

Nov. 18, 1941.

P. T. FARNSWORTH

2,263,032

COLD CATHODE ELECTRON DISCHARGE TUBE

Original Filed Nov. 4, 1936

2 Sheets-Sheet 1

Fig. 1.

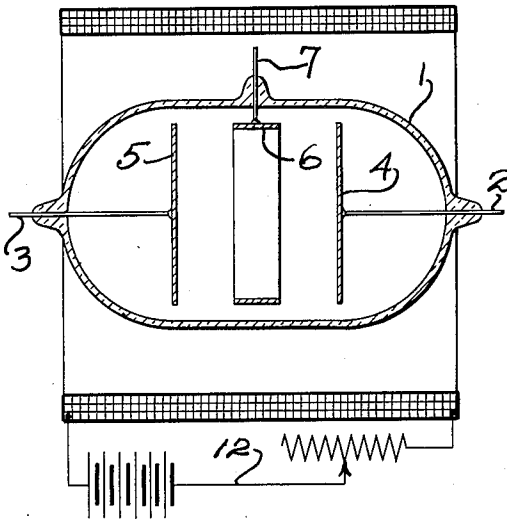


Fig. 2.

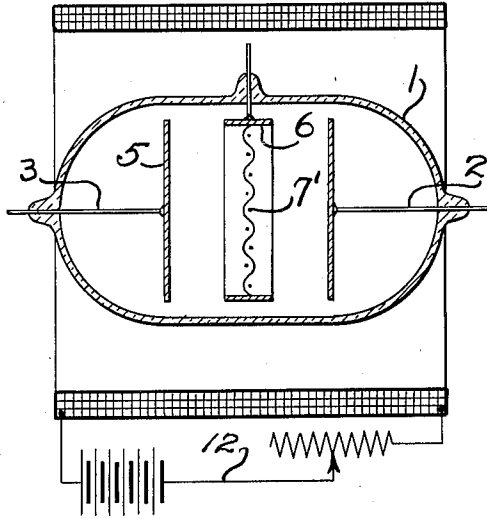


Fig. 3.

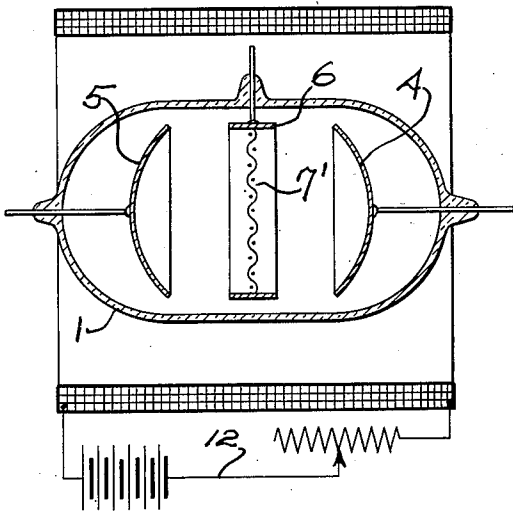
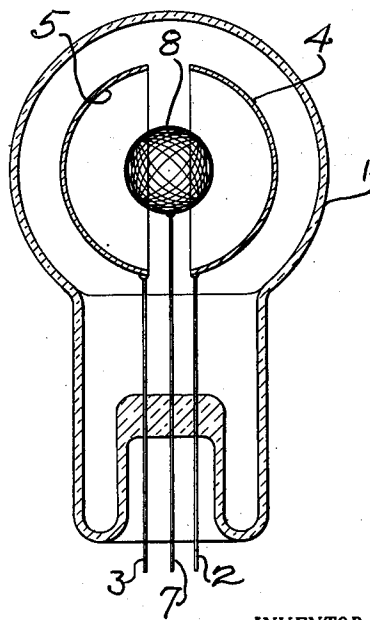


Fig. 4.



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2 Sheets-Sheet 2

Fig. 5.

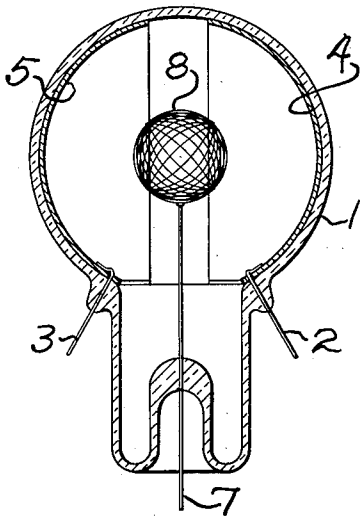


Fig. 6.

