May 3, 1955 D. E. MARSHALL 2,707,753

ELECTRON DISCHARGE DEVICE

Filed March 28, 1951

Fig. 1.

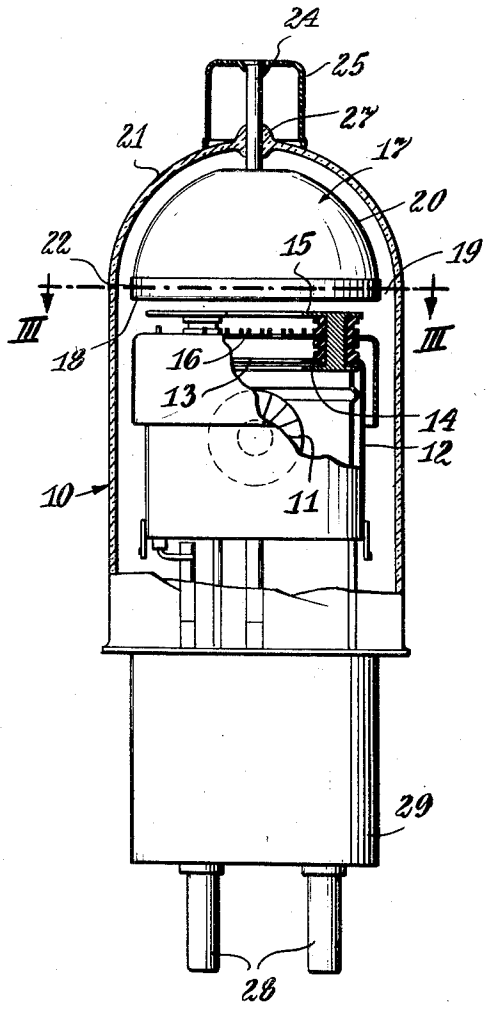


Fig. 2.

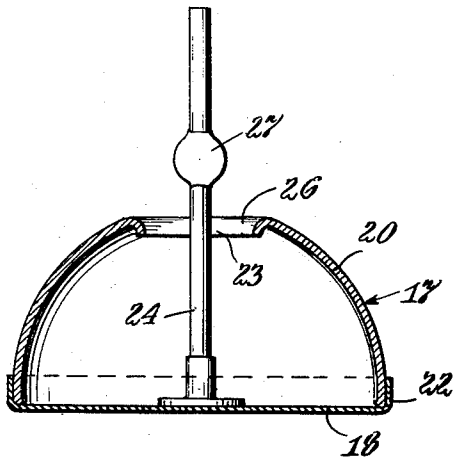
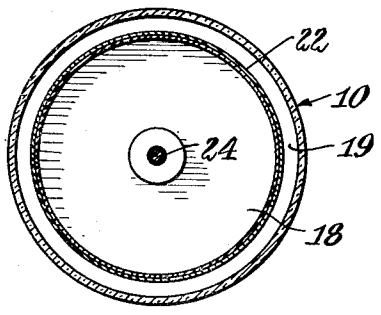


Fig. 3.



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ELECTRON DISCHARGE DEVICE

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5 Claims. (Cl. 313—187)

This invention relates to electron discharge devices, and more especially to such devices wherein a gas is present in the envelope and ionization developes in operation.

Inasmuch as gas-filled thyratrons are benefited by utilization of the present invention, I have arbitrarily selected one type thereof for purpose of illustration and exemplification, and accordingly, while the following description includes specific recitation of details of that particular device, the broad concept disclosed is applicable to other embodiments of electron discharge devices.

Rectifiers, thyratrons and numerous other tubes operate on alternating current with expectation of passing current in one direction only. Spurious passage of current in the opposite direction is generally referred to as "break-down." In gas-filled tubes more especially, break-down occurs all too frequently, and is believed to be due to one or more electrons breaking away from the anode, in its negative cyclic period when current is not supposed to pass, and that electron thereupon impinging upon a gas atom and instigating the ionizing current-passing reaction.

