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SECONDARY ELECTRON DISCHARGE DEVICE

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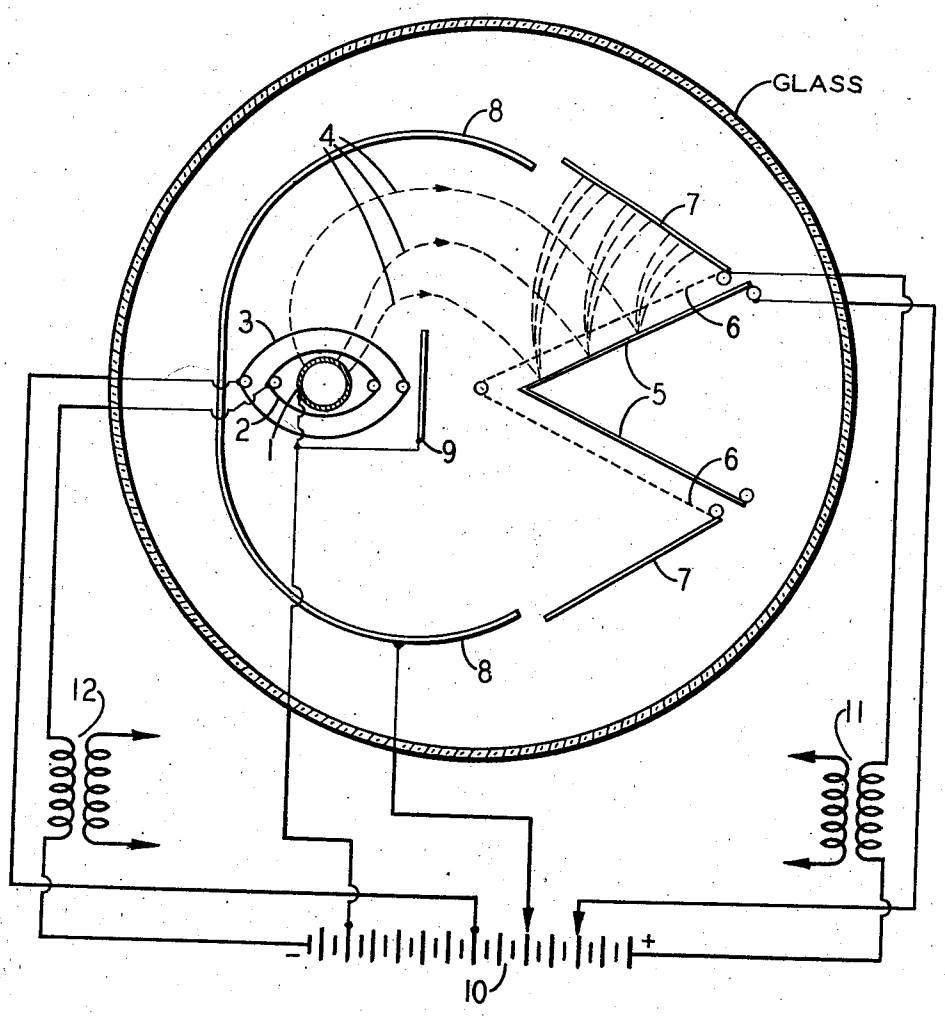

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SECONDARY ELECTRON DISCHARGE DEVICE

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6 Claims. (Cl. 250—174)

This invention relates to electron discharge tubes having a secondary emission electrode provided on at least part of its surface with a substance, such as one of the metals or oxides of the group of alkali or alkaline earth metals, which upon being struck by a primary electron stream readily emits secondary electrons.

In discharge tubes of this type the electrodes have been so mounted that the primary elctrons from the cathode pass through one or more grids, and then through a grid-like anode to impinge upon a secondary emission electrode located near and behind the grid-like anode. The secondary electrons are collected by the grid-like anode, and may oscillate through and around it to some extent, which is disadvantageous for short-wave uses. Furthermore, all the electrodes are in the discharge path of the primary electrons. To improve the properties, particularly the internal resistance, of such discharge tubes, it has been proposed to construct the tube so that the secondary electrons issuing from the secondary emission electrode are collected by an anode mounted outside the discharge path of the primary electrons. In tubes thus constructed it has been found that in some cases the secondary electrons are not fully and completely drawn away from the vicinity of the secondary emission electrode.

