May 26, 1936. E. LÜBCKE 2,042,183

INDIRECTLY HEATED HEAVY DUTY CATHODE

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Fig. 1.

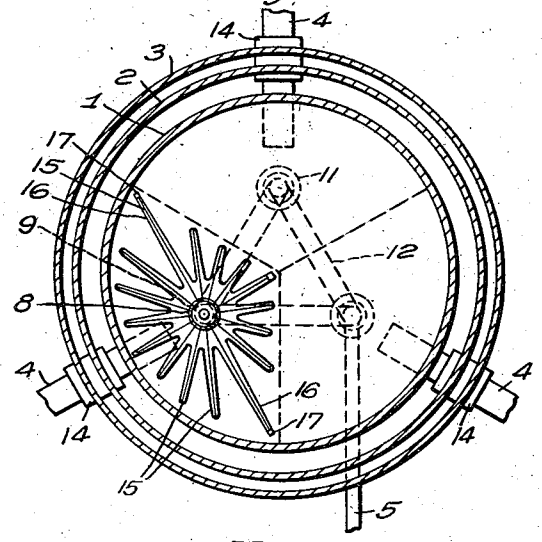


Fig. 2.

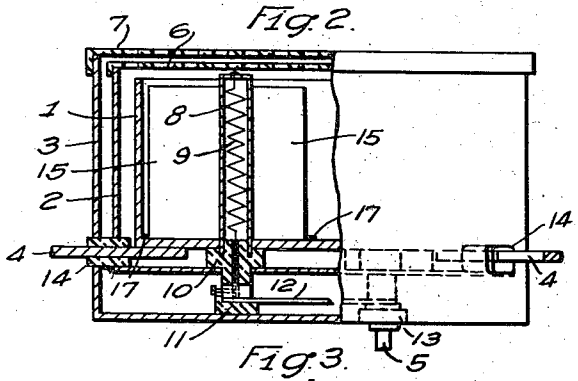
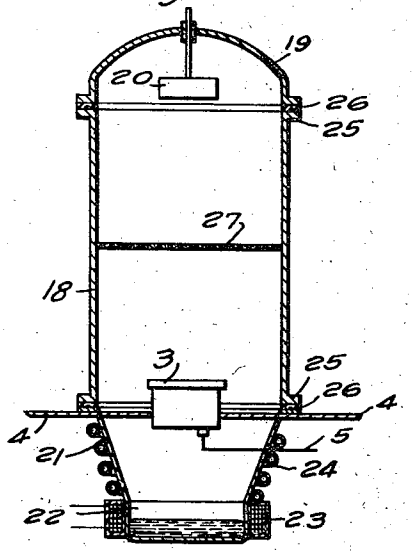


Fig. 3.



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INDIRECTLY HEATED HEAVY DUTY CATHODE

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2 Claims. (Cl. 250—27.5)

My invention relates to electron discharge devices and particularly to a cathode body for high capacity electron discharge devices having a plurality of heating bodies symmetrically located therein.

It is an object of my invention to provide an indirectly heated cathode body suitable for large electron emission.

Another object of my invention is to control the temperature of the gas filling of the device.

Other objects will be apparent from the following description.

It is possible to take care of much greater electric loads and particularly to effect switching operations and to control by means of an ion discharge effected in a gas or vapor-filling than by means of a pure electron discharge. Although the advantages inherent in the use of incandescent cathodes in gas or vapor-filled discharge tubes over cold cathodes usually consisting of a mass of mercury are well known, it has not yet been possible to build properly operative incandescent cathodes for similarly large loads as have already been made in cold cathodes. The difficulties which have been found even after going to an indirect heating of the cathodes, in the making of large incandescent cathodes, are to be found only in part in the short length of life relatively to the cold cathodes, which is caused by the using up of the material mounted on the support of the incandescent cathode and emitting the electrons. For the greater part these difficulties are that the cathodes had to be overheated at certain places because of the construction used in order to show sufficient emissivity in all parts to correspond to the demanded output and that the cathodes had unequal emissivity because of this local overheating and were used up relatively quickly. The construction of a heavy duty incandescent cathode for gas or vapor-filled discharge tubes free of these drawbacks is based upon the knowledge that the problem of an incandescent cathode with heating elements located centrally in the cathode cannot be solved. In such cathodes in which the emitting surfaces are connected to a metal cylinder in the shape of ribs, the heater being inside of the cylinder, the increase in the size of the heating body does not result in any appreciable increase in the load. An increase in the heating winding as by connecting additional units in parallel with a first unit and combined therewith on the same support, such as welding the spaces left by the first winding, does not yield any appreciable increase.