At pressures used in many gas-filled tubes, the break-down voltage is, in tubes of usual construction and dimensions, lower over a long path than over a short path. This circumstance is probably due to the fact that over a longer path an electron collides with more gas atoms than on a shorter path and each collision detaches ions and additional electrons from the gas atom struck, so, as a minimum condition with each collision, there is still the original electron plus a detached ion and electron from the gas atom. Thus with each collision of electron and atom, the current is increased to correspond to the two negative electrons and to the positive ion as distinguished from original correspondence to only one electron.

Consequential upon the fact of break-down at lower voltages over a longer path than on a shorter one, spurious discharges often occur from the cathode to remote parts of or connections to the anode, and avoidance thereof constitutes the primary object of this invention.

Equally essential as an object of the invention is the provision of structure which will deter or prevent ionization on paths to remote parts of the anode.

Of similar character, an object of the invention is to prevent break-down discharge to the lead-in connection to the anode.

An object of the invention is to provide a readily fabricated anode and one which may be assembled with the envelope and other parts of the device with facility and with accuracy.

A further object of the invention is to provide an anode of minimum mass, and shock-proof to maximum degree.

Still other objects of the invention will appear to those skilled in the art to which it appertains as the description proceeds, both by direct recitation thereof and by inference from the context.

Referring to the accompanying drawing in which like numerals of reference indicate similar parts throughout the several views:

Fig. 1 is a sectional elevation of an electron discharge device embodying my invention;

Fig. 2 is an axial-diametric section of the anode of the device; and

Fig. 3 is a cross-section of the device through the anode and envelope on line III—III of Fig. 1.

In the specific embodiment of the invention illustrated in said drawing, the reference numeral **10** designates an envelope of suitable material, such as glass, which is evacuated, filled to desired extent with an appropriate gas, such as xenon, neon, helium, argon, mercury vapor or the like, and sealed. Within the envelope are provided, in proper relation to each other, electrodes consistent with the type of tube desired. According to the present showing, the device is provided with a cathode **11** within a shielding cylinder **12** having an electron passage opening **13** at the forward end thereof, together with shield grids **14** and **15** at cathode potential of which one, as **14**, is within shielding cylinder **12** and another, **15**, in front of and spaced from said cylinder. Electrodes shown also include a control grid **16** located between the open end of cylinder **12** and the outer shield grid **15**, as well as an anode **17** located beyond the said outer shield grid. The construction and arrangement of the anode is of particular concern to the present invention.

Normal and desired discharge from cathode **11** to anode **17** is preferably emission from the cathode which approaches the anode on substantially straight lines perpendicular to a flat end wall or face **18** of the anode directed toward the cathode. Said flat end face of the anode is parallel to the control grid **16** and to shield grids **14** and **15** and has spacing from said grids in accordance with usual engineering formula and calculations for effecting discharge from cathode to anode at the desired operating potential.

The radial spacing **19** of the periphery of said flat face **18** of the anode from the surrounding wall of the envelope **10** is substantially no greater, and preferably less than the mean-free path spacing of ions of the particular gas and pressure of gas-filling of the tube. Specifically, for xenon at **100** micron pressure, the spacing distance should be within the approximate range of one quarter of a millimeter to one millimeter.

The rear of the anode, that is, the portion of the anode projecting away from the cathode, is preferably in the form of a dome **20** or partial sphere to follow the contour of and maintain short radial spacing **19** from the correspondingly domed end **21** of the envelope. This spacing **19** of rear portion **20** of the anode from the envelope wall is preferably substantially a continuation of the spacing defined by the periphery of the flat face of the anode to the envelope wall, and therefore no greater and preferably less than spacing distance for normal means free path of ionization defined by the same considerations as recited above. By virtue of the narrow spacing **19** between the anode **17** and envelope **10**, any ions generated in this small space are quickly lost by collision with the anode or the glass wall. Furthermore, due to the narrow spacing, a considerably higher voltage is required to start a spurious break-down discharge from the rear of the anode than would normally be the case with the usual wider spacings.

The anode may be, and preferably is made of metal and of hollow construction with the basal part of the dome closed by a flanged cap by welding the flange **22** of the cap to the basal rim of the dome and the major portion of the cap constituting the afore-mentioned flat face **18**. The anode is accordingly light in weight or of minimum mass and its inertia is consequently minimized under shock impacts.

