April 10, 1934. K. C. BLACK 1,954,195

VACUUM TUBE

Filed April 21, 1930

Fig. 1.

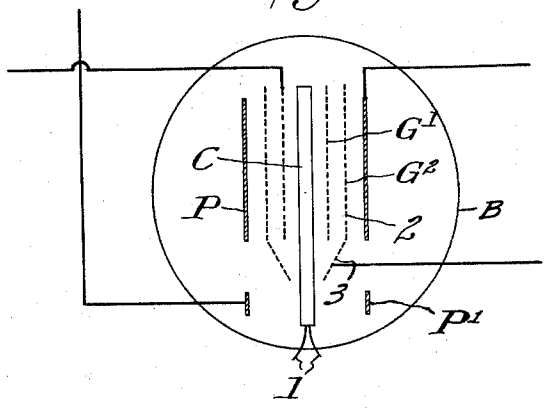
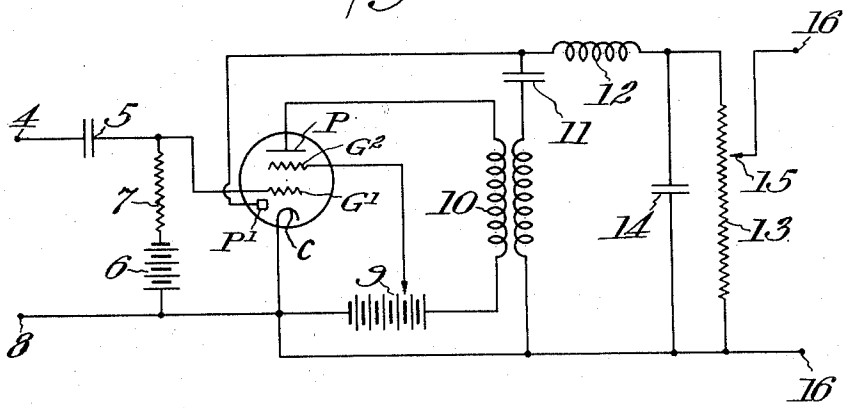


Fig. 2.



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VACUUM TUBE

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Application April 21, 1930, Serial No. 446,098

5 Claims. (Cl. 250—27.5)

This invention relates to vacuum tubes and particularly to a multi-element tube in which the relative physical arrangement of the elements is such that the tube may function simultaneously as a rectifier and amplifier.

In my copending applications, Serial Number 446,755 filed April 23, 1930 for rectifier circuits and Serial Number 447,303 filed April 25, 1930 for combined rectifier and amplifier circuit, I have described and claimed methods of and circuits for employing a multi-element tube as a combined diode rectifier and amplifier of alternating voltages.

An object of this invention is to provide a vacuum tube which is particularly adapted for use as a sensitive linear detector. An object is to provide a vacuum tube which combines the properties of a normal amplifier tube with those of a diode rectifier. A further object is to provide a vacuum tube having, in addition to a cathode and elements cooperating therewith to constitute an amplifier, an additional element located outside of the electron field between said cathode and amplifier elements. More specifically, an object is to provide a multi-element tube in which the cathode and a diode rectifier element are so positioned that other tube elements produce substantially no secondary emission from the rectifier element.

These and other objects of the invention will be apparent from the following specification when taken with the accompanying drawing in which:

Fig. 1 is a somewhat diagrammatic longitudinal central section illustrating the relative arrangement of the tube elements, and

Fig. 2 is a circuit diagram of an amplifier-detector circuit in which tubes embodying the invention are useful.

As is shown in Fig. 1, the tube may resemble the known commercial type employing a plurality of coaxial cylindrical elements enclosed in an evacuated bulb B diagrammatically shown, the central element being a heater enclosed by the cathode C and having terminal wires 1.

The amplifier elements comprise an inner grid G^1, an outer or screen grid G^2 and a plate P. These elements are not coextensive with the cathode C but terminate a substantial distance from the lower end thereof, and the cylindrical portion 2 of the screen grid G^2 merges into a conical section 3 which extends below the control grid G^1.

A separate anode or plate P' surrounds the lower end of the cathode C and is so positioned, below the other tube elements, that it lies outside the line of acceleration of electrons under the influence of the potential on the grid G^2. In other words, the electrons accelerated by positive potentials on tube elements will not strike anode P' and cause the emission of secondary or impact electrons. A further limitation on the preferred location of the anode P' is that the electrostatic capacity between grid G^1 and anode P' should be small. Except for these limitations, there may be considerable latitude of choice as to the geometrical shape and location of the anode element P'.

Vacuum tubes of this general type may be employed for the simultaneous amplification and rectification of alternating voltages. Rectification may precede amplification as shown in my above copending application Serial No. 446,755, or in the application of Jan Van der Mark, Serial No. 484,006, filed Sept. 24, 1930 or, as shown in Fig. 2, the circuits may provide for amplification followed by rectification as shown in said copending application 447,303.