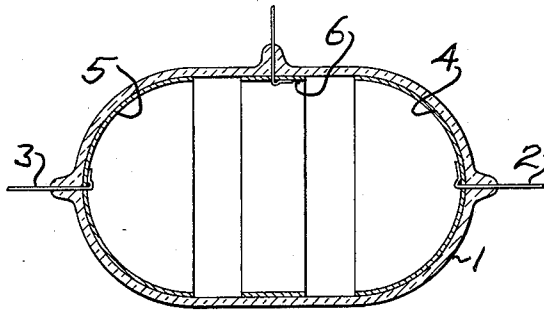
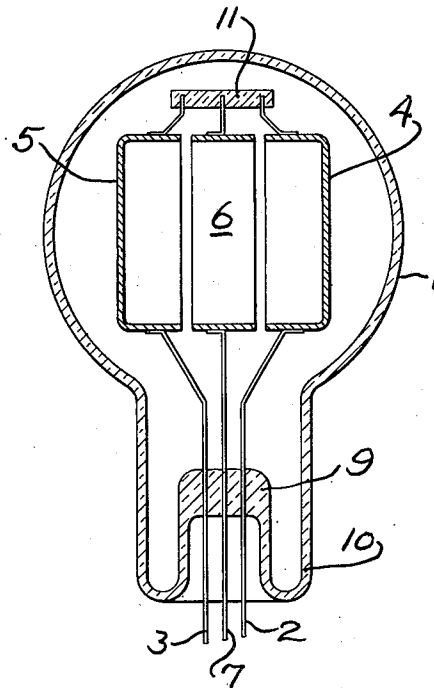


Fig. 7.



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COLD CATHODE ELECTRON DISCHARGE
TUBE

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Original application November 4, 1936, Serial No.
109,154. Divided and this application April 5,
1939, Serial No. 266,137

2 Claims. (Cl. 250—174)

My invention relates to an oscillation generator tube, and more particularly to such a tube utilizing cold cathodes, and is a division of my copending application, Serial No. 109,154, filed November 4, 1936, now United States Patent No. 2,184,910 issued December 26, 1939, which in turn is a continuation-in-part of the following patents: Oscillation generator, Patent No. 2,071,516, issued February 23, 1937; Electron multiplying device, Patent No. 2,071,515, issued February 23, 1937.

The two prior patents mentioned immediately above describe and claim a method of electron discharge tube operation and circuits used to practice the method, whereas the present application deals solely with the tube structure capable of producing oscillations, or electron multiplication, when utilized in accordance with the methods and in the circuits above referred to.

The primary object of this invention is to provide a new type of electron multiplier and oscillation generator tube.

Among the other objects are: To provide an electronic oscillator tube capable of converting direct current energy into oscillations at extremely high frequencies; to provide an electron multiplier tube having a minimum of electrodes; to provide an oscillation generator and electron multiplier utilizing cold cathodes; and to provide a new and improved electron discharge device having cold electrodes, and capable of electron multiplication and oscillation generation, when energized.

Other objects of my invention will be apparent or will be specifically pointed out in the description forming a part of this specification, but I do not limit myself to the embodiment of the invention herein described, as various forms may be adopted within the scope of the claims.

Referring to the drawings:

Figure 1 is a longitudinal sectional view of a simple form of my invention.

Figure 2 is a longitudinal sectional view of a multiplier tube having a screen anode.

Figure 3 is a longitudinal sectional view of a tube having concave cathodes.

Figure 4 is a longitudinal sectional view of a tube having electrodes describing concentric, spherical surfaces.

Figure 5 is a longitudinal sectional view of a tube similar to Figure 4, but having the cathodes deposited on the envelope.

Figure 6 is a longitudinal sectional view of a tube having concave cathodes deposited on the wall of the envelope.

Figure 7 is a longitudinal sectional view of a tube having concave electrodes providing electrostatic focusing.

In my prior patents mentioned above, I have described a method and system for electron multiplication and oscillation generation, utilizing, as an electron discharge device, a tube comprising three electrodes. Two of these electrodes are cathodes having opposed surfaces which are sensitized to emit secondary electrons at a ratio greater than unity, when impacted by traveling electrons, and the third electrode is an accelerating anode located between the cathodes. All of the tubes herein to be described operate in one mode, simply by connecting the two cathodes by a resonant circuit and supplying the anode with an accelerating potential. Certain of the tubes herein to be described are adapted for use in combination with a longitudinal magnetic field parallel to the electron paths, whereas others, as will be later described, utilize electrostatic focusing, automatically obtained by the shape of the electrodes.

