

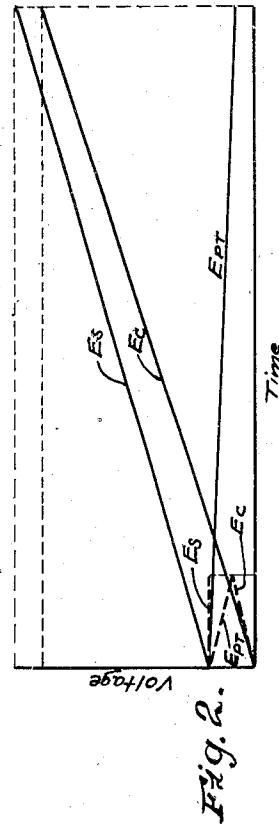
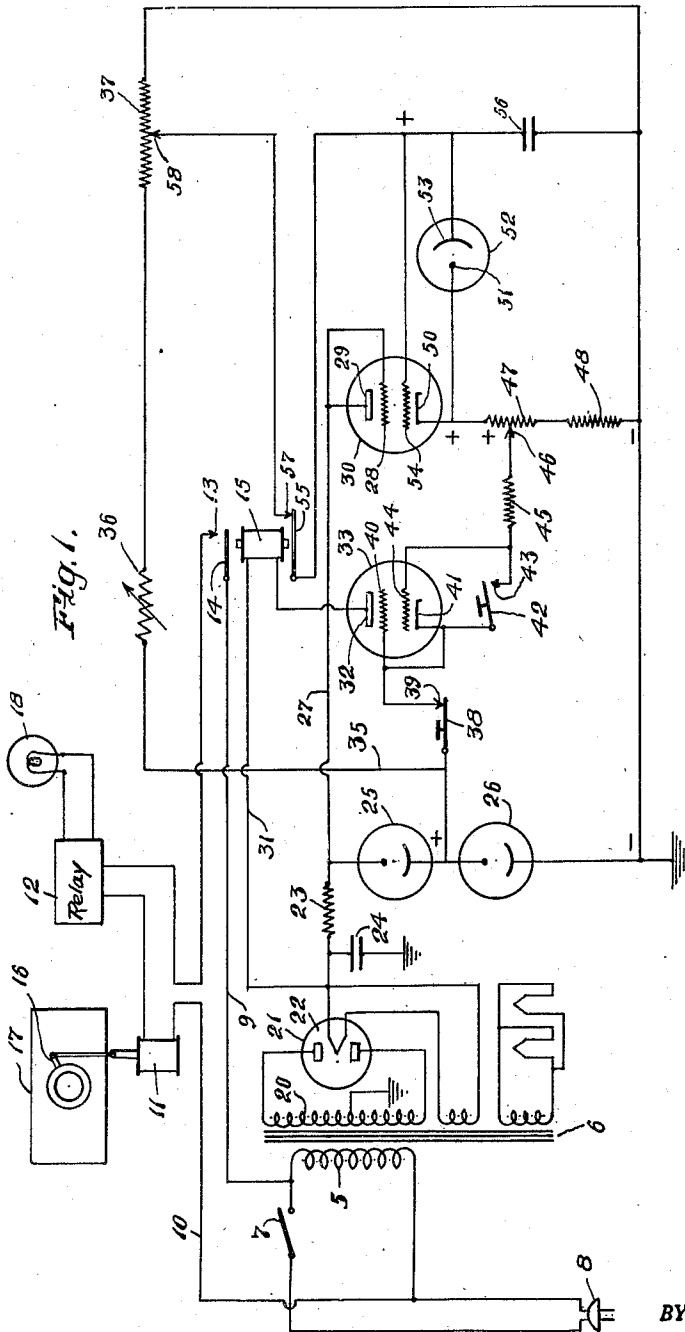
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ELECTRONIC LIGHT INTEGRATOR

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ELECTRONIC LIGHT INTEGRATOR

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1

This invention relates to the integration of light, and relates more particularly to electronic light integrators that can be used to control the exact quantities of illumination to be applied to light sensitive surfaces.

In photographic timing it is desirable to be able to provide a certain quantity of illumination regardless of variations in the intensity of the source of illumination. The prior electronic light integrators which have been proposed for such a duty have been operated through the application of a constant supply voltage through the phototubes which control the charging of condensers. This constant supply voltage has necessarily had to be limited to about twenty volts because of the instability of the phototubes when higher voltages are applied thereto. This has resulted in a small charging interval for a given size of condenser. It has not been feasible to greatly increase the capacities of the condensers used for correspondingly increasing their charging intervals because of the cost. Accordingly it has been the practise to use the expedient of repeatedly charging a relatively small condenser when a long timing interval is desired, each charging of the condenser resulting in the advance of a stepping mechanism one notch. Such controls have the faults that a mechanical counter subject to errors is required, the control is not continuous but in steps, and requires considerable care and skill from an operator.

This invention provides a condenser charging circuit including a phototube, in which the interval for charging a given size of condenser is many times as long as in prior timers, and which has the additional advantage that the rate of charge is linear enabling standard potentiometers with direct reading dials to be used as timing controls. A supply voltage many times higher than those previously used is provided, but the voltage across the phototube is maintained below the critical voltage by the use of a thermionic vacuum tube.

An object of the invention is to increase the timing intervals of electronic light integrators.

Other objects of the invention are to improve the performance, and to reduce the cost of electronic light integrators.

The invention will now be described with reference to the drawing, of which:

Fig. 1 is a circuit schematic illustrating a photographic timer embodying this invention, and

Fig. 2 is a chart comparing the performance of this invention compared with that of prior timers.

