

Feb. 25, 1941.

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2,232,900

ELECTRON MULTIPLYING DEVICE

Filed Feb. 15, 1938

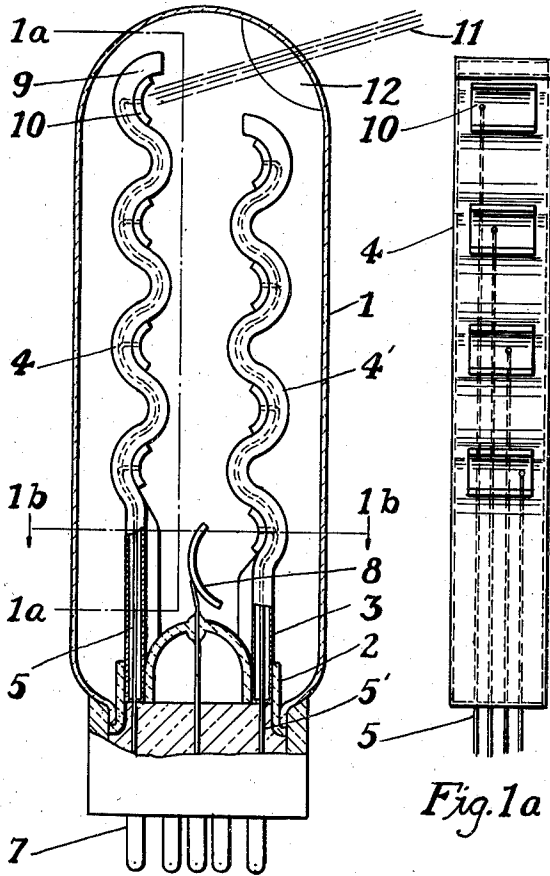


Fig. 1a

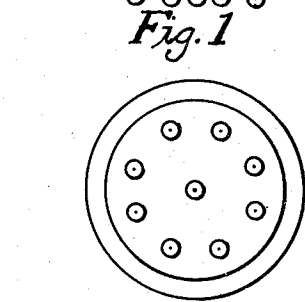


Fig. 1c

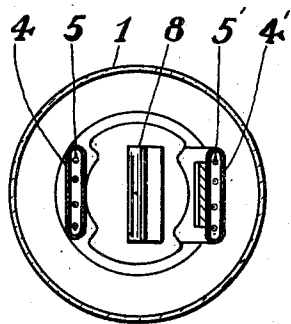


Fig. 1b

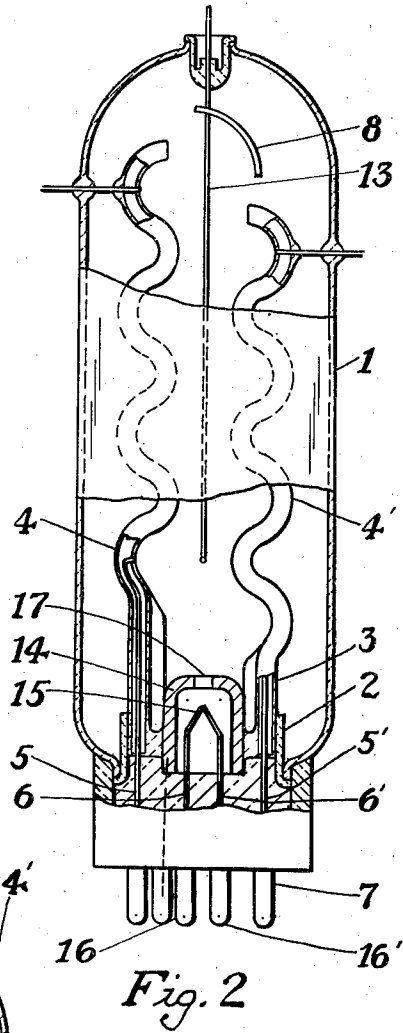


Fig. 2

WITNESS -

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2,232,900

ELECTRON MULTIPLYING DEVICE

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Application February 15, 1938, Serial No. 190,578

8 Claims. (Cl. 250—175)

This invention relates to electron multipliers and more particularly to devices for causing secondary emission of electrons, whereby certain advantages are obtained in improving and controlling the electronic output and in simplifying and rigidifying the structure of the elements, to attain this end.