Referring directly to the figures for a more detailed description of my improved tube structure, in various modification, and referring first to Figure 1, an envelope 1 is provided at each end with cathode lead wires 2 and 3, to which are attached a pair of facing cathodes 4 and 5. The opposed surfaces of cathodes 4 and 5 are treated so that they will emit secondary electrons at a ratio greater than unity upon electron impact therewith.

I find that one of the most satisfactory methods of sensitizing these surfaces is to make the cathodes from silver, or at least with a silver inner surface, oxidize the silver, and deposit caesium thereon until maximum thermionic emission is obtained. However, inasmuch as these devices operate by repeated electron impacts, it will be obvious that less sensitive surfaces may be used and an extra impact provided to bring the output of the tube to a high value. The cathodes, for example, may be made from a nickel-barium alloy, and be treated, during exhaust, to have opposed surfaces containing barium. Or, again, the entire material of the cathodes may be made of aluminum, for example, which will give emission at a ratio greater than unity when impacted by an electron traveling at velocities easily obtained. I do not, therefore, wish to be limited to any particular type of surface, but simply state that the surface should be capable of emitting secondary electrons at a ratio greater than

unity when impacted by electrons traveling at velocities obtainable in operation.

An anode is provided with the customary anode lead 7 passing through the envelope, and in its simplest form this anode is merely a ring 6 surrounding the space between the two cathodes in which the electrons oscillate. Inasmuch as the longitudinal magnetic field is used in conjunction with this type of tube, electrons from one cathode are accelerated to hit the other and opposing cathode, because the magnetic field prevents immediate collection by the surrounding anode. This field may be produced by solenoid circuit 12.

Figure 2 shows a modified anode structure where, in addition to the ring 6, there is a screen 7' dividing the space between the two cathodes.

Figure 3 shows another modification wherein the cathodes 4 and 5 are formed slightly concave to each other, and with this type of structure there will be some electrostatic focusing which may be supplemented by an additional magnetic field.

Figure 4 illustrates a modification in which the cathodes 4 and 5 are spherical surfaces approaching hemispheres, and the anode, in this case, is in the form of an apertured spherical electrode, preferably made by winding fine wires into a mesh sphere 8. In this case no magnetic field is needed, the electrostatic field of the electrodes themselves providing a focus such that electrons from one cathode will be sure to reach the opposing cathode, passing through the Faraday space formed by the sphere 8. It is preferable, of course, that the sphere 8 be concentric with the sphere described by the cathodes.

In Figure 5 I have shown a modification of the same structure as shown in Figure 4, except that the cathodes 4 and 5 here are deposited as a film upon the interior of the envelope itself. Otherwise, the structure is identical.

In Figure 6 I have shown a modification combining the envelope films of Figure 5 with the

type of anode utilized in Figure 1, except that here the anode ring is, itself, a film on the envelope wall.

In Figure 7 I have shown an electrode arrangement similar to that of Figure 6, except that in this case the cathodes 4 and 5, and the anode ring 6, form a cylindrical chamber, so that electrostatic focus is present to a high degree, and in this particular instance I have shown the electrodes mounted in the usual manner upon a reentrant stem 9 located in an envelope arm 10. The electrodes are maintained in position within the envelope by an insulating bead 11 to which all the electrodes are attached, as is well known in the art.

Other modifications of the three fundamental electrodes herein described and claimed will be immediately apparent to those skilled in the art, and shall be deemed to be included within the scope of the claims hereto appended.

I claim:

1. An electron discharge tube comprising an envelope, deposits of conducting material on opposed interior surfaces of said envelope, said deposits being spaced and electrically separate, said deposits also having substantially equal areas and being capable of producing secondary electrons at a ratio greater than unity upon electron impact therewith, and an additional spherical electrode surrounding a portion of the space between said deposits.

2. An electron discharge tube comprising an envelope, deposits of conducting material on opposed interior surfaces of said envelope, said deposits having substantially equal areas and being electrically separated but disposed with their edges closely adjacent to provide a substantially closed electron chamber, and an additional spherical electrode surrounding a portion of the space within said chamber.

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