

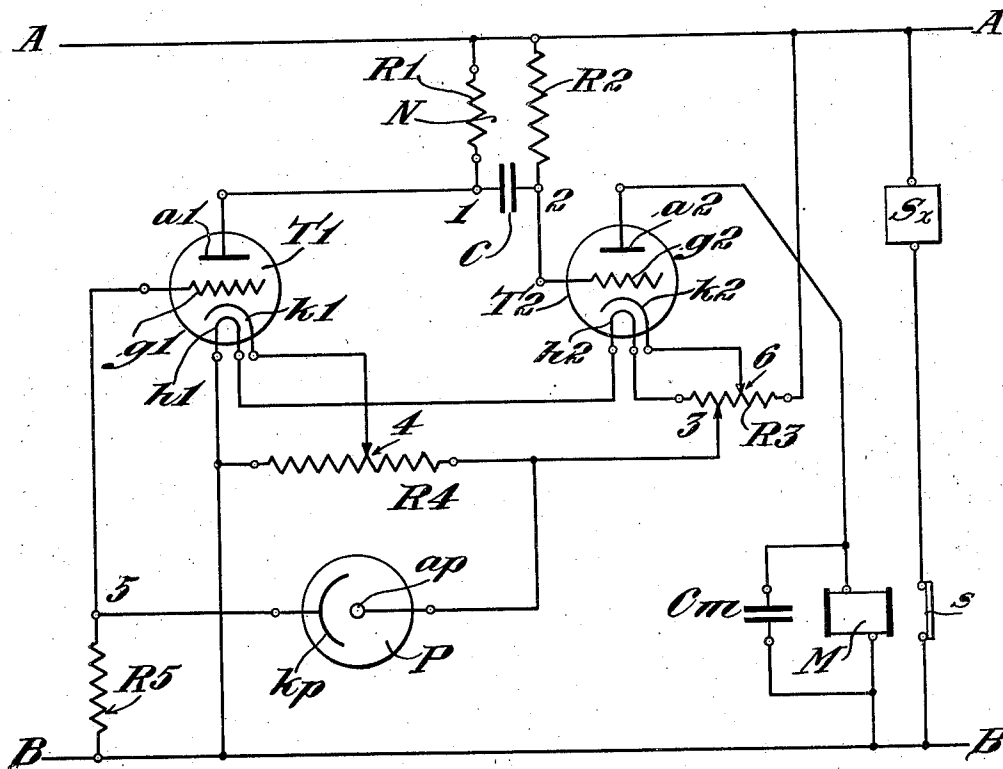
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PHOTOELECTRIC SAFETY CIRCUIT

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PHOTOELECTRIC SAFETY CIRCUIT

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The present invention deals with electronic relays of the type which are controlled by a variable detecting impedance, as a photoelectric tube.

It is the main object of the invention to provide a circuit which responds not only to the event intended to be detected, but also to failure of any element of the circuit itself. Another object is to provide a safety circuit of this type which is very sensitive and therefore suitable for use under circumstances which call for absolute reliability, as for example in arrangements which operate installations whose condition is of vital importance, through the varying light flux from controlling light sources.

These and other objects will be apparent from a consideration of the following description of an embodiment illustrating the general character of my invention, which description refers to a drawing representing a circuit diagram of this embodiment.

In the drawing, wires A and B represent the terminals of an alternating current supply source, P a phototube constituting the detecting impedance, T1 and T2 electron discharge tubes of suitable conventional design, which if desired may include screen and suppressor electrodes, but are herein shown as simple triodes associated with a sustaining network N and a relay apparatus M responsive to the conductivity of tube T2.

The network N consists of resistors R1 and R2, the value of R2 preferably being considerably higher than that of R1, and a condenser C which is dimensioned according to well known principles in order to provide, with the particular tubes in use, the function described hereinafter. As shown in the drawing, resistors R1 and R2 are connected on one side to line A, whereas condenser C is inserted between the other terminals 1 and 2 of the resistors.

The heater elements h1 and h2 of tubes T1 and T2 are connected between supply terminals A and B in series with a tapped resistor R3. Another tapped resistor R4 apportions the voltage between point 3 on resistor R3 and supply line B.

The anode a1 of tube T1 is connected to point 1 of network N, control electrode g1 is connected to supply line B through a resistor R5, and cathode k1 to the adjustable tap 4 of resistor R4. The anode a2 of tube T2 is connected to line terminal B through a current responsive device, here shown as relay magnet B bridged by a sustaining condenser Cm which, when energized, holds closed a switch s controlling apparatus Sx which for example may be an illuminating installation. Grid g2 of tube T2 is connected to point 2 of net-

work N, and cathode k2 is connected to adjustable tap 6 of resistor R3. The anode ap of phototube P is connected to the tap 3 and its cathode kp to point 5 between resistor R5 and grid g1.

