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SECONDARY ELECTRON TUBE

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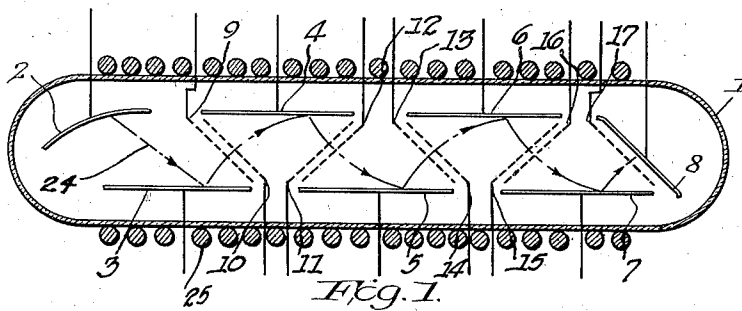


Fig. 1.

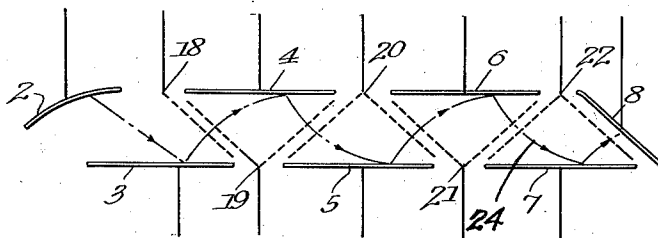


Fig. 2.

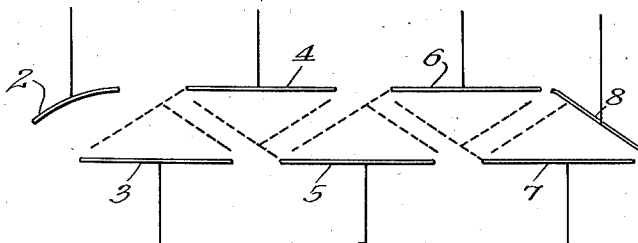


Fig. 3.

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SECONDARY ELECTRON TUBE

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5 Claims. (Cl. 250—175)

This invention is related to electron tubes operating with secondary emission, in which a repeated emission of secondary electrons takes place. Tubes with electrostatic and magnetic fields are known in which secondaries liberated from an emitting electrode by primary electrons impact a further emitting electrode where they liberate new secondaries, whereupon this procedure may be repeated several times.

The paths of the electrons travelling from one emitting electrode to the next, may be influenced by accelerating electrodes disposed between the emitting electrodes. Hereby voltages are applied to all electrodes which increase from stage to stage, so that a special lead or voltage tap is necessary for every single electrode.

The object of this invention is to obtain a more favorable configuration of the fields, and of the electron paths, and at the same time decrease the number of voltages and electrodes per stage. This results in a more simple construction of the tube. According to the invention, two permeable accelerating electrodes, for instance grids, foils, mesh-work, sieves or a combination of these elements, are disposed between each two subsequent emitting electrodes. The accelerating electrodes are positive in respect to the neighboring emitting electrodes and the second accelerating electrode in the direction of the electron path, is more positive than the first. In order to decrease the number of leads, the second accelerating electrode of one stage and the first accelerating electrode of the next stage, are preferably held at the same positive potential, in respect to the neighboring emitting electrode. A further simplification is obtained if both accelerating electrodes of the same potential are connected to the emitting electrode of the next stage.

It may seem useful to arrange the accelerating electrodes, between which the main part of the accelerating field lies, in such a manner that the electrons are given a certain direction after passing the second accelerating electrode, if necessary, by means of a magnetic field towards a certain part of the following emitting electrode. Such a part of this emitting electrode is chosen that one can safely assume that the secondaries emitted from that part will strike the next stage.

The drawing shows several modifications of the invention.

Figure 1 shows a cross-section of the tube according to the invention.

Figures 2 and 3 show an arrangement of the electrodes in such a tube.

The evacuated envelope 1 contains a cathode 2, for instance, a thermionic or photo cathode, which emits primary electrons. The electrons strike a first emitting electrode 3, opposite which but displaced to the side, lies a second parallel emitting electrode 4. Opposite to this lies a further

emitting electrode 5, and the arrangement repeats itself at the emitting electrodes 6 and 7. The collecting anode 8 is placed at the end of the tube. Two accelerating electrodes lie between each two emitting electrodes which are coated with a secondary emitting material. In this case, the accelerating electrodes are formed as grids or mesh-works, 9-17. The grids 9 and 10 between the emitting electrodes 3 and 4 are at such potentials that the electrons accelerated by the first grid 9 are again accelerated by the second grid 10. The electrons are decelerated between the second grid 10 and the following emitting electrode 4, because the emitting electrode is less positive than the foregoing emitting electrode. The electrons are decelerated to a velocity which corresponds to the stage voltage, i. e., the voltage between subsequent emitting electrodes. The potentials of the electrodes 11 to 17 are chosen accordingly, so that a voltage distribution for the total arrangement results as follows:

	Volts
Emitting electrode 3	0
Emitting electrode 4	400
Emitting electrode 5	800
Emitting electrode 6	1200
Emitting electrode 7	1600
Anode 8	1700
Accelerating electrode 9	50
Accelerating electrode 10	500
Accelerating electrode 11	450
Accelerating electrode 12	900
Accelerating electrode 13	850
etc.	