The principal object of the invention is to provide a tube of the secondary emission electrode type in which the secondary electrons are promptly removed from the vicinity of the secondary electron emitter without oscillating about an anode, and which is well adapted for short-wave uses. According to the present invention, an electron discharge tube is constructed with an electrode system including a secondary emission electrode and a collector electrode comprising a plate-shaped output anode outside of and alongside the path of the primary electrons and a grid-like electrode or anode extension mounted immediately in front of the secondary emission electrode and connected to the plate-shaped output anode. The primary electrons pass through the grid-like anode extension to the secondary emission electrode and the secondary electrons which are liberated are rapidly and completely drawn away from the secondary emission electrode principally to the plate-shaped anode of the collector electrode. The advantages of the secondary electron emission type of tube are retained, while no difficulty is experienced from electrons oscillating to and fro around the grid-like anode extension, a feature of particular importance in the use of this type of tube for short-wave purposes.

According to one particular embodiment of the present invention the secondary emission electrode is so arranged that any material projected from the primary cathode cannot reach the secondary emission electrode. To this end the primary electrons are constrained to follow curved paths from the primary cathode through the grid-like extension conductively connected to the plate anode mounted to one side of the paths of the primary electrons, and thus reach the secondary emission electrode, which extends across and is normal to the paths of the primary electrons at a point out of the straight line trajectories of particles thrown off from the cathode.

The invention will be explained more fully with reference to the accompanying drawing, which represents diagrammatically one embodiment of the invention in an electron discharge tube with the electrodes arranged according to the present invention.

The tube shown in the drawing comprises the usual evacuated envelope enclosing a conventional indirectly heated rectilinear cathode **1** consisting of a tubular cathode sleeve coated with barium and strontium oxides, said cathode in turn being surrounded by a coaxial control grid **2** and a coaxial screen grid **3**, each of the conventional helical type with two side rods or supports parallel to said cathode. The side rods of the grids act to some extent as beam forming electrodes which concentrate the primary electron discharge from the cathode **1** into two fairly well defined electron beams proceeding from the cathode in diametrically opposite directions. These beams follow curved paths, as indicated by the arrows **4**, which indicate the path of one of the beams. The primary electrons proceeding from the cathode are led over the curved paths to an emitter anode **5** having a surface coated with a substance, such as caesium oxide or caesium, which readily emits secondary electrons, so that the emitter anode has a high coefficient of secondary electron emission.

The emitter anode **5** preferably has a flat surface treated with a substance, such as casein oxide, so that it has a high coefficient of secondary electron emission and on which the primary electron discharge impinges. The secondary electrons emitted by the bombarded surface of the emitter **5** greatly exceed in number the primary electrons which fall on the emitter. The emitter anode **5** may, as indicated in the drawing, be made of sheet metal and in the general

form of a V with its apex toward the cathode and its median plane in alignment with the grid side rods and the cathode. The two flat secondary electron emitting surfaces of this particular form of emitter anode intersect at an acute angle along a line which is parallel to and in alignment with a grid side rod and the cathode. This form of emitter anode is not essential, but is convenient where, as in the tube shown in the drawing, all of the discharge from the cathode is brought to the emitter anode. The flat secondary electron emitting surfaces of the emitter anode 5 are set edgewise to the cathode and the planes of these surfaces are transverse to the direction of the electron discharge as it leaves the cathode, so that the beams must follow curved and substantially semi-circular paths in order to reach the secondary electron emitting surfaces of the emitter anode.

The output current of the tube is secured from a collector electrode comprising a grid-like anode extension 6 mounted in front of and parallel to the flat surface of the emitter anode 5 and constituting an extension of an output anode 7 mounted outside the path of the electron discharge to the emitter anode. The output anode 7 is preferably an imperforate sheet of metal and is substantially parallel to and to one side of the path followed by the primary electron discharge from the cathode to the emitter anode. As indicated by the dotted lines, the primary electron stream passes through the grid-like extension 6, impinges on the surface of the emitter anode 5, thus producing a great number of secondary electrons, which are rapidly and completely withdrawn from the vicinity of the emitter anode and also from the path of the primary electrons by the positive collector electrode. As a result of this construction, the secondary electrons which pass through the grid-like anode extension 6 do not oscillate about or through the anode extension, but are quickly drawn away to the output anode 7. Due to freedom from oscillations of the secondary electrons the tube is particularly suitable for short-wave work.

The discharge from the cathode is constrained by an accelerating electrode 8, which is more or less semi-cylindrical in form and partially encloses the cathode, to follow the curved and substantially semi-circular paths indicated in the figure by the arrows 4. The field produced by the accelerating electrode 8 causes the discharge from the cathode to flow in a fairly well defined beam alongside but not touching the output anode 7 and through the grid-like anode extension to impinge upon the emitter anode 5 with sufficient velocity to cause copious emission of secondary electrons.