Resistor R3 is so dimensioned and tap 6 so placed as to establish a certain bias between cathode k2 and grid g2, which bias is sufficient normally to cut off current flow through T2, but is correlated to the properties of network N in a manner which will be pointed out below. Resistor R4 is so dimensioned and tap 4 so placed that, with the phototube dark, grid g1 is more negative than cathode k1 during the half cycle when line terminal A is positive. This arrangement permits adjustment of the sensitivity of the circuit.

It will be understood that, instead of the heater circuit including resistors R3 and R4, any other suitable circuit may be employed for applying to tubes T1, T2 and P potentials which are suitable for the operation now to be described.

Although it is not the normal condition in the above-mentioned embodiment, it will first be assumed for the sake of easier explanation, that phototube P is dark and substantially non-conducting. During the half cycles when line terminal A is positive, grid g1 is, due to the above-described resistor arrangement, more negative than cathode k1 and only a small amount of current flows through tube T1. During these half cycles tube T2 is non-conductive since supply terminal A is positive and hence its plate is negative, but it acts as a grid current rectifier in circuit A—R2—2—g2—k2—6—B. Since resistor R1 and condenser C are in series parallel with resistor R2, the voltage drop across the network N is such that condenser C is charged with point 1 positive relative to point 2.

During the other half cycles, with A negative and B positive and phototube P still dark, tube T1 is obviously non-conductive, and tube T2 is likewise non-conductive because tap 6 is so positioned that the potential of grid g2, due to the bias to which the charge on condenser C is added, is sufficiently negative to cut off current flow. Tube T2 therefore will be non-conductive during both half cycles and M deenergized with s open, so long as phototube P is dark.

When phototube P is illuminated (which is in the above-mentioned embodiment the normal condition) and again considering first the half cycles during which A is positive and B negative, the reduced impedance of the phototube establishes a current path between points 3 and 5 and causes such a voltage drop in R5 as to render g1 less negative with respect to k1, whereupon tube T1

becomes conductive. The anode current of tube T1 causes a voltage drop across resistor R1 and as resistor R2 and condenser C are in series parallel with resistor R1, the voltage drop across the network N is such that condenser C is now charged so that point 1 is negative relative to point 2—a change in polarity attributable to the increased conductivity of the detecting impedance P. However, the tube T2 is non-conductive during this half cycle.

During the other half cycle, with B positive and A negative, tube T2 is conductive because the bias of grid g2 caused by the drop across resistor R3 at 6 is overcome by the opposing voltage drop placed on g2 by the charge on condenser C. Hence, the circuit from B, through relay M to A is established and relay M is therefore energized and switch s closed. During the half cycles when A is positive condenser Cm retains switch s closed in the well-known manner.

Summing up, it will be noted that the operation of this circuit depends on the polarity of the condenser C as charged either by the voltage drop across tube T1 or by the voltage drop in the grid rectifying circuit of tube T2, and that so long as the phototube P is conducting both the tubes T1 and T2 are conducting during alternate half cycles and the relay M is energized.

It will now be evident that the circuit will become abnormally conditioned to open switch s whenever any one of the tubes T1 or T2 fails, when the phototube fails, when the current supply fails, when any one of the resistors R1, R2, R3 fails, if R4 fails between point 4 and k1 or if its tap does not make proper contact, when either one of condensers C or Cm fails, or when the relay magnet M fails.

It is to be understood that in operation, when resistor R5 and phototube P constitute a high impedance of the order of 100 megohms, there is a change in average plate current of tube T1 due to a shift of the phase of the grid potential relative to the plate potential, which shift increases with increasing conductivity of the phototube. This phase shift is effected by the capacitive component of impedance R5. If R5 and the phototube constitute the above-mentioned high impedance, R5 may be an ohmic resistance with the capacitive component supplied by the wiring capacity between grid g1 and line B shunting resistor R5. Hence, if the resistor R5 be considered a generalized impedance, the plate current in tube T1 is varied by virtue of the resultant shift in phase of the grid due to changing conductivity of phototube P.

It is to be further understood that the capacity of condenser C may be greatly increased so that, if desired, several seconds may elapse after the conductivity of phototube P has changed before the condenser reaches a different equilibrium of charge sufficient to change the conductivity of tube T2. In this way the advantage of slow response is obtained without loss of sensitivity, thus making the control insensitive to rapid changes in light as, for example, the flickering of an arc lamp.

A circuit of the type herein described may be relied upon automatically to cut off and turn on an illuminated sign, display or the like, upon the darkening and relighting of a street lamp toward which the detecting phototube of the circuit is directed from some distance. Accordingly, the circuit is particularly suitable for use in locations subject to air-raid alarms, although it is to be understood that its utility is not limited

to such use since the design of the circuit is such that the tubes T1, T2 and associated parts respond to changes or variations in impedance of the detecting circuit, irrespective of whether such changes in impedance are attributable to the action of a photocell or other instrumentality.