The high potential input terminal 4 is connected through the blocking condenser 5 to the control grid G^1 and the grid bias potential is supplied by a battery 6 through the usual leak resistance 7. The incoming carrier wave signal is impressed between the stage input terminal 4 and the low potential terminal 8 that leads to the cathode C. The screen grid G^2 may be energized from the plate battery 9, and the plate circuit includes an appropriate coupling device, such as the primary of a radio frequency transformer 10 for feeding the amplified carrier voltage to the diode rectifier. The secondary of transformer 10 is connected through the radio frequency by-pass condenser 11 to the rectifier anode P'. The audio frequency circuit of the diode rectifier is connected in parallel with the radio frequency input circuit, and includes the radio frequency choke 12 and a resistance 13, the latter being by-passed for radio frequencies by the condenser 14. The audio frequency load circuit may be connected across the terminals of resistance 13, or when volume control is desired, an adjustable tap 15 may be employed to impress any desired portion of the audio frequency voltage across the terminals 16 of the load circuit.

With tubes embodying the invention, the amplification and rectification operations may take place with substantially no interaction or disturbance, since the rectifier anode P' is not subjected to bombardment by electrons accelerated by other tube elements. The fact that it is un-

necessary to employ a grounded shield to prevent secondary emission from the rectifier anode materially simplifies the circuit arrangement of the amplifier-rectifier stage.

For example, the commercial tetrode tubes could be employed in a circuit of the type shown in Fig. 2 by employing the outer grid G^2 as the amplifier anode and the plate P as the rectifier anode. With such an arrangement, the amplifier is essentially an unshielded triode and it may be necessary to employ a special balance circuit to prevent feed back through the intra-electrode capacity. Furthermore, secondary emission from the tetrode plate P, when employed as the rectifier anode, would interfere with the intended rectifier action. Secondary emission may be avoided by introducing a grounded grid to shield the rectifier anode, but in such a pentode tube only three of the five elements would be available for amplification and an external balance circuit would be required for neutralization.

Although I have described a tube construction in which the several elements are coaxial, it will be apparent that other physical arrangements will result in a substantially independent assembly, in a single tube, of a diode rectifier and an amplifier.

I claim:

1. A vacuum tube having coaxial cylindrical elements, a cathode, a control grid and an amplifier anode, both of less length than said cathode and positioned in radial alinement with one end of said cathode, and a cylindrical screen grid between said control grid and said amplifier anode, a rectifier anode in radial alignment with the other end portion of said cathode and outside the electron field between said cathode and said amplifier anode said screen grid terminating in a transversely disposed section extending toward said cathode and positioned to shield said rectifier anode from said control grid.

2. An electron discharge tube comprising a sealed envelope enclosing a tubular amplifier anode, a coaxial control grid inside said anode, a coaxial screen grid extending beyond the end of said control grid, a rectifier anode coaxial with and spaced longitudinally away from one end of said amplifier anode and said grids and beyond the end of said screen grid, a lead extending through the wall of said envelope and constituting the sole connection to said rectifier anode, and a common elongated cathode coaxial with and extending through both said anodes with a portion near one end surrounded by said grid and said amplifier anode and a longitudinally distinct portion near the other end surrounded by said rectifier anode only.

3. An electron discharge device comprising an elongated cylindrical cathode, a control grid and an amplifier anode coaxial with and completely surrounding and extending along said cathode for only a part of its length, a diode rectifier anode mounted in radial alignment with another longitudinally separate and distinct length of said cathode and spaced lengthwise of said cathode away from said grid and beyond one end thereof to cooperate with said other portion of said cathode beyond and distinct from the portion surrounded by said grid, and a shield extending transversely outward from an intermediate portion of said cathode and positioned between one end of said control grid and said rectifier anode to electrostatically shield said control grid and said rectifier anode from each other.

4. An electron discharge device comprising a sealed vessel enclosing a straight elongated cathode, an amplifier having a coaxial control grid and amplifier anode both shorter than said cathode and completely surrounding said cathode for a portion of its length near one end, a rectifier having a rectifier anode located beyond and spaced lengthwise of said cathode to be separated from one end of said amplifier anode and to cooperate with another longitudinally and separate and distinct length of said cathode near the other end thereof, a lead extending through the wall of said envelope and constituting the sole electrical connection for said rectifier anode, and a metal shield mounted adjacent said rectifier anode to extend transversely of said cathode and between said rectifier anode and said grid to shield them from each other.

5. An electron discharge tube comprising a sealed envelope enclosing a tubular amplifier anode, a cylindrical grid inside of and substantially coextensive with said anode, a rectifier anode mounted in end to end alignment with and spaced a substantial distance away from said amplifier anode along the longitudinal axis of said amplifier anode, a lead extending through the wall of said envelope and constituting the sole connection to said rectifier anode, a straight cylindrical cathode common to both said anodes having a portion of its length near one end coaxial with and surrounded by said amplifier anode and grid and a longitudinally separate and distinct portion of its length near the other end operatively associated with said rectifier anode only, and a conductive shield associated with said rectifier anode and said amplifier grid to electrostatically shield them from each other.

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