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ILLUMINATION CONTROL

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This invention relates to a system for the remote control of lighting circuits, and is particularly concerned with apparatus by which the electric lights inside a particular premises may be energized for inspection purposes conveniently from a location outside the building, such as from a police patrol car, or other inspection vehicle passing through the vicinity. The invention is herein illustratively described by reference to its presently preferred form but it will be appreciated by those skilled in the art that certain changes and modifications therein may be made without departing from the characterizing features comprising the invention.

It is of course old in the art basically to operate lighting circuits from outside a shop, bank, or other premises in order to inspect the interior thereof without actually going inside and operating an electrical switch. For instance, it has been proposed in the past to accomplish this result by shining a flashlight on a photocell through the building window and thereby temporarily energize control apparatus producing illumination inside the building. According to one such proposal illumination would be maintained only as long as the flashlight was held on the photocell. This requirement limited the inspection to areas which could be seen from the position required to be taken in order to illuminate the photocell. Moreover, it would be quite awkward, if not impossible, to carry out this procedure of control from an appreciable distance, such as from a moving vehicle. For these reasons, apparatus of that general type requiring continuous illumination of the photocell would not be satisfactory under present day conditions in which police patrols are usually conducted from moving vehicles.

Another disadvantage of such photoelectric control systems was that the owner of the premises was required to remember every morning to disconnect the apparatus so that it would not be operated by daylight, and every night to reconnect the apparatus for its intended purpose.

An object of the present invention is to provide apparatus for the described purpose which may be actuated by a brief impulse of electromagnetic wave energy emanating from an inspection station outside the premises, such as from the conventional transmitter of a police patrol car, and which after actuation will hold the electric lighting circuit closed for a definite time period sufficient for a normal inspection of the premises, whereupon the circuit will automatically open in order to conserve electrical energy. In particular, it is an object to achieve this holding action by relatively inexpensive and reliable circuit apparatus.

A related object is the provision of such apparatus wherein the holding period in which the premises are illuminated can be extended at will for any desired length of time from the external inspection station. More specifically, the receiving apparatus located inside the premises and responsive to the impulse of the electromagnetic wave energy is so constituted that it may be

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recycled one or more times for an indefinite period simply by repeating the control impulses at intervals which are shorter than the predetermined holding period of the apparatus. The receiving apparatus may thus be recycled prior to expiration of its holding period, and thereby provide uninterrupted illumination of the premises as long as the recycling continues.

Still another object of the invention is the provision of a relatively simple and reliable means automatically desensitizing the apparatus during daylight hours so that normal illumination in the premises may be maintained without being increased or disturbed by accidental operation of the illumination control apparatus due to the presence of energy sources such as radio transmitters operating in the vicinity of the premises for other reasons during daylight hours.

In accordance with the apparatus herein disclosed, a first grid-controlled gaseous discharge tube is rendered conductive by an impulse of control energy and thereby instantly charges a storage condenser. The resulting condenser voltage decays slowly through a shunt resistor after termination of the control impulse, and in the process of its decay produces conduction in a second grid-controlled gaseous discharge tube which operates a relay or other lighting circuit control device. An important feature of the invention resides in the provision of a glow discharge diode or equivalent automatic switch interposed between the plate-cathode circuit of the first gaseous discharge device and the storage condenser, whereby not only is the storage condenser isolated from its charging circuit to prevent immediate loss of charge after termination of the control impulse, but the first gaseous discharge tube itself is isolated from the condenser voltage so that a separate quiescent bias voltage may be applied to such tube. Consequently the residual charge on the condenser at any time during conduction of the second grid-controlled discharge tube will not block energization of the first grid-controlled discharge tube necessary for recycling of the apparatus.

As a further feature of the invention, a daylight responsive photoelectric cell is arranged in the grid circuit of the first grid-controlled discharge tube with a polarity such that during daylight hours a negative bias is produced preventing accidental operation of the apparatus, whereas during the hours of night such bias is insufficient to prevent such operation by the reception of a control impulse.

These and other features, objects and advantages of the invention including certain details of the preferred form thereof will become more fully evident from the following description by reference to the accompanying drawing which constitutes a schematic diagram of the control apparatus.