The objects of my invention are: First in an electron multiplier, means for obtaining discharges of secondary electrons by impact of primary electrons on ridged surfaces of unit construction and of such sturdy form and character as can be made easily and held firmly in position in the device.

Another object of my invention is to provide such a general form of structure as can be disposed in various geometrical locations. Another object is to provide interrupted emissive surfaces which can be located at any desired distance apart, to permit a length of electron path to suit any required conditions of the actuating means.

Another object is to provide an electron emissive element of such shape and contour of its emissive surface as to interrupt the flow of the electron stream to cause successive impact upon surface contours of the emissive element.

Another object is to provide a form of construction of secondary emissive elements which can be used in known general types of electronic tubes for example hot cathode, cold cathode, phot sensitive, magnetically controlled or electrostatically controlled.

It will be seen that by a suitable combination and form of the means hereinafter described, convenient and effective methods of producing electron multiplication can be attained. As distinct from previous practice of providing a number of separate frail elements to cause impact of the electron stream, my present novel invention combines the functions of such elements, each in one simple, sturdy structure which can be made as a single unit and sealed into the enveloping tube or casing of an electron multiplier, in a simple and reliable manner.

It is to be understood that I do not limit myself to this disclosure of the species of my invention, as various embodiments of the same may come within the scope of the claims.

To the above ends, and for the purpose of illustrating my invention, I have shown in the accompanying drawing forms thereof which are at present preferred by me, since they will give satisfactory and reliable results. It is understood that the various instrumentalities of which my invention consists can be variously arranged and my invention is not limited to the precise arrangement as herein shown and described.

Fig. 1 represents a side elevation, partly in section of a phototube embodying my invention.

Fig. 1a is a side elevation of an element 4 on line 1a of Fig. 1.

Fig. 1b is a view partly in section on line 1b of Fig. 1.

Fig. 1c is a plan on the base of Fig. 1.

Fig. 2 represents an elevation, partly in section, of a thermionic tube embodying my invention.

Similar numerals of reference indicate corresponding parts in the figures.

Describing the drawing in detail, the apparatus comprises an evacuated tube or case 1. One end of the tube is sealed to a stem or press 2. This press carries the mounting means 3, 3' of the elements 4, 4' which form the subject matter of my invention. In addition the press carries the electrical connections 5, 5' in Figs. 1 and 2 and the filament connections 6 and 6' in Fig. 2, the leads are connected to the pins 7 in the usual manner.

An anode 8 is placed in any convenient position. Referring to Fig. 1, for phototubes the anode is near the base, the emitting surface of the cathode for primary electrons is located at the upper end 9 of one of the elements 4. The photo emissive area 10 is acted upon by a light beam 11 through the window 12 and the path of the electrons is thence along the tube to the anode 8. In its travel to the anode, the beam of electrons is bombarded against the interrupting surfaces of the elements 4, 4', back and forth from one to the other, and is urged in these movements by electro-static or electro-magnetic forces impressed thereon as described in known manner.

A filamentary electrode extension 13 is shown on the drawing Fig. 2 and may be used attached to the anode 8. Alternative circuit arrangements of known types may be used, the two elements 4, 4' may be maintained with a potential gradient lengthways and constructed to have high electrical resistance. For this purpose the said elements can be made of glass coated with mineral oxides in known manner. The potential of the filament extension may be of any desired degree for the purpose required to ensure its functioning. A high frequency oscillating circuit may couple the elements which form the subject matter of my invention or any other known means for causing the acceleration of the electron flow.

In the construction of the elements described, the abutments cause scattering of the secondary electrons and their direction of flow path will be influenced by the fields of force set up as described. In Fig. 2 a thermionic emitter is indicated, the radially heated cathode 14 is shown coacting with the filament 15 which is supported by leads 6 carrying the heating current and attached to the usual pins 16, 16', when alternating current is used. The emitting cathode has an aperture 17 which can be disposed to discharge electrons against the element 4' at its extremity.

Direct current can be employed in known manner and the element 14 omitted, this, or any other means of originating the primary electron stream does not form part of my invention.

5 This type of electron multiplier is preferred for use in industrial applications for direct connection to a relay or other similar device, without intermediate amplification.