The zenith portion of the dome preferably provides an opening **23** thereat to admit passage therethrough of a

lead-in and supporting post or wire 24. Said post extends to the flat wall or cap member 18, centrally thereof, and is secured thereto by welding or in other suitable manner. The outer end portion of said post passes through and is sealed vacuum-tight through the glass of the envelope and provided with a suitable exterior metallic terminal 25 on the said post and next the glass of the envelope. The margin of the dome of said anode next said opening 23 preferably curls inward, as at 26, to maintain appropriate spacing from the glass beading 27 required for the seal of the post through the envelope wall. The metal of the dome in this manner affords desired shielding of the lead-in post electrostatically and thereby prevents spurious discharge being instigated from said lead-in post. The construction described furthermore permits use of a relatively thin lead-in post having the advantage of holding conduction of heat to the glass envelope at the seal to a minimum.

It will be understood that electrical connections to the other electrodes than the anode are sealed through the envelope at its end opposite from the anode lead-in post, and are attached to appropriate prongs on pins 28 protruding from an exterior tube base 29.

I claim:

1. An electron discharge device having an envelope with a dome-shaped end thereto, and said envelope having a gas content at a selected pressure, a cathode in said envelope, a transverse grid in said envelope between said cathode and dome-shaped end of the envelope, an anode in said envelope having a dome-shaped portion extending in a direction away from the cathode and with said dome-shaped portion of the anode conforming to the dome-shaped portion of the envelope, said anode having a flat wall at the basal portion of the dome-shaped portion and located in parallelism to said grid, said cathode being external of said dome-shaped portion and flat wall, and said dome-shaped portions of envelope and anode having substantially uniform proximity to each other providing a dome-shaped spacing having thickness numerically substantially no greater than the calculated means-free-path of ionization of said gas at the said selected pressure thereof.

2. An electron discharge device having an envelope with a dome-shaped end thereto and said envelope having xenon gas therein at approximately one hundred microns pressure, a cathode in said envelope, an anode in said envelope, said anode having a dome-shaped portion extending in a direction away from the cathode and in proximity to and conforming to the contour of said dome-shaped end of the envelope with a substantially uniform spacing therefrom approximately within the range of one quarter to one millimeter rendering the distance between the domed surfaces of said dome-shaped anode and dome-shaped end of the envelope commensurate witth the mean-free-path of xenon gas ions at tthe aforesaid pressure.

3. An electron discharge device having an envelope with a dome-shaped end thereto, and a hollow anode in said envelope having a dome-shaped portion with the dome-shaped wall thereof in proximity to and conforming to the contour of said dome-shaped end of the envelope with close spacing preventing straight-line passage of electrons therebetween from one end of the anode to the other, said anode having a flat wall extending across and closing the basal end of the dome-shaped wall of the anode, said dome-shaped wall of the anode having an opening at its zenith, and a lead-in post sealed through the dome-shaped portion of the envelope and extending through the said opening in the anode to said flat wall of the anode and secured to said flat wall.

4. An electron discharge device having an envelope with a circular wall portion terminating with a hollow dome-shaped end providing an inwardly directed concave surface, and an anode in said envelope having basal, zenith and intermediate portions thereof in proximity to and providing an outwardly directed convex surface from the basal portion to the zenith portion substantially conforming to the contour of said concave surface of the dome-shaped end of the envelope, said zenith portion being spaced from the concave surface of the envelope, a transverse plane at the zenith portion intercepting the concave surface on a circle of less diameter than the diameter of said basal portion thereby providing an end space between said envelope and anode next to the dome-shaped end of the envelope, said surfaces providing a dome-shaped curved space from said end space to the basal portion of the anode and opening thereat to the interior of the envelope away from the dome-shaped end of the envelope whereby electrons admitted to said domed curved space will impinge in straight-line travel against one of said surfaces and be intercepted thereby from entry into said end space.

5. An electron discharge device having an envelope with a dome-shaped end thereto, and an anode in said envelope having a dome-shaped portion thereof in proximity to and conforming to the contour of said dome-shaped end of the envelope, said anode having a flat end face opposed to the zenith of the dome-shaped portion thereof, both said flat end face and dome-shaped portion of the anode being metallic and constituting electron-receiving surfaces, and the spacing between said dome-shaped portions of the anode and envelope constituting means for preventing entry of electrons above the level of the zenith of the anode.

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