The single figure constitutes a schematic diagram of the preferred form of the illumination control apparatus. With reference to the drawing, alternating voltage, such as the standard 110 volt supply commonly used for electric lighting circuits, is applied to the terminals 10 and 12. Representative electric lights required to be energized by operation of the apparatus are labelled as such in the diagram, the energization circuit for these lights comprising the conductors 14 and 16 and the switch contacts CR₂ of the control relay CR. The operating coil of this relay, shunted by the filter condenser C7, is connected in series with the plate-cathode circuit of the grid-controlled gaseous discharge tube T2. Conduction of this tube causes energization of the relay coil thereby closing the electric light circuit and illuminating the interior of the particular premises being inspected. The filter condenser C7 is sufficiently large to maintain energization of the relay coil despite the pulsating nature of

current flow through the tube T2 due to the fact that the circuit is energized by alternating voltage.

The apparatus input terminals 18 and 20 are connected to a suitable receiving antenna (not shown). The terminal 18 is coupled through condenser C2 to a selected point on the inductance L1 shunted by the tuning condenser C1 and forming a resonant circuit tuned to the desired reception frequency. One side of this resonant circuit is connected to a conductor 14 whereas the opposite side thereof is connected to the control grid of the first gaseous discharge tube T1, through the detector D. The polarity of the detector is such that positive potential is applied to the control grid of tube T1 during energization of the tuned circuit L1, C1. The conductor 14 is connected to ground through the condenser C4. A filter condenser C3 is connected between the control grid of tube T1 and conductor 14 to provide a constant direct voltage at such grid during energization of the tuned circuit L1, C1. Antenna terminal 20 is grounded.

The receiving means comprising condenser C2, inductance L1, condenser C1, detector D and condenser C3 represent merely one arrangement for translating signals from the receiving antenna into a circuit operating response.

Alternating potential is applied to the anode of tube T1 through a conductor 16. The cathode of this tube is connected to a load resistor R1. The opposite side of this load resistor is connected to the wiper of the potentiometer R2 having a winding connected between conductors 14 and 16 as shown. The setting of this potentiometer establishes the normal or quiescent bias voltage existing between the grid and cathode of tube T1. This bias voltage is selected so that the tube T1 is maintained at the threshold of conduction yet is sufficiently great that the tube will not conduct under normal amounts of stray field pick-up in the wiring or from like causes. A glow discharge diode, such as the neon tube N2, is connected between the cathode of tube T1 and conductor 14 through a current limiting resistor R3 in order to provide an indication as to whether the tube T1 is or is not conducting. Without signal applied to the input terminals 18, 20 the amount of negative bias applied to the cathode of tube T1 is progressively increased by adjustment of potentiometer R2 until the neon tube N2 just ceases to glow. When this occurs, the apparatus is adjusted for maximum sensitivity.

The cathode of tube T1 is also connected to one side of a storage condenser C5, the opposite side of which is connected to conductor 14. A gaseous discharge diode such as neon tube N1 is interposed between the condenser and such cathode whereas a resistor R4 is connected between the juncture of this diode and condenser and the control grid of the tube T2. A small filter condenser C6 is connected between the control grid of this latter tube and conductor 14. During application of positive voltage to the control grid of tube T2 rendering such tube conductive, charging current for condenser C5 flows through the tubes T1 and N1 in series. The ionizing voltage of the neon tube N1 is so small with relation to the applied voltage existing between terminals 10 and 12 that this diode conducts automatically whenever the tube T1 is rendered conductive. The storage condenser C5 is thus charged almost instantly due to the low impedance presented by the two gaseous discharge tubes T1 and N1 when T1 is rendered conductive.

The resulting positive voltage produced by the charge on condenser C5 is applied to the control grid of tube T2 through resistor R4 and renders this tube also conductive, energizing the control relay. Due to flow of grid current in tube T2 the charge on the storage condenser C5 gradually decays until its voltage is insufficient to produce ionization of tube T2. The time required for this decay to take place is determined by the size of the resistor R4 in the discharge circuit and is

selected to produce an illumination holding period sufficient for a normal inspection of the premises in which the apparatus is installed. The discharge circuit for storage condenser C5 comprises the condenser C5, resistor R4, the grid and cathode of tube T2, and conductors interconnecting the condenser C5 and the cathode of tube T2.