While I have shown and described one desirable embodiment it is to be understood that various changes and modifications may be made, as well as the substitution of equivalent elements, without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim:

1. Electronic apparatus comprising a source of alternating current, two electron discharge tubes having anode, cathode and control electrode, the respective output circuits of said tubes being oppositely connected to said source for conditioning said tubes to become conductive during alternate half cycles, means adapted to bias the control electrode of the first one of said tubes, said biasing means including a detecting impedance for varying the conductivity of said first tube upon variation of said impedance, a network including a condenser connected in series between the output circuit of said first tube and the control electrode of the second tube and resistance means leading from each side of said condenser to a terminal of said source for conducting current and providing voltage drop from the respective tubes to said terminal, and current-responsive means in the output circuit of said second tube, said condenser, when charged during one half cycle because of increased conductivity of said first tube, affecting the bias of the control electrode of said second tube to render it conductive during the next half cycle.

2. Electronic apparatus comprising a source of alternating current, two electron discharge tubes having anode, cathode and control electrode, the respective output circuits of said tubes being oppositely connected to said source for conditioning said tubes to become conductive during alternate half cycles, means adapted to bias the control electrode of the first one of said tubes, said biasing means including a detecting impedance for increasing the conductivity of said first tube upon a decrease in said impedance, a sustaining network including a condenser connected in series between the output circuit of said first tube and the control electrode of the second tube and resistance means leading from each side of said condenser to a terminal of said source for conducting current and providing voltage drop from the respective tubes to said terminal, and current-responsive means in the output circuit of said second tube, said condenser, when charged during one half cycle because of increased conductivity of said first tube, affecting the bias of the control electrode of said second tube to render it conductive during the next half cycle.

3. Electronic apparatus comprising a source of alternating current, two electron discharge tubes having anode, cathode and control electrode, the respective output circuits of said tubes being oppositely connected to said source for conditioning said tubes to become conductive during alternate half cycles, means adapted to bias the control electrode of the first one of said tubes, said biasing means including a photoelectric cell for varying the conductivity of said first tube in accordance with variations in the conductivity of said cell, a sustaining network including a condenser connected in series between the output circuit of said first tube and the control electrode of the

second tube and resistance means leading from each side of said condenser to a terminal of said source for conducting current and providing voltage drop from the respective tubes to said terminal, and current-responsive means in the output circuit of said second tube, said condenser, when charged during one half cycle because of increased conductivity of said first tube, affecting the bias of the control electrode of said second tube to render it conductive during the next half cycle.

4. Electronic apparatus comprising a source of alternating current, two electron discharge tubes having anode, cathode and control electrode, the respective output circuits of said tubes being oppositely connected to said source for conditioning said tubes to become conductive during alternate half cycles, means adapted to bias the control electrode of the first one of said tubes, said biasing means including a detecting impedance for varying the conductivity of said first tube upon variation of said impedance, a network including a condenser connected between the output circuit of said first tube and the control electrode of the second tube and a pair of resistors connected in parallel between opposite sides of said condenser and one of said supply lines so as to shift the charge on said condenser in response to the conductivity of said first tube during half cycles of the supply current and thereby to control the conductivity of said second tube during the other half cycles, and means in the output circuit of said second tube responsive to the current flowing therein.

5. Electronic apparatus comprising alternating current supply lines, an electron discharge tube having an anode connected to one of the supply lines, a cathode connected to the other of the supply lines and a control grid, a detecting circuit including a detecting impedance for varying the conductivity of the circuit, a condenser having one of its terminals connected to said control grid, a resistor connected between one of the supply lines and said terminal, a resistor connected between said supply line and the other condenser terminal, means electrically connecting said other terminal with said detecting circuit so as to shift the charge on said condenser

during half cycles of the supply current in response to the conductivity of said detecting impedance and thereby to control the conductivity of said tube during the other half cycles, and means in the output circuit of said tube responsive to current flowing therein.

6. Electronic apparatus comprising alternating current supply lines, an electron discharge tube having an anode connected to one of the supply lines, a cathode connected to the other of the supply lines and a control grid, a detecting circuit including a photocell for varying the conductivity of the circuit, a condenser having one of its terminals connected to said control grid, a resistor connected between one of the supply lines and said terminal, a resistor connected between said supply line and the other condenser terminal, means electrically connecting said other terminal with said detecting circuit so as to shift the charge on said condenser during half cycles of the supply current in response to the conductivity of said photocell and thereby to control the conductivity of said tube during the other half cycles, and means in the output circuit of said tube responsive to current flowing therein.

7. Electronic apparatus comprising alternating current supply lines, two electron discharge tubes, each having an anode, a control grid and a cathode connected to one of the supply lines, a detecting impedance connected to the supply lines and to the control grid of the first tube so as to control its conductivity in accordance with the conductivity of said impedance, a condenser having one terminal connected to the control grid of the second tube and its other terminal connected to the anode of the first tube, two resistors connected between one of the supply lines and respective opposite terminals of said condenser so as to effect a shift in the charge on said condenser during half cycles of the supply current in response to the conductivity of the first tube and thereby to control the conductivity of said second tube during the other half cycles, and a circuit connecting the anode of the second tube to the other of said supply lines, said latter circuit including means responsive to the current flowing therein.

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