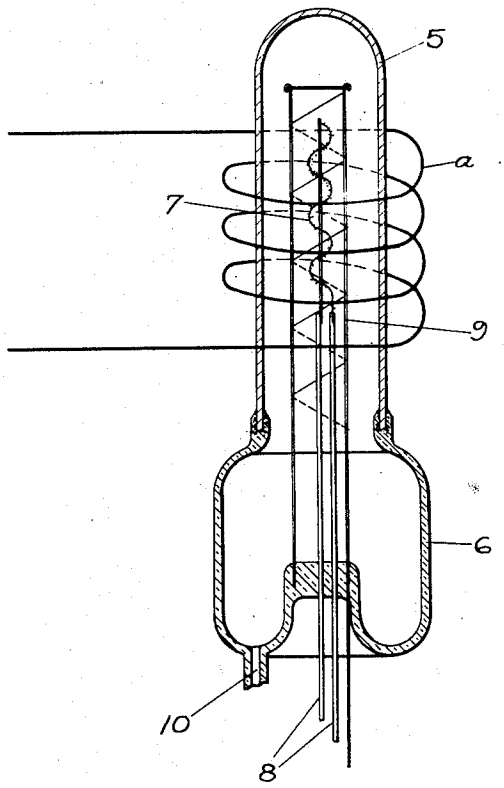
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HELIUM SPACE DISCHARGE TUBE

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HELIUM SPACE DISCHARGE TUBE.

Application filed April 3, 1924. Serial No. 703,921.

This invention is for a space discharge tube of the hot cathode type, wherein helium is present between the cathode and the anode of the tube, and for a method of making the same.

It is well known in the art that space discharge tubes that are evacuated to an extremely high degree have very marked characteristics differing from the so-called gaseous tubes wherein the gaseous condition is produced either by failure to evacuate the tube to an extremely high degree, or by restoring to the highly evacuated tube an inert gas from an external supply.

Due to the greater stability of the highly evacuated tubes, or hard tubes, over the gaseous or soft tubes, the former have generally been preferred.

I have discovered, however, that, if helium can be produced in the tube after the tube has been thoroughly de-gasified by the usual methods of heating and evacuation on the pump, and the tube sealed off, very satisfactory and highly efficient results may be obtained, and this with a very low temperature on the cathode.

According to the present invention, I propose to provide in the tube a cathode capable of producing or liberating helium gas, in sufficient quantities to lower the impedance across the space between the cathode and the anode, but insufficient to render the tube unstable in the manner that the so-called gaseous tubes are unstable.

My invention may be explained in connection with the accompanying drawing, which represents a more or less diagrammatic section through a space discharge tube produced in accordance with the invention, the tube disclosed being generally of the construction described in my application filed March 13, 1924, Serial No. 698,925, this type of tube having a metal envelope which also comprises the anode of the tube.

In the drawings, 5 designates a metal envelope which also comprises an anode for the tube; 6 is a glass seal secured thereto; 7 is a cathode or filament supported by and joined to connectors 8; and 9 designates the grid. At 10 is designated the point where the tube is evacuated and eventually sealed off.

The cathode 7 comprises a metal base or wire preferably formed of molybdenum on which is a coating of thorium nitrate or uranium nitrate. This coating may be applied by alternately dipping the wire base in a thorium nitrate or uranium nitrate solution and drying the coating until the coating is sufficiently heavy.

This filament is then assembled in the tube, and the tube placed on the pump for evacuation. After a preliminary exhaustion, an oven is lowered around the entire tube and the tube baked at a fairly high degree of temperature, but below the melting point of the glass. While the tube continues on the pump, a heating coil *a* is placed around the metal part of the tube only, and the temperature of the metal raised to about 800 degrees or 1000 degrees C., by means of which the metal shell is de-gasified. This heating of the shell also heats the cathode, to substantially the same temperature. This heating of the cathode in a high vacuum from an external source is very important in that it conditions or activates the filament, and brings it to a state where it will properly function in the tube and resist disintegration. This heating of the filament drives out all of its absorbed gases, and liberates a certain amount of helium, although the process is not continued for a sufficient period to drive out all helium that may be evolved.

After being heated with the external coil *a* for a sufficient period of time, the tube may subsequently be sealed off.

After sealing the tube, a very low current is applied to the filament which is gradually increased until the filament becomes hot, perhaps to a dull red heat. The tube, which has been extremely hard, due to the de-gasifying process, is allowed to age for a while with the current applied to the filament. After a comparatively short period of time, helium will be found to be present in the tube. This probably results from atomic disintegration of thorium at this temperature and under this particular condition. That helium may be evolved from thorium nitrate under proper conditions has long been known to chemists and the present invention utilizes this phenomenon to advantage in an electron tube.

The quantity of helium evolved is, of course, very minute, but is amply sufficient to lower the impedance from the cathode to the anode, so that the tube will function with a very low heating current in the filament, and helium will assist in cooling the tube. Upon reaching a certain stage, the evolution

of helium apparently ceases, a state of equilibrium apparently being reached.

It further appears that the tube is quite distinctly more satisfactory than the usual gaseous tubes having an appreciable residuum of atmospheric gases therein or having an inert gas restored thereto from an external supply. This may perhaps be due to the fact that the helium evolved from the cathode returns into more intimate contact therewith than would gas supplied to the tube from an external source. This would seem to be borne out by a spectroscopic inspection, wherein the greatest manifestation of helium is apparent in immediate proximity to the cathode, although such manifestation may be due also to the greater atomical or molecular activity of the gas in the vicinity of the cathode by reason of the cathode being hot.

Whatever the theory as to the presence and distribution of the evolved helium may be, the practical result is that an exceptionally efficient tube is provided by its presence, and that this tube can be operated at very low temperatures comparatively, so that it is very desirable, particularly in power tube work where the question of dissipating the heat energy of the cathode is a serious problem, and is very suitable for tubes having an exterior air cooled metallic anode.

I claim as my invention:

1. The method of making a space discharge tube having helium therein which consists in assembling a tube having an anode and a cathode on which latter there is a substance capable of liberating helium when heated, exhausting and de-gasifying the anode and the cathode by exhaustion and baking, sealing off the tube, and applying a current to the cathode to heat the same, whereby helium is evolved in the tube.

2. The method of making space discharge tubes having an anode and a cathode which consists in assembling into the tube a cathode having a helium emitting coating thereon, thoroughly de-gasifying the tube and cathode, sealing off the tube, and then evolving helium into the tube in sufficient quantities to materially lower the impedance between the cathode and the anode.

In testimony whereof I hereunto affix my signature.

FREDERICK S. McCULLOUGH.