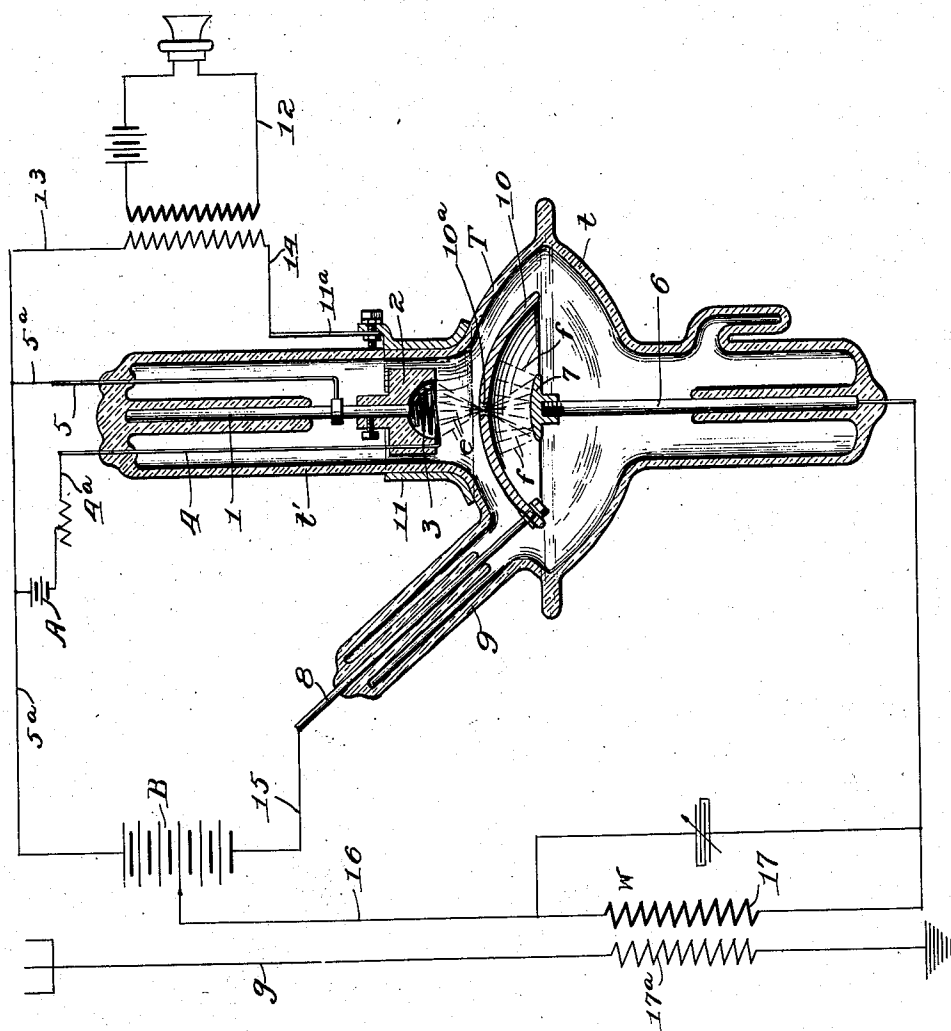


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S. RUBEN
ELECTRON TUBE
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SAMUEL RUBEN, OF NEW YORK, N. Y.

ELECTRON TUBE.

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To all whom it may concern:

Be it known that I, SAMUEL RUBEN, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Electron Tubes, of which the following is a specification.

This invention relates to improvements in electron tubes, and it comprises means for controlling the current in the discharge circuit and novel means for causing the amplified current to fluctuate in accordance with the fluctuations in a variable current circuit such, for instance, as the circuit of a line or radio telephone transmitter or a telegraph circuit. In carrying out the invention, I provide an exhausted tube or casing, within which is arranged an electron emission element, such as a filament, and a primary anode, opposed to the filament, and these are connected so that the electrons emitted from the filament will flow to said anode. Between the filament and said anode, I arrange a secondary anode in a circuit which includes the primary anode, and this secondary anode forms a screen between the filament and the primary anode, for cutting off the electron flow between the filament and primary anode, except such electrons as are directed through an opening formed in the secondary anode. Adjacent the filament, I provide a concentrating element for causing the electrons emitted from the filament to converge or focus at the opening in the secondary anode and pass through said opening to the primary anode. This concentrating element, when connected in a variable current circuit, such as the circuit of a telephone transmitter, causes variations in the focusing point of the electron stream, so that more or less of the electrons pass through the opening to the primary anode, in accordance with the fluctuations in said variable current circuit. The primary anode forms a secondary source of electron emissions, and electrons emitted from the filament and striking said primary anode cause a much greater number of electrons to be emitted from said anode than are emitted from the filament. These secondary emissions flow to the secondary anode, which is included in circuit with the primary anode and with a suitable battery or generator, and an amplified current flows in this latter circuit and varies in accordance with

the fluctuations in the telephone or signaling circuit.