Contamination of the secondary electron emitting surfaces of the emitter anode 5 by particles thrown off by the cathode is very unlikely for the reason that particles thrown off from a thermionic cathode travel in straight lines and the trajectories of practically all of these particles will be such that the particles will miss the emitting surfaces of the emitter anode. To insure that none of the particles thrown off from the cathode will reach the emitter anode surfaces a shield 9 may be interposed between the inner edge of the emitter anode and the cathode. This shield is preferably a sheet of metal set transversely of the median plane of the cathode and emitter anode, and of such dimensions that a straight line cannot be drawn from any point on the surface of the cathode to any point on the emitting surface of the emitter anode without passing through the shield. As a result, the shield 9 acts as a physical barrier to any particles thrown off from the cathode and moving in straight lines toward the emitting surfaces of the emitter anode. The shield may to advantage be connected to the cathode so that it is at zero potential and thus acts as an electrostatic shield between the cathode and the emitter anode.

As illustrated in the drawing, the tube may be connected to a source of potential such as a battery 10 with the negative terminal connected to the control grid 2 and the positive terminal connected through a load circuit 11 to the collector electrode 7. The discharge may be modulated by an input circuit 12 connected to vary the potential of the control grid.

I claim:

1. An electron discharge device comprising an emitter anode having a high coefficient of secondary electron emission, means for producing a modulated stream of primary electrons to said emitter anode, and a collector electrode comprising an output anode mounted adjacent said emitter anode and outside of the path of said modulated primary electron stream and a grid-like extension of said output anode mounted in front of said emitter anode and athwart the path of said primary electron stream to said emitter anode.

2. An electron discharge device comprising a thermionic cathode, an emitter anode having a high coefficient of secondary electron emission, means for directing a primary electron stream from said cathode to said emitter, an output anode adjacent said emitter anode and outside the path of said electron stream and having a grid-like anode extension connected to said output anode and extending across the path of said electron stream to said emitter anode, and a shield interposed between said cathode and said emitter anode in position to prevent impingement upon said emitter anode of particles ejected from said cathode.

3. An electron discharge device comprising a thermionic cathode, beam-forming electrodes for concentrating the discharge from said cathode into an electron beam, a plate emitter anode having a high coefficient of secondary electron emission and mounted edgewise to said cathode with a flat surface in a plane transverse to the axis of the electron beam at said cathode, a curved accelerating electrode with its concave surface facing said cathode and extending from the vicinity of said cathode toward said emitter to constrain said electron beam to follow a curved path to said surface of said emitter, a collector electrode comprising an output anode outside and substantially parallel to the path of said electron beam adjacent said emitter and a grid-like extension projecting across the path of said beam and in front of said emitter.

4. An electron discharge device comprising a thermionic cathode, an emitter anode having a high coefficient of secondary electron emission, a collector electrode comprising an output anode adjacent said emitter anode and outside the path of discharge from said cathode to said emitter and having a grid-like extension across the path of said discharge adjacent said emitter, and a solid shield mounted between said cathode and said emitter and extending across any straight line between any point of said emitter surface and any point of said cathode.

5. An electron discharge device comprising a

thermionic cathode, an emitter anode having a flat surface substantially in a plane extending radially of said cathode, a collector electrode comprising a solid output anode positioned outside the path of discharge from said cathode to said emitter anode and inclined to said emitting anode surface, said output anode having a grid-like anode extension in front of and parallel to said emitter surface, and a shield interposed between said cathode and said emitter anode and constituting a solid physical barrier to particles which move along a straight line from any point on said cathode to any point on said emitter surface.

6. An electron discharge device comprising a rectilinear cathode, a grid surrounding said cathode and having a pair of side rods parallel to said cathode, an emitter anode having two flat surfaces inclined to each other and intersecting at an acute angle with the line of intersection of the planes of said surfaces in alignment with said grid side rods and said cathode, a semi-cylindrical accelerating electrode facing said emitter and partially surrounding said cathode to cause the electron discharge from said cathode to said emitter to follow curved paths to both surfaces of said emitter, a collector electrode comprising a solid output anode adjacent each surface of said emitter and outside the path of discharge to said emitter and a grid-like extension parallel to and in front of each emitter surface, and a shield interposed between said grid and said emitter extending transversely of the median plane of said emitter and said cathode.

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