating for about ½ hour to a temperature of 2400 to 2500° K. One of the filaments, for example, filament