It will be noted that the neon diode N1 functions as an automatic switch interconnecting the cathode of tube T2 and one side of the storage condenser C5. This switch instantly closes when tube T1 becomes conductive, and presents a negligible resistance in the charging circuit for the condenser at that time. However, when the positive grid voltage producing conduction of tube T1 is removed, as by termination of the control impulse of radio frequency energy applied to the input terminals 18 and 20, tube N1 also deionizes and thereby isolates the cathode of tube T1 from the voltage then existing on the storage condenser C5. One effect of this isolating action is to require that the entire discharge of storage condenser C5 occur through the high impedance represented by the resistor R4, and hence produce a protracted illumination holding period in the apparatus. The second and equally important effect of this isolating action of the automatic switch diode N1 is to restore the normal or quiescent bias potential to the cathode of tube T1, as established by the setting of potentiometer R2. As a result the sensitivity of tube T1 to energization by a subsequent control impulse of radio frequency energy is the same as it was initially and is not affected by any residual charge on the storage condenser C5. This means that the apparatus may be recycled by renewing the charge on storage condenser C5 without requiring that the original charge on this storage condenser be dissipated before the tube T1 is sensitive to a subsequent control impulse. In terms of practical results the presence of neon tube N1 or an equivalent automatic switch in the condenser charging circuit makes it possible to maintain continuous illumination in the premises under inspection simply by transmitting radio frequency energy to the installed apparatus at intervals which are shorter than the effective decay period of the storage condenser. Illumination of the premises continues until expiration of the apparatus holding period following termination of the last transmitted impulse. It is to be understood, however, that for many purposes the normal holding period of the apparatus established by the discharge time constant of the storage condenser is sufficiently long that a single brief impulse of radio frequency energy transmitted to the apparatus will suffice for a complete inspection of the premises.

As a further feature of the apparatus a photo-conductive cell P is incorporated in the grid circuit of the first grid-controlled gaseous discharge tube T1. This photocell is arranged to receive a sufficient amount of light energy during normal daylight hours to provide a negative bias voltage at the control grid of tube T1 preventing accidental energization of this tube during daytime. Such bias voltage is developed by connecting the photocell P in series with the battery E and the large resistance R5 so that the current through the photocell produces a voltage drop across resistance R5 proportional to the amount of light incident upon the photosensitive cathode of the cell. This voltage is applied between the conductor 14 and the control grid of tube T1. During the hours of night the amount of light incident upon the photocell is so slight that the negative bias voltage developed across resistance R5 is insufficient to prevent ionization of tube T1 by the control signal of radio frequency energy appearing across terminals 18 and 20. It will be understood that this photocell relieves the owner of the premises from the responsibility of turning the apparatus on and off at night and in the morning respectively in order to prevent untimely over-illumination of the premises during daylight hours, while insuring that

the apparatus will always be operative during the hours of night, as desired.

The following table of values of various components employed in the illustrative circuit are satisfactory in a typical case. It will be understood that these values may vary according to design or preference.

Table of values

L1	Dependent on operating frequency.
C1	Dependent on operating frequency.
C2	Dependent on operating frequency.
C3	.01 mfd.
C4	.01 mfd.
C5	1.0 mfd.
C6	100 mmfd.
C7	40 mfd.
R1	33×10^3 ohms.
R2	1×10^3 ohms (winding).
R3	100×10^3 ohms.
R4	44×10^6 ohms.
R5	Dependent on characteristics of "P."
T1	Type 2D21.
T2	Type 2D21.
D	Type CK705.
P	Photoconductive cell.
E	Dependent on characteristics of "P."

With the foregoing values, particularly those of condenser C5 and resistor R4, an illumination holding period of one one-half minutes was obtained, representing the effective decay period of storage condenser C5 following termination of a control impulse applied to the first grid of tube T1. This holding period may be increased or decreased by changing the values of either or both condenser C5 and resistor R4.

Condenser C6 connected between the first grid of tube T2 and conductor 14 is provided as a filter. Without this condenser it is found that the tube T2 has the tendency to become conductive one or more times after release of the relay CR upon completion of the discharge of condenser C5. However, the condenser C6 must not be too large or it will act as an effective short circuit between the control grid of tube T2 and its cathode preventing reliable ionization of this tube in accordance with the charge on condenser C5.