10 It is understood that the elements 4, 4' which are the essence of this device, are capable of construction in any practical manner and of any suitable material. When glass is used as the foundation, the conducting lead-in can be sealed into the glass and a contact plate provided or
15 other means for connecting an emissive coating to be deposited subsequently thereon. The glass element can then be sealed into the press making a robust connection, and it may be supported at the other end if desired. A thin coating of
20 oxide may be used on the glass where a high potential gradient is required or the elements 4, 4' may be constructed of metal when a high frequency oscillation is used as an accelerator.

25 It is not essential to my invention that the secondary emissive elements be electrically conductive throughout their length in every application. In certain types, when acceleration of the electrons towards the anode takes place through definite potential steps from one area
30 to another, the various interruptions in the surfaces of my elements may be electrically discontinuous. This effect can be obtained by leaving breaks in the emissive surfaces when, or after the coatings are applied. When metal is used
35 with, or without activation, these metal units can be molded to the glass foundation and each unit connected to a lead-in wire sealed into the supporting member 3 or 3' and attached to suitable base pins thus formed into a self-contained
40 sturdy unit structure.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. An electron multiplier tube comprising an envelope housing an anode and a cathode, secondary
45 emissive electrodes mounted between said anode and said cathode, said secondary emissive electrodes being each composed of a series of hollow cylindrical members having their linear edges contiguous to each other and their
50 hollow surfaces coated with secondary emissive material, the hollow surfaces of one series facing the hollow surfaces of the other series.

2. An electronic multiplying device comprising
55 an envelope, a pair of secondary emissive electrodes each having a surface formed in a single unit, an interrupting contour on said surface formed by a series of substantially semi-cylindrical elements having their linear edges disposed
60 longitudinally of said envelope, an anode and a cathode disposed within said envelope, one substantially at each end of said secondary emissive elements and disposed to generate an electron stream between the interrupting contours
65 of said secondary emissive electrodes.

3. An electron multiplying device comprising
70 an envelope housing an anode, a cathode comprising, a source of primary electrons, a pair of single unit non-conducting elements each comprising a series of substantially semi-cylindrical surfaces disposed along a path between the anode and the cathode and having the concave surfaces of one element facing the concave surfaces of the other element, said concave surfaces each

supporting a conductive area coated with secondary emissive material and a conductor connected to each said emissive element at one end and to a contact pin external of the envelope, at the other end.

4. An electron multiplier tube comprising a containing envelope, an anode, a cathode, secondary emissive elements between the anode and the cathode and extending longitudinal of said envelope, said emissive elements being each of unit construction composed of a series of substantially semi-cylindrical members having their linear edges contiguous to each other and similar surfaces facing each other and longitudinally in staggered relation to each other, said
1 surfaces coated with a secondary emissive material.

5. An electron multiplier device comprising a containing envelope, an anode, a cathode comprising a source of primary electrons, secondary
2 emissive elements between the anode and the cathode and extending longitudinal of said envelope, said elements being each of unit construction of non-conductive material provided with a series of substantially semi-cylindrical
2 surfaces, the concave portions thereof being provided with conductive area coated with secondary emissive material, each conductive area conductively connected through the containing non-conductive element to an attachment pin
30 external of the containing envelope.

6. An electron multiplier tube comprising an envelope housing an anode and a cathode, secondary emissive electrodes mounted between said
35 anode and said cathode, said secondary emissive electrodes each composed of a unit structure formed as a series of substantially semi-cylindrical elements mounted in series relation between the anode and the cathode and having
40 their linear edges contiguous to each other and the hollow surfaces of one element staggered with respect to the hollow surfaces in the other element and said surfaces coated with secondary emissive material.

7. A secondary emissive element for an electron multiplying device comprising a corrugated
45 tubular ribbon of non-conductive material and of substantially rectangular external form, electron emissive conductive surfaces disposed in the hollow faces of said element at one side thereof, 50 each said emissive conductive surface conductively and severally attached to a conductor internal of said ribbon at one end of said conductor and the other end of said conductor adapted to coact with a contact pin, said element
55 to form a complete unit, two of which comprise an electron multiplying device when sealed into a suitable housing containing an anode and a cathode disposed one at each end of the said pair of secondary emissive elements. 60

8. A secondary emissive element for an electron multiplier comprising a hollow stem of vitreous material, one side of said stem being flat and formed in a series of concave surfaces, said
65 surfaces each separately coated with secondary emissive material and electrically discontinuous from adjacent coated surfaces, each said surface electrically connected to an insulated conductor contained in the said hollow stem and extending
70 therethrough, said conductor connected to a contact means external of the said stem.

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