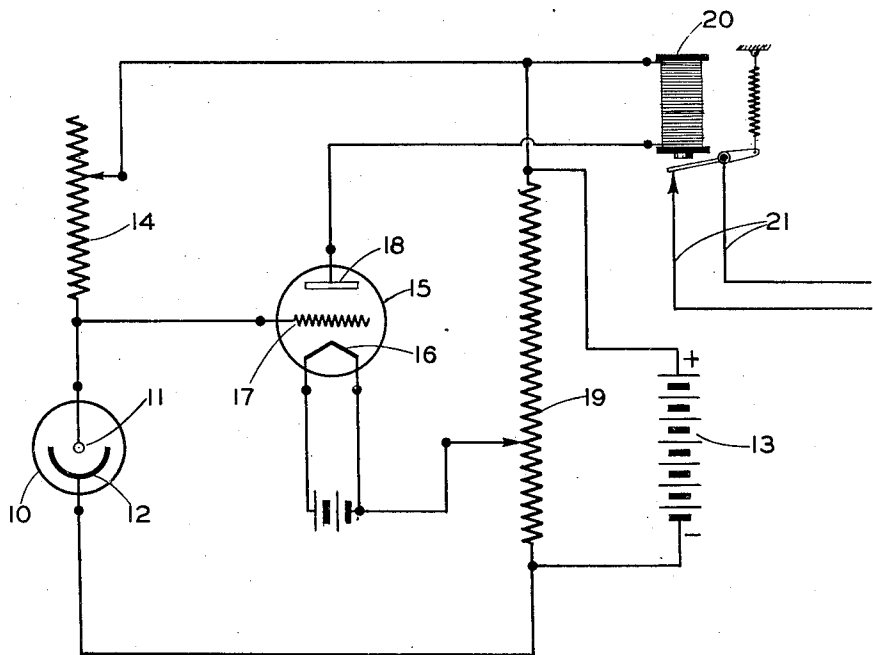


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PHOTO ELECTRIC APPARATUS
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PHOTO ELECTRIC APPARATUS

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6 Claims. (Cl. 250—41.5)

My invention relates to photoelectric apparatus and more particularly to means for operating photoelectric tubes at maximum efficiency and sensitivity.

5 The conventional gas filled phototube having a photocathode and an anode operates at maximum efficiency and is most sensitive when the voltage across the tube is the maximum the tube will stand without glowing. Glowing causes
10 rapid deterioration of the phototube cathode. In practice, a load resistor is connected in series with the phototube and a source of voltage for the tube. In order to prevent the voltage across the tube from rising above the maximum allowable
15 voltage of the tube when the light is taken off the tube or when the intensity of the light on the tube decreases with a resultant decrease in phototube current, the voltage across the tube and the load resistor must be limited to some value less
20 than the maximum operating voltage which the tube can stand without glowing. The reason for so limiting the voltage is that as the photocurrent decreases the voltage drop through the load resistor decreases, while the voltage drop
25 across the tube increases, the effective resistance of the phototube increasing as the intensity of the light on the tube decreases. With no light on the tube no current would pass through the tube and resistor and the entire voltage drop from the
30 voltage supply would be across the tube which voltage, if it exceeded the maximum allowable operating voltage, would cause the tube to glow. The voltage across the tubes is, therefore, of necessity considerably less than the maximum
35 allowable operating voltage to insure against glowing of the tube, hence, the tube is not ordinarily operated at maximum efficiency or sensitivity.

40 The principal object of my invention is to provide means for operating a phototube at its optimum sensitivity and efficiency without danger of causing a glow discharge through the tube or otherwise adversely affecting the tube due to a voltage increase across the tube above the maximum allowable operating voltage when the
45 photocurrent decreases.

50 The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing in which:

55 The figure shown in the drawing is a diagrammatic representation of a phototube and associated circuit embodying my invention.

Referring to the drawing, the phototube 10 has an anode 11 and a photocathode 12 connected to the negative pole of the voltage supply source, preferably a battery 13, although any other source of direct current voltage supply would be satisfactory, the positive pole of the battery being connected to the anode 11 in series with the variable load resistor 14 which has a high value of resistance of the same order as the internal phototube direct current resistance.

10 In accordance with my invention I associate with the phototube a thermionic voltage regulator such as a thermionic device 15 having an electron emitting cathode electrode 16, a grid electrode 17 connected to the anode 11 of the photocell, 15 and a plate electrode 18 connected to the positive pole of the battery 13 through a plate circuit having in it an electro-responsive operating means, such as an electro-magnetic relay 20 for controlling a circuit 21 although this electro-
20 responsive operating means could be any other form of electro-responsive device such as a meter or the input of an amplifier. The cathode 16 is connected to the battery 13 through a voltage divider 19. The voltage regulator 15, which by
25 way of example has been shown as a thermionic discharge device, may for the purpose of my invention take the form of any variable impedance the value of which decreases upon the application of a potential above a certain predetermined
30 value.