In the accompanying drawing, the electron tube is shown in longitudinal central section and a simple arrangement of circuits is shown in connection with the tube, for the purpose of illustration.

Referring to the drawing, T indicates the casing or tube proper, preferably made of pyrex, in order to withstand a considerable degree of heat without breakage. The tube is formed with an enlarged central portion *t*, which affords a large heat radiating surface, and when the tube is arranged vertically, as shown in the drawing, the air flowing upwardly around the bulbous portion *a* carries off the heat. In the upper half of the tube is arranged a metal stem 1, which projects downwardly toward the bulbous portion of the tube, and upon the lower end of this stem is secured a cup of insulating material 2, preferably of lava, within which is arranged a spiral filament 3. This filament has one end connected to the rod 1, and its other end connected to a conductor 4 which leads out through the upper end of the tube. Another conductor 5 extends through the upper end of the tube and is connected to the rod 1. When current is applied to the conductors 4 and 5 from a suitable current source, the filament will be heated thereby. A rod 6, fused into the lower part of the tube, projects upwardly into the bulbous portion and carries a metal plate 7, which plate is preferably in the form of a disk and has a convex surface opposed to the filament 3. For convenience, the plate 7 will be referred to as the primary anode.

A rod 8, fused into a branch 9 of the tube, carries a secondary anode 10, consisting of a concavo-convex metal body having its concave face opposed to the convex face of the primary anode 7 and substantially concentric with it. This secondary anode has a central perforation 10^a, located on a line passing centrally through the filament and the primary anode.

The upper part *t'* of the tube is cylindrical in form, and upon this part of the tube is arranged a conducting ring 11, which ring is substantially concentric with a line passing from the center of the filament through the center of the opening 10^a to the primary anode. The ring 11 is also adjustable

longitudinally upon the cylindrical part L' of the tube. This ring, as hereinafter explained, serves as a deflector or concentrator, for deflecting the electron stream emitted from the filament and causing it to concentrate in the opening 10^a , from whence it flows through to the primary anode 7, as indicated by the dotted lines e . By varying the position of the ring the concentration of the electron stream may be varied, as will be explained.

In the diagrammatic arrangement of circuits shown in the drawing, the filament conductors 4 and 5 are connected to a battery A by conductors 4^a and 5^a , respectively, this battery furnishing current to heat the filament so that the latter will emit electrons. The concentrator 11 is connected to one terminal of a variable current source, the other terminal of said source being connected to the filament. This variable current source may be a telegraph or a telephone transmitter circuit and in the drawing a telephone transmitter circuit is shown. The primary of the telephone transmitter circuit is indicated at 12, and the opposite sides of the secondary circuit, 13 and 14, are shown connected to the filament and concentrator, respectively. The wire 5^a , which is connected to one terminal of the filament and also to the concentrator, extends to one terminal of a battery B, and the other terminal of this battery is connected by conductors 15 and 8 to the secondary anode 10 of the tube. Another conductor 16 leads from an intermediate portion of the battery B, through the primary 17 of an induction coil w , to the rod 6, which is connected to the primary anode 7.

The arrangement of circuits shown provides a heating circuit which includes the filament and the battery A; a charging circuit which extends from one terminal of the battery B through conductors 5^a and 5 to the filament and from an intermediate portion of battery B, through conductor 16, coil 17 and rod 6 to the primary anode 7; a discharging circuit which includes a portion of battery B and extends from one terminal of said battery, through conductors 15 and 8 to the secondary anode 10, and from an intermediate portion of the battery through conductor 16, coil 17 and rod 6 to the primary anode 7; and a circuit leading from a source of variable currents and connecting the concentrator to one terminal of the filament and one terminal of the battery B.