The two grids 10 and 11, respectively 12 and 13, etc., which neighbor an emitting electrode, may also share the same potential between each other. Such an arrangement is shown in Figure 2. The grid pairs then require only one lead to each of the common points 19, 20, 21 and 22 between the grids 10 and 11, 12 and 13, 14 and 15, and 16 and 17 respectively, so that the number of leads is decreased. The emitting electrodes may have, for instance, the same potential as in Figure 1 and the accelerating electrodes are kept at the following potentials:

	Volts
Accelerating electrode 18	50
Accelerating electrode 19	450
Accelerating electrode 20	850
Accelerating electrode 21	1250
Accelerating electrode 22	1650

Figure 3 shows a further simplification of the device. The accelerating electrodes are connected to the emitting electrode of the next higher stage, so that only one lead is necessary per stage. The electrons leaving an emitting electrode are first accelerated to the stage voltage between the electrode and the first grid, and then accelerated to

twice the stage voltage between the first and the second grid, and finally decelerated again to the stage voltage between the second grid and the following emitting electrode. Because of the high potential of the first grid, secondaries are already liberated from this grid, which are drawn to the following emitting electrode by the second grid. This may be amplified by coating the first grid with a secondary emitting material.

The accelerating electrodes are preferably arranged in such a manner that they lie parallel to each other, and that two accelerating electrodes neighboring an emitting electrode form a triangle, together with the latter. The value of the angle between the two accelerating electrodes should be such that the electrons passing the accelerating grid impact the next emitting electrode. This angle may be, for instance, larger than 90 degrees.

In the arrangement shown in Figures 2 and 3, only half of the secondaries from the emitting electrode are accelerated in the direction of the following stage by the accelerating electrode. In the tube of Figure 1, the utilized area of the emitting electrode is larger or smaller, according to the potentials of the accelerating electrodes. Therefore, it is advisable that the electrons impact only this area of the emitting electrode. Such an effect partly takes place because of the fact that the high velocity electrons, which are, for instance, accelerated in the space between the grids 18 and 19, are decelerated before arriving at the electrode 4, and a prevailing number of which will impact an area of the electrode which lies towards the next higher stage. The path of an electron is indicated by the dotted line 24. The electrons impact the emitting electrode at an angle, whereby the gain of secondaries is favorably influenced. It may also be useful to make only the utilized part of the emitting electrode secondary emitting.

In order to guide the electrons safely to a certain area of the emitting electrode, it is advisable to provide a magnetic field which lies parallel to the surfaces of the emitting electrodes. Such a field is produced by a magnetic coil 25 wound about the envelope 1 and causes a more or less strong curvature of the electron paths, so that the majority of the electrons impact areas of the emitting electrodes, which are near to the next higher stage.

The tube is specially suitable for multiplication of photo currents, and allows, for instance,

such an amplification that the currents taken from the anode are sufficient to operate a loud-speaker if the photo cathode is exposed to light modulated by the sound trace of a sound film device.

I claim:

1. An electron multiplier comprising an evacuated envelope having therein a plurality of secondarily emissive cathode plates parallelly disposed in staggered opposition, a pair of electron permeable grids parallelly disposed between each of said cathode surfaces and the cathode surface disposed in staggered opposition thereto, said grids being placed at acute angles to said cathode surfaces, leads disposed through said envelope whereby said grids and cathode surfaces may be serially energized.

2. An electron multiplier comprising an evacuated envelope having therein a primary cathode and a collecting anode, a plurality of secondarily emissive cathode surfaces disposed between said primary cathode and said collecting anode, said secondarily emissive cathodes being parallelly disposed in staggered opposition, two electron permeable accelerating grids parallelly disposed between each of said secondarily emissive cathode surfaces and the one next in staggered opposition thereto, said grids being disposed at an acute angle to said cathodes and that pair of said grids adjacent each of said cathode surfaces making equal acute angles therewith.

3. An electron multiplier comprising an evacuated envelope having therein a primary electron source and a collecting anode, a plurality of flat secondarily emissive cathodes disposed between said primary cathode and said collecting anode, said secondarily emissive cathodes being parallelly disposed in staggered opposition, two electron permeable grids disposed between each of said secondarily emissive cathode surfaces and the one therefollowing in said staggered opposition.

4. An electron multiplier defined in claim 1 wherein a common lead is connected to each of said grid pairs closest adjacent to each of said secondarily emissive cathodes.

5. An electron multiplier defined in claim 1 wherein a common lead connects the pair of said grids closest adjacent to said secondarily emissive cathode surfaces to the following one of said cathode surfaces in staggered arrangement.

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