In operation the slider on the voltage divider 19 is set so that the voltage impressed upon the cathode 16 from the battery 13 has a value slightly less than the maximum allowable voltage
35 which the phototube 10 can stand without glowing. The slider on the load resistor 14 is set so that the current flowing through the load resistor 14 and the phototube 10, at the particular light intensity with which the phototube is to operate, 40 will cause a voltage drop across the tube which is slightly less than the voltage impressed on the cathode 16. Due to this voltage drop the grid 17 is biased slightly negative with respect to the cathode 16 so that at the operating voltage with
45 the normal photocurrent through the phototube 10 no current will flow through the grid circuit of the thermionic device 15. For example, if the voltage which is impressed on the cathode is 90 volts, the drop across the phototube is adjusted to 88 volts, thus making the grid 2 volts
50 negative with respect to the cathode.

As the light intensity on the cell decreases the effective resistance of the phototube increases with the result that the photocurrent decreases. 55

With a decrease in photocurrent the voltage drop across the phototube increases, causing the voltage on the grid to increase in a positive direction. A point is quickly reached where the grid becomes positive with respect to the cathode, whereupon a grid current flows. The constants of the associated elements in the circuit are such that the increase in grid current through the thermionic device together with the current through the phototube is always sufficient to maintain the voltage drop through the load resistor 14 at such a value that the voltage drop across the phototube is prevented from rising above the maximum allowable operating voltage. In this way the phototube is prevented from glowing on decrease of the phototube current for any cause, thus permitting operation of the phototube at its maximum efficiency and sensitivity.

The change in the anode cathode current through the thermionic device 15 when the grid changes its potential can be used to operate an electro-responsive device; for example the electro-magnetic relay 20, to control a circuit 21 of some kind. For the purposes of this invention the thermionic device 15 could obviously be a two electrode thermionic device with the amplifying or operating circuit associated with the phototube connected across the load resistor 14.

While I have indicated the preferred embodiment of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims.

What I claim as new is:—

1. The combination with a gas filled phototube having a photocathode and an anode, a source of voltage supply of its negative terminal connected to said photocathode, and a resistor connected between said anode and the positive terminal of said source of voltage supply having at normal photo current through the tube a voltage drop such that the voltage drop across said tube is the maximum allowable operating voltage without causing said tube to glow, and a thermionic voltage regulator connected between the anode of said phototube and a less positive point on said source of voltage to permit in response to an increase in voltage drop across said phototube a sufficient increase in thermionic current through said regulator to maintain the voltage drop across said resistor and thereby prevent the voltage drop across said phototube rising above the maximum allowable operating voltage.

2. A circuit for operating a gas filled phototube at substantially maximum sensitivity including a phototube having a cathode and an anode, a source of voltage supply for said phototube, a resistor connected between the anode of said phototube and the positive pole of said voltage supply, a connection from said cathode to the negative pole of said source, and a thermionic voltage regulator connected between said anode and a point of a potential intermediate the potentials of said poles of said voltage supply.

3. A circuit for operating a gas filled phototube at substantially maximum sensitivity including a phototube having an anode and a photocathode, a source of voltage supply for said

phototube, a connection between the photocathode and a point of relatively negative potential on said source, a resistor connected in series with said tube between said anode and a point of positive potential on said source of voltage supply to provide the maximum allowable voltage drop across said tube with a predetermined light intensity without causing said tube to glow, an electron discharge device having a cold electrode connected to the anode of said phototube and a thermionic cathode cooperating with said cold electrode, and a connection between said thermionic cathode and a point on said source of voltage supply of a potential intermediate said positive and negative potentials for maintaining said thermionic cathode at a bias which is positive with respect to said cold electrode when the current through said phototube and resistor is above a predetermined limit thereby preventing said electron discharge device drawing current through said resistor, and negative with respect to said cold electrode when the photocurrent through said tube decreases below a predetermined limit whereby said electron discharge device will draw sufficient current through said resistor to maintain the voltage drop across said resistor and thereby maintain substantially constant the voltage impressed upon said phototube.

4. In combination a gas filled phototube having a photocathode and an anode, a source of voltage supply for said phototube, a resistor connected in series with said tube between said anode and said source of voltage supply to provide the maximum allowable operating voltage across said tube without causing said tube to glow, a regulator comprising a thermionic device having a thermionic cathode, a grid connected to said anode and a plate connected to said source of voltage, current responsive means connected in circuit with the plate of said thermionic device, and means connected between said thermionic cathode and said voltage supply for biasing said cathode positive with respect to said grid during normal operation of said phototube, said grid becoming positive with respect to said cathode in response to a decrease of the phototube current thereby providing a grid current through said resistor sufficient to maintain the voltage drop across said resistor and prevent the voltage applied to said phototube rising above the maximum allowable operating voltage.

5. The combination with a phototube having a photocathode and an anode, a source of voltage with its negative terminal directly connected to said photocathode, and a resistor connected between said anode and the positive terminal of said source of voltage, a voltage regulator for said phototube comprising a thermionic discharge device with an electron emitting electrode and a cold electrode, a connection from said cold electrode to the anode of the phototube, and a connection from said emitting electrode to a positive source of voltage of a value slightly greater than the normal or static potential drop across said phototube.

6. The combination with a phototube having a photocathode and an anode, a source of voltage in series with a resistor connected across the phototube for applying a normal operating voltage to the electrodes of the phototube, and an impedance connected across said phototube which decreases in value in response to a rise in voltage above said operating voltage.