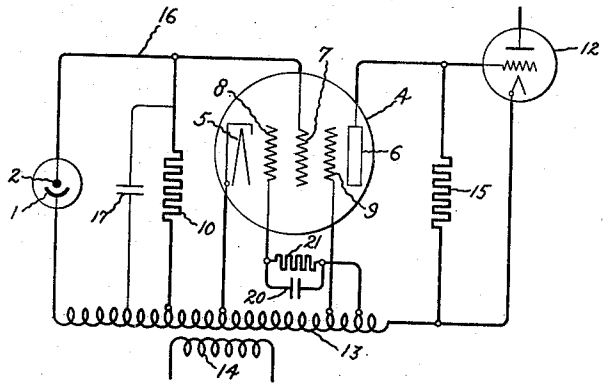
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AMPLIFIER

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AMPLIFIER

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The present invention relates to improvements in amplifiers, and more particularly to an improved amplifying circuit especially useful in connection with control apparatus such as photo-sensitive devices which are adapted to produce very small potentials varying in accordance with a physical condition.

Known types of photo-sensitive devices are characteristically of very high impedance and require to be used with an amplifying circuit which has an input resistance of commensurately high value. For reasons which will be more fully explained in the following, this last condition further necessitates the use of an amplifier which is adapted to pass only a very low current to the control electrode or grid.

It is an object of the present invention to provide, in connection with an amplifying circuit suitable for use with a photo-sensitive device, means whereby the current drawn by the control electrode of the amplifier can be reduced to an extremely small value, or even substantially eliminated.

It is a further object to provide an amplifier adapted to be energized by alternating current and characterized by means for preventing the flow of current to the control electrode for all normal variations in the relative potentials existing between the various electrodes of the amplifier.

The features of my invention which I desire to protect herein are pointed out with particularity in the appended claims. The invention itself, however, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawing, in which the single figure shows schematically a control circuit suitably embodying my invention.

Referring to the drawing there is shown a photo-sensitive device comprising a cathode 1 and an anode 2 connected to a vacuum tube amplifier designated as a whole by the numeral 4. This amplifier includes a cathode 5, an anode 6, a control electrode 7 and intermediate electrodes 8 and 9 whose nature and function will be more fully explained hereinafter. The output voltage of the amplifier, as developed across the resistor 15, may be impressed on the control grid of a suitable triggering or control device exemplified in the present case by a thermionic discharge tube 12. For impressing a difference of potential between the various electrodes of the amplifier and associated devices there is provided a source of alternating current potential illustrated as including a transformer having a secondary 13, and a primary 14.

The photo-sensitive device is connected in the cathode-control-grid circuit of the amplifier 4 in parallel with an input resistance 10. As previously noted, for proper cooperation with the high impedance photo-sensitive device this resistance should have an extremely high value, for example, on the order of several megohms. Accordingly, any current, however minute, which may flow from the cathode 5 to the control electrode 7 during the half cycle in which the latter is positive will produce a considerable voltage drop across the resistance 10. This drop will tend to charge such stray or other capacities as may exist between the associated elements of the circuit and, particularly, between the lead 16 and the transformer secondary 13.

During the portion of the alternating current cycle in which the control electrode is negative with respect to the cathode such a charged capacity (indicated in light outline as a neutralizing condenser 17) will oppose the action of the photo-sensitive device and render the control circuit unable to respond in the intended manner to the stimulus of a light beam impinging on the photo-sensitive element.

This difficulty is overcome in accordance with the invention by providing electrostatic means associated with the control electrode 7 and the cathode 5 for preventing current flow between them. This means suitably comprises a space charge electrode 8 which is adapted to be negatively charged whenever the control electrode becomes positive with respect to the cathode, so that its effect is to inhibit the movement of electrons from the cathode. As illustrated the desired potential relationship is obtained by connecting the electrode 8 to a point of the alternating current source which is opposite in sign to the control electrode when referred to the cathode as a reference point.