Preferably the detector circuit comprising the inductor L1 and tuning condenser C1 is made resonant to the carrier frequency of the portable transmitter conventionally used in police patrol cars and other similar vehicles. A very brief impulse of carrier wave energy transmitted from the patrol car antenna in the vicinity of the inspected premises will be sufficient to fire the grid-controlled tube T1 and produce illumination of the premises. By proper adjustment of potentiometer R2 establishing the sensitivity of the receiving apparatus in a particular premises, it will be necessary for the radio transmitter to be within a certain distance from the premises before this effect will be produced. Consequently normal operation of the radio transmitter for communications purposes will not operate the illumination control devices in various premises throughout an area, but only those in the immediate vicinity. During daylight hours even this will be prevented, however, by the photocell P incorporated in the grid circuit of the tube T1.

It will be appreciated by those skilled in the art that certain changes and substitutions may be made in the illustrated apparatus without altering the operating principles involved. For instance the portion of the circuit comprises the control relay CR and the grid-controlled gaseous discharge tube T2 comprises a voltage controlled switch means for operating the electric lighting circuit, and it will be evident that other forms of voltage controlled switch means may be substituted. Also it will be evident that the remotely controlled charging circuit for the storage condenser C5 comprising the grid-controlled gaseous discharge tube T1 and the radiation responsive means in-

cluding the detector D and the tuned circuit L1, C1 may be replaced by other equivalent electron tube means rendered temporarily conductive by reception of electromagnetic wave energy. Also it should be understood that the neon diode N1 comprises an automatic switch means rendered conductive by conduction of the grid-controlled tube T1 for charging the storage condenser C5 and becoming non-conductive automatically following termination of conduction of the tube T1, whereupon the storage condenser is effectively isolated from the plate-cathode circuit of the tube T1, and that other automatically acting switch means may be substituted therefor. These and other variations may be made without exceeding the scope of the invention.

I claim as my invention:

1. In a lighting circuit remote control system for an inspection of premises, the combination comprising voltage controlled switch means operable to complete a lighting circuit responsively to applied voltage above an initiating value and to open said circuit responsively to a reduction of such applied voltage below a lesser terminating value, and remotely controlled means arranged for applying control voltages to said switch means including a normally nonconductive grid-controlled electron tube having plate-cathode circuit, a source of plate voltage for said tube connected in said plate-cathode circuit, a storage condenser connected to said plate-cathode circuit to be charged relatively rapidly to a voltage exceeding said initiating value by conduction of said tube, a discharge circuit for said storage condenser including a connection to said switch means applying condenser voltage thereto for operating said switch means and an impedance element prolonging decay of condenser voltage relatively slowly to said terminating value and thereby providing a holding period of predetermined duration for said switch means following termination of conduction of said tube, and radiation receiving means energizably connected to the control grid of said tube, and selectively energizable by electromagnetic radiation incident thereon from a remote source for rendering said tube conductive during such energy reception and thereby effecting charging of said storage condenser for operating said switch means.

2. The combination defined in claim 1, wherein the connection of the storage condenser to the plate-cathode circuit of the electron tube includes automatic switch means rendered conductive by conduction of the grid-controlled tube for charging of the storage condenser and becoming nonconductive automatically following termination of conduction of said tube for effectively isolating such condenser from said plate-cathode circuit.

3. The combination defined in claim 2, wherein the automatic switch means comprises a gaseous discharge diode.

4. The combination defined in claim 1, and daylight responsive photocell means connected to the control grid of the electron tube and biasing such tube negatively to prevent conduction thereof by electromagnetic radiation during daylight hours.

5. In a lighting circuit remote control system for inspection of premises, the combination comprising voltage controlled switch means operable to complete a lighting circuit responsively to applied voltage above an initiating value and to open said circuit responsively to a reduction of such applied voltage below a lesser terminating value, and remotely controlled means arranged for applying control voltages to said switch means including a normally nonconductive grid-controlled gaseous discharge tube having a plate-cathode circuit, a source of alternating plate voltage for said tube connected in said plate-cathode circuit, a source of bias voltage connected to the cathode of said tube establishing the conduction sensitivity of such tube to control grid signals, a storage condenser, automatically acting switch means connecting said storage condenser to said plate-cathode circuit for charging

ing of said condenser to a voltage exceeding said initiating value by conduction of said tube and for automatically isolating said condenser from said plate-cathode circuit following termination of conduction of said tube, a discharge circuit for said storage condenser including a connection to said voltage controlled switch means applying condenser voltage thereto for operating the same and an impedance element prolonging decay of condenser voltage and thereby providing a holding period for said voltage controlled switch means following said termination of conduction of said tube, and radiation receiving means energizingly connected to the control grid of said tube, said radiation receiving means being selectively energizable by electromagnetic radiation incident thereon from a remote source, for rendering said tube conductive during such energy reception and thereby charging said storage condenser for operating said switch means.