In operation, with the arrangement of circuits shown, the filament is heated by current from the battery A and electrons are given off which would flow in parallel lines to the primary anode 7 but for the interposition of the secondary anode 10 and the proximity of the concentrator ring. With the concentrator ring and the secondary

anode present, as shown in the drawing, the electron stream indicated at e will be deflected, and by proper adjustment of the concentrator ring the stream will be focused in the opening 10^a and will thence diverge and the electrons will strike against the primary anode 7, this anode being one terminal of the charging circuit which, as above explained, includes a portion of the battery B, the filament being the other terminal of said circuit. The plate 7 is, however, one terminal of another circuit, which includes the secondary anode 10 and has been described as the discharging circuit, including, as it does, a portion of the battery B and the primary of the induction coil 17. When the electrons emanating from the filament strike the primary anode 7, a much greater number of electrons are emitted from this primary anode and these will flow in a diverging stream, as indicated by the dotted lines f , from the primary to the secondary anode and through the discharging circuit of which these anodes are the terminals. As the electrons take the shortest course between the opposing surfaces, and as these surfaces are concentric, it will be evident that the electron stream will be divergent and that very few of the electrons will flow from the primary anode toward the point of concentration of the electrons flowing from the filament, at the opening 10^a .

If, now, the concentrator ring or band is affected by a variable potential in the telephone or signaling circuit, its repellant action upon the electrons will vary accordingly and cause like variation in the focusing point of the electron stream. As the focusing point varies so will the number of electrons passing through the opening in the secondary anode to the primary anode vary. This will cause variations in the number of electrons emitted from the primary anode and flowing to the secondary anode. Hence, the current in the charging and discharging circuits will vary according to the fluctuations in the signaling circuit. As the number of electrons emitted in the discharging circuit is much greater than in the charging circuit, an amplified current will flow in the discharging circuit which includes the primary winding 17, and high tension impulses at proper frequency will be generated in the secondary winding 17^a of the transformer w , which is connected to the aerial g .

It will be understood that the arrangement of circuits shown is merely for purpose of illustration and that the tube may be connected up in various arrangements of circuits and for various purposes.

I have found it to be of great advantage to calorize all of the conducting parts within the tube except the filament and the primary anode, as calorization decreases the amount of occluded gas in the metal and de-

creases the electron emission from the calorized parts; also, by reason of the reduction in the occluded gases in the metal the vacuum in the tube is better preserved, and the calorized parts are capable of withstanding greater heat.

What I claim is:

1. An electron tube comprising a thermionic emission element, a primary anode, a secondary anode interposed between said element and primary anode, said secondary anode having an opening therethrough, and means adapted to be connected to a variable current source for focusing the electron stream passing between said element and primary anode in said opening.

2. An electron tube comprising a thermionic emission element, a primary anode, a secondary anode interposed between said element and primary anode, said secondary anode having an opening therethrough, and adjustable means adapted to be connected to a variable current source for focusing the electron stream passing between said element and primary anode in said opening.

3. An electron tube comprising a thermionic emission element, a primary anode, a secondary anode interposed between said element and primary anode, said secondary anode having an opening therethrough, and an annular conducting element concentric with the axis of the electron stream passing between said emission element and primary anode and adapted to be connected to a variable current source for focusing said stream in said opening.

4. An electron tube comprising a thermionic emission element, a primary anode, a secondary anode interposed between said element and primary anode, said secondary anode having an opening therethrough, and an annular conducting element concentric with the axis of the electron stream passing between said emission element and primary anode for focusing said stream in said opening, said annular element being adjustable

parallel with the axis of said stream and adapted to be connected to a variable current source.

5. An electron tube comprising a thermionic emission element, a primary anode, a secondary anode interposed between said element and primary anode, said secondary anode having an opening therethrough, a concentrating element for focusing the electron stream in said opening, and a variable current source connected to said concentrating element.

6. In an electron tube, a thermionic emission element, a primary anode, a secondary anode between said element and primary anode, said anodes having parallel opposed faces and said secondary anode having an opening therethrough, and means adapted to be connected to a variable current source for focusing the electron stream emitted from said element in said opening.

7. In an electron tube, a thermionic emission element, a primary anode having a convex surface, a secondary anode interposed between said element and primary anode and having a concave surface opposed to the convex surface of the primary anode, said secondary anode having an opening in line with said element and primary anode, and means for focusing the electron stream emitted from said element in said opening.

8. An electron tube comprising a thermionic emission element, a primary anode, a secondary anode interposed between said element and said primary anode, said secondary anode having a focusing orifice therethrough, means for focusing the electron stream in said opening, including a source of variable currents, a charging circuit including said elements and said primary anode, and a discharging circuit including said primary and secondary anodes.

In testimony whereof I affix my signature.

SAMUEL RUBEN.