In order further to block the random electron current which tends to flow from the cathode during the period in which all the electrodes are at substantially zero potential, additional means are provided in the connection between the electrode 8 and the transformer secondary 13 for definitely biasing the electrode negatively with respect to the cathode 5 whenever the control element ceases to be negative with respect thereto. This means as illustrated comprises a condenser 20 in parallel with a resistance 21, these elements being so related in magnitude that any charge accumulated on the condenser will not be

lost in less than a full cycle of the alternating current. Under these conditions current drawn by electrode 8 during the period of normal conduction of the amplifier charges the condenser 20 and thus maintains a negative bias on the electrode when a reversal of the alternating potential occurs.

The electrode 9 comprises a screen grid which may be interposed between the anode and the control grid if desired. This provision does not comprise an essential part of my invention, but if used will increase the effective amplification of the device and shield the electrode 7 from the effects of the anode field.

While I have shown a particular embodiment of my invention, it will be understood by those skilled in the art that many modifications may be made without departing from the invention, and I aim by the appended claims to cover all such modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. An amplifying device comprising a vacuum tube enclosing main discharge electrodes including an anode and an electron emissive cathode, a control electrode between the anode and cathode, means for impressing an alternating difference of potential between said various electrodes, and means including a space charge electrode between the cathode and control electrode effective when said control electrode becomes positive with respect to the cathode to prevent the flow of electrons therebetween.

2. An amplifying device adapted for use with a high impedance input circuit comprising a vacuum tube enclosing main discharge electrodes including an anode and a cathode, a pair of intermediate electrodes arranged between the anode and cathode, and means comprising an alternating current source for impressing an alternating difference of potential between said various electrodes, the one of said intermediate electrodes nearest the cathode being negatively charged with reference to the cathode whenever the other of said intermediate electrodes is positive with reference thereto.

3. An amplifying device adapted for use with a high impedance input circuit comprising a vacuum tube enclosing main discharge electrodes including an anode and a cathode, a pair of intermediate electrodes arranged between the anode and cathode, means comprising an alternating current source for impressing an alternating difference of potential between said various electrodes, and means connecting the one of said intermediate electrodes nearest the cathode to a portion of said source which is negative with reference to the cathode whenever the other of such electrodes is positive with reference thereto.

4. In combination, an electrical device adapted to develop a potential difference variable in accordance with a physical condition, a vacuum tube amplifier including an anode, a cathode, a control electrode between the anode and cathode and a space charge electrode between said cathode and said control electrode, means for impressing the variations in potential across said electrical device on said control electrode, means including an alternating current source for impressing an alternating difference of potential between said various electrodes, and means connecting said space charge electrode to a portion of said source which is negative with reference to said cathode whenever said control electrode is positive with reference thereto.

5. In combination, a photo-sensitive device, an amplifier cooperatively related to said photo-sensitive device and including an anode, a cathode, a control electrode between the anode and cathode, and a space charge electrode between the cathode and control electrode, means including an input resistance of high value for impressing the variations in potential across said photo-sensitive device on said control electrode, means including an alternating current source for impressing an alternating difference of potential between said various electrodes, and means connecting said space charge electrode to a portion of said source which is negative with reference to said cathode whenever said control electrode is positive with reference thereto.

6. In a vacuum discharge device, main discharge electrodes comprising an anode and a cathode, a control electrode between the anode and cathode, a space charge electrode between the cathode and the control electrode, means including an alternating current source for impressing an alternating difference of potential between said various electrodes, means connecting said space charge electrode to a portion of said source which is negative with reference to the cathode when said control electrode is positive with reference thereto, and means associated with said connecting means for impressing a definite negative bias on said space charge electrode whenever said control electrode ceases to be negative with respect to the cathode.

7. In an electrical discharge device, main discharge electrodes comprising an anode and cathode, a pair of intermediate electrodes between the anode and cathode, means including an alternating current source for impressing potential differences between said various electrodes, and means for connecting the one of said intermediate electrodes nearest the cathode to a portion of said source which is negative with reference to the cathode when the other of such electrodes is positive with reference thereto, said last-named means having in circuit therewith a condenser and a resistance connected in parallel.

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