6. The combination defined in claim 5, wherein the automatically acting switch means comprises a gaseous discharge diode.

7. The combination defined in claim 5, and daylight responsive photocell means connected to the control grid of the gaseous discharge tube and biasing such tube negatively to prevent the radiation receiving means effecting conduction thereof during daylight hours.

8. The system for controlling interior illumination of a premises from a remote source, comprising in said premises radio frequency electromagnetic wave energy detection means, a grid-controlled gaseous discharge tube having a control grid connected to said detection means for rendering said tube conductive by reception of electromagnetic wave energy therein, said tube having a plate-cathode circuit including a source of alternating plate voltage, a storage condenser, means including a gaseous discharge diode connecting said storage condenser to said plate-cathode circuit for charging said storage condenser by conduction of said tube and for isolating said storage condenser from said plate-cathode circuit automatically following termination of conduction of said tube, said tube having a grid-cathode circuit including bias means establishing the conduction sensitivity of said tube to control signals applied to the grid thereof by said detection means, a second grid-controlled gaseous discharge tube, lighting circuit means arranged for energization by conduction of said second tube, and means including a relatively large resistance connecting said storage condenser to the control grid of said second tube for applying condenser voltage thereto, said resistance comprising a discharge path for said storage condenser with a relatively long time constant prolonging conduction of said second tube by condenser voltage during decay of such voltage and thereby providing a holding period during which conduction of said second tube maintains energization of said lighting circuit means following termination of electromagnetic wave energy in said detection means.

9. In a lighting circuit remote control system for an inspection of premises, the combination comprising voltage controlled switch means operable to complete a lighting circuit responsively to applied voltage above an initiating value and to open said circuit responsively to a reduction of such applied voltage below a terminating value, and remotely controlled means arranged for applying control voltages to said switch means includ-

ing a storage condenser connected to means operable when energized to charge said storage condenser rapidly, the voltage applied by said remotely controlled means being determined by the instantaneous charge on said condenser, radiation receiving means energizingly connected to said condenser charging means for effecting charging of said storage condenser to apply voltage to said switch means materially above said initiating value, whereupon said switch means remains operative during discharge of said condenser and accompanying reduction of said applied voltage to a value below said terminating value.

10. In a lighting circuit remote control system for an inspection of premises, the combination comprising voltage controlled switch means operable to complete a lighting circuit responsively to applied voltage above an initiating value and to open said circuit responsively to a reduction of such applied voltage below a lesser terminating value, and remotely controlled means arranged for applying control voltages to said switch means including a storage condenser, means operable to charge said storage condenser relatively rapidly to a value materially above said initiating value, a discharge circuit for said storage condenser including a connection to said switch means applying condenser voltage thereto for operating said switch means, and an impedance element prolonging decay of condenser voltage relatively slowly to said terminating value and thereby providing a holding period for said switch means during such voltage decay, and radiation receiving means energizingly connected to said condenser charging means for operating the same to effect charging of said storage condenser to operate said switch means.

11. In a lighting circuit remote control system for inspection of premises, the combination comprising a source of illumination, switch means actuatable for energizing said source, a receiver of radiant energy, and means controlled by said receiver and in turn connected for actuating said switch means to energize said illumination source substantially instantly on reception of radiant energy in said receiver, said controlled means including holding means operated by said receiver and in turn controlling said switch means for delaying deactuation of said switch means for a predetermined holding period following termination of the radiant energy received in said receiver, which holding period materially exceeds the period of actuation of said switch means.

12. The system defined in claim 11, wherein the holding means comprises an energy storage element charged with energy upon initiation of radiant energy received by the receiver to initiate actuation of the switch means, and means operable to slowly discharge the energy from said storage element upon termination of radiant energy received by said receiver, said switch means being adapted to remain actuated with an energy charge in said storage element above a predetermined value and to become deactuated by a reduction of such energy charge below such value.

References Cited in the file of this patent

UNITED STATES PATENTS

1,774,457	Singleton	Aug. 26, 1930
2,052,333	Williams	Aug. 25, 1936