In the indirectly heated high duty incandescent cathode according to the invention a plurality of independent heating bodies, each provided with their own emitting surfaces, are located within the cathode and preferably symmetrically relatively to each other, thus varying from the heretofore usual central arrangement.

In the cathodes designed according to the invention on the one hand optimum values of emission or anode currents can be obtained for each ampere of heater current, for instance, one watt heater energy per ampere emitting current of the cathode. On the other hand, it is possible in accordance with the invention to provide almost any desired large emitting surfaces in a cathode and to go up to anode currents of well over 100 amperes. Between the value of the emission or anode current and the area of the emitting surface there is the relation that per ampere emitting current there is necessary about 1 square centimeter of emitting surface. While it is easily possible, in accordance with the method suggested by the invention, to heat uniformly surfaces of several hundred or several thousand square centimeters, this is practically impossible with centrally arranged heaters because of the effect of the unavoidable damming up of the heat for the reason that an overheating is effected near the heater while the emitting surfaces are not sufficiently heated at a greater distance from the heater. The heater elements according to the invention are preferably connected in parallel in order to maintain operation of the cathode even though at a reduced output. The parallel connection simplifies also the arrangement of the current leads in the cathode, a detail which is important as heating current of about 30 amperes or more are utilized and the current leads must, therefore, be made relatively heavy. It is desirable to make the arrangement of the heating current leads in accordance with the special distribution of the heater in the cathode. In order to further simplify the construction of the cathode, it is advantageous to use as low a voltage as possible thereon as by the use of special transformers. In any case, the voltage between the individual adjacent parts of the heater winding and the heater leads must not exceed the ionization voltage of the gas or vapor filling of the discharge tube.

The drawing shows several modifications of the invention, Figure 1 being a cross-section and Fig. 2 a longitudinal section through a cathode according to the invention.

Fig. 3 shows the location of such a cathode in

a high output tube, in section. The same numerals are used as far as is possible.

The cathode body 1 is open towards the anode and is preferably of cup shape and of a nickel alloy. This cup shape body is surrounded by two heat protecting housings 2 and 3, which serve at the same time to secure the anode current lead 4 and the heating current lead 5. The housings 2 and 3 are provided with perforated covers 6 and 7 which aid in the concentration of the heat in the cathode body 1 but, do not hold back the electrons. The bottom part of the cathode body 1 is preferably made heavier than are its walls. Three separate cylindrical heater housings or casings 8 are preferably inserted in this bottom part of the cathode body and in electrical conducting connection therewith. In each of these casings there is located a self-supporting heater winding 9, one end of which is connected electrically with the casing 8 while the other end is insulated by means of a quartz member 10 and extends outwardly through the body 1 and the inner protective casing 2. This free end of each winding 9 which is preferably of tungsten and which is wound closer at that end of the heater winding connected to casing 8, is connected rigidly with a cross connection 12 of iron or nickel mounted on insulators 11, which connects each of the three heater windings 9 to the lead 5 projecting outwardly through the outer casing 3 and through an insulating bushing 13. The cross connections 12 may consist of a single plate instead of a plurality of individual plates or rods. The anode current leads 4, of which there are provided at least one for each heater, extend through a heat insulating member 14 and through the protecting casings 2 and 3. An electrical insulation of the anode current lead relatively to the housings 2 and 3 is not necessary. The anode current leads serve, as is shown particularly in Fig. 3 of the drawing, simultaneously as a support for the cathode. The sub-division of the support into a number of individual cathode supports has the purpose of preventing as far as is possible, the flow of heat from the cathode. A single central anode current lead supporting the cathode would require too large an area of cross section and would result in too great a loss of heat from the cathode.

