March 22, 1932. E. LÜBCKE 1,850,967

VAPOR DISCHARGE TUBE WITH CONTROL GRID

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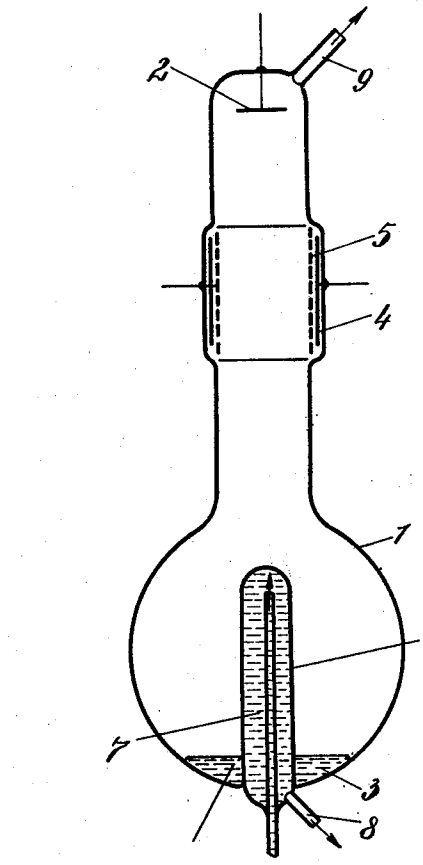
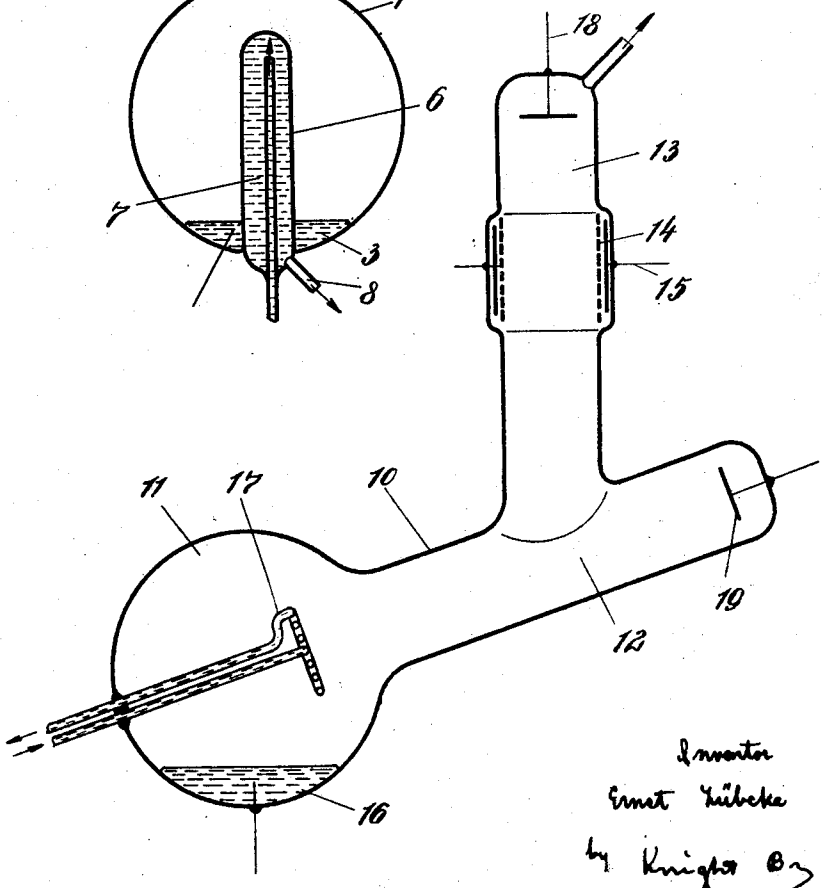


Fig. 1

Fig. 2



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UNITED STATES PATENT OFFICE

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VAPOR DISCHARGE TUBE WITH CONTROL GRID

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My invention relates to vapor discharge tubes having a control grid.

In tubes of this character a discharge occurring between the cathode and an auxiliary anode serves as a source of electron discharge. The electron emanating from this auxiliary discharge flow to a main anode which has a function similar to the anode in the well known conventional three electrode tubes. This electron stream flowing to the main anode is then controlled by a control grid also similar to the manner practiced in three electrode tubes. It is well known that in this type of discharge vessel, the danger exists that in case of great potential differences between the main anode and the cathode, the auxiliary discharge quite easily flashes over either to the control grid or to the main anode.

In accordance with my invention this is prevented by using a cooling device which affects the auxiliary discharge occurring between the cathode and the auxiliary anode in such manner that in a portion of the discharge vessel the auxiliary discharge is principally carried by electrons, at least one control grid and at least on main anode being arranged in that portion of the vessel.

Two embodiments of my invention are diagrammatically illustrated in the drawings affixed hereto.

Fig. 1 shows a discharge tube in which the auxiliary discharge part is divided into two parts, the discharge in the vessel portion adjoining the cathode being carried by ions, and

Fig. 2, shows a discharge tube in which only part of the cathode chamber is cooled, but not the cathode itself.

