Jan. 25, 1949. E. D. McARTHUR 2,460,141

ELECTRIC DISCHARGE DEVICE

Filed June 4, 1946

Fig. 1.

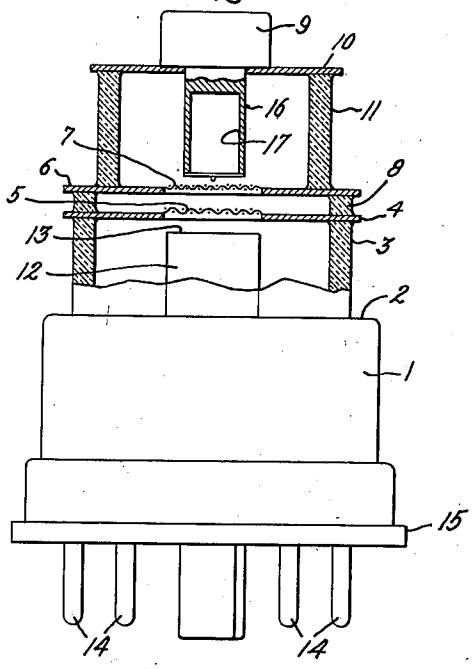


Fig. 2.

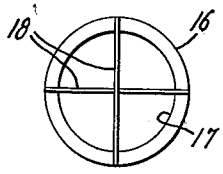


Fig. 3.

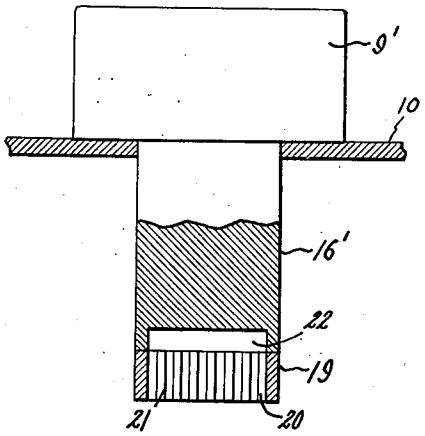


Fig. 4.

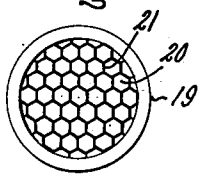
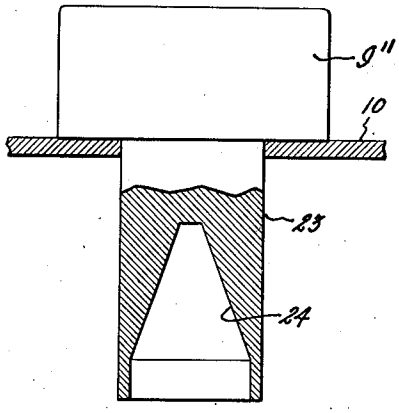


Fig. 5.



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ELECTRIC DISCHARGE DEVICE

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1 Claim. (Cl. 250—176)

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My invention relates to electric discharge devices and more particularly to improved anode or collecting electrode structures.

The emission of secondary electrons from the surfaces of the anode or collecting electrode of an electric discharge device is a disadvantage in many cases. For example, in the operation of screen grid electric discharge devices the screen grid is often positive with respect to the anode and secondary electrons are readily collected by the screen grid to such an extent that the characteristics of the device are unsatisfactory and the useful output of the device is decreased. The secondary electrons may be emitted from the anode with such a phase relation as to diminish the alternating component of the plate current. Any energy transferred to the secondary electrons by the electric field within the device is an energy loss and a source of unwanted heat within the device.

In accordance with my invention I provide a new and improved anode structure in which the high frequency energy is effectively delivered to the output circuit by collecting the electrons of the normal discharge while at the same time secondary electrons are almost entirely suppressed or are collected within the anode structure in a substantially field-free region. As a result, the collecting of secondary electrons by the screen grid, for example, is substantially prevented.

It is an object of my invention to provide a new and improved collecting electrode structure for electric discharge devices.

It is another object of my invention to provide a new and improved anode for electric discharge devices which substantially prevents the emission of secondary electrons.

It is a still further object of my invention to provide a new and improved electric discharge device of the screen grid type.

Further objects and advantages of my invention will become apparent as the following description proceeds, reference being had to the accompanying drawing, and its scope will be pointed out in the appended claim. In the drawing, Fig. 1 is an elevational drawing, partially in section, of an electric discharge device embodying my invention; Fig. 2 is an enlarged end view of the anode structure shown in Fig. 1; Fig. 3 is an enlarged elevational view partially in section of a modified anode structure embodying my invention; Fig. 4 is an end view of the anode structure shown in Fig. 3, and Fig. 5 is an enlarged elevational view, partially in section, of

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a still further anode structure embodying my invention.

Referring now to the drawing, I have shown my invention embodied in an electric discharge device of the disk-seal type which may to advantage embody the structural features of the electric discharge device described and claimed in the copending Beggs application Serial No. 436,633, filed March 28, 1942, now Patent 2,416,565, and assigned to the assignee of this application. As illustrated in the drawing, the envelope of the device includes a generally cylindrical metal member 1 having an inwardly directed flange 2 at its upper end to which is sealed the lower end of an insulating cylinder 3 which may consist of glass. A disk-like terminal 4 of suitable conducting material, such as copper or silver-clad iron, is sealed to the upper end of cylinder 3 and is provided with a central aperture covered with a suitable mesh 5 which provides the control grid of the device. A similar grid structure including a disk-like terminal 6 and centrally located mesh 7 provides the screen grid of the device and is supported by a hollow cylindrical insulator 8 sealed between the terminals 4 and 5. The anode 9 of the device is supported from a disk-like conducting terminal member 10 which is supported from the screen grid terminal 6 by a glass cylinder 11 which, as illustrated, is of smaller diameter than the glass cylinders 3 and 8.