The heating windings 9 and the casings 8 surrounding them constitute together the actual heating elements. On the cylindrical housing 8, as is shown more particularly in Fig. 1, there are located ribs 15 serving as a support for the emitting layers, the ribs being of different lengths such that almost the entire interior space of the cathode is effective in the emission of electrons. In addition to the ribs 15, specially corrugated members 16 may be provided which can serve as a support for the emitting layers either instead of the ribs 15 or in addition thereto. If the ribs 15 are rigidly connected at their outer ends with the corrugated member 16 they will act as a heat conductor to the ends of the emitting surfaces, which will be heated in addition to this heat-conducting thereto by heat radiating from the inner cylinder 8. The ribs 15, or instead or these, the corrugated members 16 are electrically connected at different places by means of special members 17 with the bottom of the cathode body 1 because the metal cylinder 8 is not sufficient to carry the large anode currents. The cylinders 8, and under certain circumstances, the ribs 15 and the corrugated members 16 are made of high fusing metals such as molybdenum, tungsten, or tantalum and are provided with a metal coating, e. g., a nickel alloy having a high emissivity when combined or coated with alkaline earths. The individual heating elements with the emission surfaces mounted thereon may be separated by cross walls indicated in the broken lines of Fig. 1 of the drawing, which separating cross walls may be used as emitting surfaces in addition to the walls of the cathode body. These walls likewise enclose a structure similar to that already described. The three sections are, of course, symmetrical within the body 1.

Fig. 3 shows the construction of a high capacity tube utilizing incandescent cathodes according to the invention. The housing of the tube consists of a vacuum-tight metal cylinder 18 which may have a relatively large diameter on the order of 70 centimeters or more with a corresponding length, and the housing ends are closed by covers which cooperate therewith to make the same vacuum-tight, but at the same time, electrically insulated therebetween as by gaskets 26. The anode cover 19 is preferably made spherical and carries the anode 20 which consists of graphite or a suitable heavy metal already used in high capacity rectifiers. The cathode cover 21 is preferably made of conical shape and provided with an extension 22 in which there is located mercury or some other substance generating the gas or vapor atmosphere. In order to provide the necessary gas or vapor pressure in the tube a means for producing desired temperatures may be associated with this extension as, for instance, a heater winding 23 and in addition, or in place thereof, a cooling coil 24. Between the cathode of which the outer casing 3 is shown and the anode 20 there may be provided a control grid 27 which is connected with the metallic casing 18, or which may be replaced thereby if the metal cylinder is made of the proper shape. The cathode is supported by means of the anode current leads 4. These leads 4 are secured directly to the flange 25 although they themselves may be made as a gasket flange so that only one such flange will be needed, which is pressed against the cylinder 18 by means of the insulating member 26. The anode current lead 4 and the heating current lead 5 extend outwardly through the cathode cover 21 insulated therefrom. Instead of this it is possible to electrically connect them with the metal cover 21 in order to avoid the difficulties attendant upon their being brought out in a vacuum-tight and insulating manner. By proper construction of the wall of the cover as by means of grooves and by the selection of the connecting points for the leads 4 and 5, the resistance of the wall between the leads may be made greater than the resistance of the heater circuit, so that the current loss in the shunt circuit of the wall of the cover will not be disturbing.

Where the term "gas" is used in the claims it is to be understood that this term is generic to vapors such as mercury vapor as well as to such gas as neon, argon, etc.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that many modifications thereof are possible. My invention therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. A cathode body for high capacity electron discharge devices having a plurality of heaters therein, said heaters comprising a heater winding, a metal housing surrounding the heater wind-

ing and a plurality of radial ribs of different lengths attached to the inside of said housing.

2. A cathode body for high capacity electron discharge devices having a plurality of heaters therein, said heaters comprising a heater winding, a metal housing surrounding the heater winding, a plurality of radial ribs of different lengths attached to said housing and corrugated members regidly connected with said ribs and a layer of electron emitting material on said corrugated members.

ERNST LÜBCKE.