Referring to Fig. 1 of the drawings, 1 is the discharge vessel, 2 the auxiliary anode, 3 a mercury cathode, 4 the main anode and 5 a control grid. The latter two electrodes are located in the upper tubular part of the discharge vessel. The main anode is of metal and has preferably the form of a cylinder placed coaxially with the tubular portion of the vessel into a widened portion thereof as shown, so that the grid 5 which is also of cylindrical form and coaxially disposed to and within the anode cylinder, is substantially flush with the remainder of the tubular vessel wall. When arranged in this manner the main anode-grid control system does not form a physical obstruction in the discharge path. The lower bulbous part of the discharge vessel is provided with a cooling device 6 which cools the cathode and the cathode chamber (cooling zone). It consists of a cylindrical member closed at the top and which projects into the spherical vessel part, being carried upwards close to the tubular part of the discharge vessel. The distance between the upper end of the cooling cylinder 6 and the top of the spherical part of the discharge tube should preferably not be less than the diameter of the upper tubular part. The cooling cylinder is supplied with a cooling agent, such as water, mercury, oil or the like through a pipe 7 which agent escapes from the cylinder at 8. 9 is a nipple for evacuating the discharge vessel. By intensely cooling the cathode chamber by means of the cooling cylinder 6 the result is obtained that the mercury vapors penetrate in small quantities only into the tubular part of the discharge vessel. The discharge in this part of the tube is then substantially carried by electrons only. The main anode current depends principally upon the electric field which is determined by the potential differences between the auxiliary anode 2 and the main anode 4 and between auxiliary anode 2 and the control grid 5. Ion discharges between the cathode 3 and the anode 4 do not develop.

Referring to Fig. 2 which illustrates a discharge tube in which only a part of the cathode chamber (cooling zone), but not the cathode itself is cooled, 10 is the discharge vessel which is again composed of a spherical or bulbous portion 11 and the tubular portions 12 and 13. The part 13 branches off the part 12 and contains the control grid 14 and the main anode 15. In the spherical part 11 of the discharge vessel is provided a mercury cathode 16 and a cooling device 17. This device consists of a spirally wound tube traversed by a cooling liquid. 18 is the auxiliary anode, and 19 a further auxiliary anode which, if necessary, may serve as ignition anode. By the powerful cooling action of

the cooling device 17 the auxiliary discharge between cathode 16 and anode 18 is divided into two portions. In the part adjacent to the cathode the discharge is carried substantially by ions, in the part 13 on the other hand by electrons. The auxiliary anode 19 serves then the purpose of withdrawing ions which enter the part 12 from the main discharge.

The cooling of the discharge path and more particularly of the cathode chamber should be so intense that the partial pressure of the vapor (mercury vapor) carrying the discharge in the cathode chamber is reduced to such an extent that it falls within the range of the partial pressure of the foreign gases. This is the case at a pressure of the foreign gases of 2×10^{-5} mm. mercury and a cooling of the vapors surrounding the cathode to approximately 0° C.

The connection of the high vacuum pump takes place as shown in the illustrations, preferably in proximity to the auxiliary anode. If, however, a lateral condenser nipple is provided, the pump may equally well be connected with this extension.

Various modifications and changes may be made without departing from the spirit and the scope of the invention, and I desire, therefore, that only such limitations shall be placed thereon as are imposed by the prior art.

I claim as my invention:—

1. An electric vapor discharge device comprising a discharge vessel having a tubular portion, a cathode and an auxiliary anode for maintaining an auxiliary discharge between it and the cathode, for serving as a source of electron discharge, a hollow metal member in said tubular portion for serving as an anode, a grid disposed within and coaxially to said anode for withdrawing electrons from the path of said auxiliary discharge, and a cooling device protruding into the portion of said auxiliary discharge path located between said cathode and said grid for preventing ions from reaching said grid.

2. The combination claimed in claim 1 wherein said cathode is liquid and the cooling device is electrically insulated from said cathode.

3. An electric vapor discharge device comprising a discharge vessel having a cylindrical portion, a cathode and an auxiliary anode for maintaining an auxiliary discharge between it and the cathode, for serving as a source of electron discharge, said cylindrical tube portion having a widened portion, a cylindrical metal main anode in said widened portion and a cylindrical grid disposed within and coaxially to said main anode and having a diameter approximately equal to the remainder of the cylindrical tube portion, for withdrawing electrons from the path of said auxiliary discharge, and a cooling device protruding into the portion of said auxiliary discharge path located between said cathode and said grid for preventing ions from reaching said grid.

4. An electric vapor discharge device, comprising a discharge vessel having a bulbous portion and two tubular extensions, a mercury cathode in said bulbous portion and an auxiliary anode at the end of one of said tubular extensions for maintaining an auxiliary discharge between the auxiliary anode and said cathode serving as a source of electron discharge, a main anode in said last-named tubular extension and a grid within said main anode for withdrawing electrons from said discharge path, and a second auxiliary anode disposed in the other tubular vessel extension and serving for drawing ions from the discharge path in the bulbous portion of said vessel, and a spirally wound tube disposed in the bulbous vessel portion for conducting a cooling medium to cool the discharge path in said bulbous portion for preventing ions from reaching said grid.

In testimony whereof I affix my signature.

ERNST LÜBCKE.