A source of electrons for the device is provided by a generally cylindrical cathode structure 12 having a planar active surface 13 extending in parallel relation to the grid meshes 5 and 7. As described and claimed in the Beggs application mentioned above, the cathode may to advantage be capacitively coupled to the metal cylinder 1 and connected with one or more of the terminal prongs 14 of the device with respect to direct currents. The other terminal prongs provide external connections for the heater element (not shown) of the cathode in a manner which is well understood in the drawing. As illustrated in the drawing, the terminal prongs are supported by a conventional insulating base 15 which is secured to the lower end of the cylindrical envelope member 1.

Referring now to Figs. 1 and 2, I have shown my improved anode structure as comprising a generally cylindrical body portion 16 extending into the envelope of the device and terminating in spaced relation with respect to the screen grid 7. The anode body is preferably cylindrical in form and is provided with a central bore

or passage 17 extending from the lower end thereof a distance which is preferably substantially greater than the diameter of the bore, and to advantage may have a depth twice the diameter of the bore. As illustrated, the area of the bore is a large portion of the total area of the anode body 16 so that a relatively thin side wall remains. Conductors 18 extend across the lower end of the anode and establish an equipotential surface substantially equal to the anode potential which does not bow into the hollowed-out surface of the anode a great distance. It will be appreciated that as electrons travel from the cathode past this equipotential surface high frequency energy is delivered to the anode in the same manner as if the electrons were collected on a metal surface maintained at that potential. It is an important aspect of my invention that the obstructed area at the end of the anode be kept relatively small so that the number of electrons collected on the end of the anode will be correspondingly small. After the electrons have passed through the coarse mesh provided by the conductors 18 and proceed into the hollow anode 17, they reach a substantially field-free region. This is a region in which there is substantially no voltage gradient so that as the electrons are collected on the anode surface and the remaining kinetic energy dissipated, there is no field to draw out secondary electrons. As the result, the secondary emission is very limited and electrons which are emitted are readily collected on the interior surface of the hollow anode.

It will be apparent from the foregoing description that it is desirable to establish an equipotential surface having the voltage of the anode as near the entrance of the hollow portion of the anode as possible. At the same time it is desirable to keep the obstructed area of the face of the anode as small as possible. In Figs. 3 and 4 I have illustrated a modification of my invention in which a large number of small passages are provided in the end of the anode structure separated by very thin bounding walls. As illustrated in Figs. 3 and 4, the anode 9' includes a cylindrical body portion 16' at the lower end of which is bonded a honeycombed structure including a supporting metal tube 19 having essentially the same outer diameter as the body 16' of the anode. This tube 19 supports a honeycombed structure including a large number of passages 20 of generally hexagonal cross section separated by thin bounding walls 21. The passages are preferably of substantially greater depth than the transverse dimension thereof. The face of the anode and preferably the total area of the metal walls exposed on the face of the anode is kept relatively small. Honeycombed structures of the type illustrated in Figs. 3 and 4 may be readily manufactured in accordance with the process described and claimed in the copending Scott application Serial No. 628,566, filed November 14, 1945, and assigned to the assignee of this application. In accordance with the method there described a large number of conductors are coated with a thin layer of metal which is to form the walls of the mesh. These coated conductors are assembled in a tube which is swaged to reduce its cross section and then the core rods are dissolved from the swaged structure to leave the honeycombed structure having bounding surfaces which are formed of material with which the core rods were coated.

Honeycombed structures of desired length may be cut from the swaged tube. In carrying out this embodiment of my invention, it is not necessary that the entire hollow structure of the anode be provided by the honeycombed structure and, if desired, a bore such as illustrated at 22 may be provided in the end of the anode body 16'.

It will be apparent that with this structure an equipotential surface having substantially the voltage of the anode will follow very closely across the anode face and will not penetrate deeply into the relatively small passages 20. At the same time by utilizing the process mentioned, the walls 21 are kept sufficiently thin so that a relatively small number of electrons are collected and very little secondary emission is experienced.

In Fig. 5 I have shown a still further modification of my invention in which an anode 9'' has a generally cylindrical body portion 23 and which is provided at its lower end with a generally conical bore 24. With this construction more of the secondary electrons released from the surface of bore 24 travel to another surface of the bore and for this reason there is more tendency for the electrons to be collected. It will be apparent that a mesh may be provided at the lower end of the bore 24 in accordance with the embodiments of Figs. 1 to 4, if desired.

It will be apparent from the foregoing description that my invention contemplates an anode or collecting electrode structure which is hollowed out to provide a substantially field-free region on the bounding surfaces of which the electrons are collected, so that there is no field tending to accelerate the secondary electrons away from the anode. In discharge devices of the screen grid type my invention is of particular advantage in that it eliminates the necessity of a suppressor grid.

While I have shown and described a particular embodiment of my invention, it will be apparent to those skilled in the art that changes and modifications may be made without departing from the features of my invention, and I, therefore, aim in the appended claim to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

An electrical discharge device including a cathode, a control grid, a screen grid and an anode mounted in spaced relation in the order enumerated, said anode comprising an elongated body recessed from the end thereof facing the screen grid, conductive means extending over the open end of said recess and conductively connected to said anode to sub-divide it so that the recess is substantially deeper than the minimum cross sectional dimension of the sub-divisions to provide a substantially field-free region for the collection of electrons whereby the emission of secondary electrons is minimized.

ELMER D. McARTHUR.

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