The primary winding 5 of the power trans-

2

former 6 is connected through the switch 7 to the plug 8 which is adapted to be plugged into a conventional receptacle supplying alternating current. The wires 9 and 10 are connected through the switch 7 to the supply leads, and connect the solenoid 11, the relay 12, the contact 13 and the armature 14 of the relay 15 in series.

The solenoid 11 has its plunger connected to the light shutter 16 of the camera 17. The relay 12 is connected to the light source 18. When the relay 15 is deenergized as will be described, its armature 14 is released and retracted to strike the contact 13 thus energizing the solenoid 11 and the relay 12.

The high voltage secondary winding 20 of the transformer 6 is connected in a conventional full wave rectifier circuit to the rectifier 21, the cathode 22 of which is connected to the filter resistor 23 and condenser 24 and to the voltage regulator tubes 25 and 26 which are connected in series to ground. The resistor 23 is also connected by the wire 27 to the screen grid 28 and plate 29 of the thermionic tube 30 which may be a 6V6GT.

The rectifier cathode 22 is also connected by the wire 31 to the energizing winding of the relay 15 which is connected to the plate 32 of the tube 33 which may be a Thyratron 2050.

The centerpoint connection between the tubes 25 and 26 is connected by the wire 35 to the compensating resistor 36 and through same to one side of the timer potentiometer 37, the other side of which is connected to ground. The centerpoint connection between the tubes 25 and 26 is also connected to the pivot side of the push-button switch 38, the other side of which is contacted, when the switch is closed, by the contact 39 to which is connected the shield grid 40 and the cathode 41 of the tube 33. The cathode 41 is also connected to the pivot end of the push-button switch 42, the other end of which contacts when closed, the contact 43 which is connected to the control grid 44 of the tube 33, and through the limiting resistor 45 to the slider 46 of the potentiometer 47.

The potentiometer 47 is also connected at one end through the biasing resistor 48 to ground, and at the other end to the cathode 50 of the tube 30 and to the electrode 51 of the phototube 52. The electrode 53 of the tube 52 is connected to the control grid 54 of the tube 30, to the armature 55 of the relay 15 and to one side of the condenser 56, the other side of which is connected to ground.

The contact 57 of the relay armature 55 is connected to the slider 58 of the potentiometer 37.

In operation, to prepare for the start of an exposure, the plug 3 is placed in its receptacle, and the switch 7 is closed. This energizes the rectifier 21 which may supply 275 volts through the winding of the relay 15 to the plate 32 of the tube 33, may supply 210 volts to the plate 29 of the tube 30, and may supply 105 volts to the cathode 41 and the grid 40 of the tube 33 when the switch 38 is closed. The switch 38 is closed and the switch 42 is open at this time. The Thyatron tube 33 is not conductive at this time.

The normally open switch 42 is then momentarily closed, connecting the control grid 44 to the cathode 41 causing the tube 33 to become conductive, causing the relay 15 to become energized and to pull in the armatures 14 and 55. This causes the armature 14 to leave the contact 13 thus de-energizing the solenoid 11 and the relay 12, and causing the shutter 16 to be closed, and the light source 18 to be turned off. The relay armature 55 at this time touches the contact 57 placing part of the resistance of the potentiometer 37 across the condenser 56, if the slider 58 is to the left of the extreme right hand end (facing Fig. 1 of the drawing) of the potentiometer, or if the slider is at the extreme right hand end of the potentiometer, placing a short across the condenser. The device is now ready for an exposure to be started.

The slider 58 of the potentiometer 37 is adjusted to provide the desired light quantity. Adjustment of the slider towards the left shortens the exposure, and its adjustment towards the right lengthens the exposure. The potentiometer preferably would have a calibrated dial.

An initial charge in the condenser 56 is provided through the potentiometer 37 except when the slider is adjusted to the upper limit where the condenser is short circuited, as described.

Assuming the longest time exposure is desired, the potentiometer slider 58 is placed at the extreme right hand end of the potentiometer 37 placing a short across the condenser 56. The exposure is then started by momentarily opening the normally closed switch 38. This opens the cathode circuit of the tube 33 causing it to de-ionize, and causing the relay 15 to be de-energized. This causes the armature 14 to strike the contact 13 closing the described energizing circuits of the solenoid 11 and the relay 12, causing the shutter 16 to be opened, and the light source 18 to be turned on. At the same time the relay armature 55 leaves the contact 57 removing the short from across the condenser 56.

The light from the source 18 then strikes the phototube 52 causing it to become conductive and to start the charging of the condenser 56 with current from the cathode 50 of the tube 30. At this time the cathode 50 is at a positive voltage of twenty volts resulting from the voltage drop through the cathode resistors 47 and 48, the condenser 56 which is in series with the phototube having a zero charge at this time. This results in twenty volts being applied across the phototube.

The cathode bias resistors are a source of variable supply voltage for charging the condenser, the phototube being in series with this supply and the condenser 56, and therefore adjusts the charging of the condenser from the source, as it conducts current. As the charge in the condenser 56 builds up due to the conductance of the phototube, the grid 54 of the tube 30 which is connected to the positive side of the condenser, is charged to a higher voltage causing the plate current of the tube 30 to increase.

This in turn, causes an increase in the voltage drop in the cathode resistors 47 and 48, resulting in an increasing positive voltage on the cathode 50, and in an increasing voltage applied through the phototube to the condenser 56, and in an increasing positive voltage on the grid 54. As the phototube continues to conduct current through its exposure to light, the voltage across the condenser 56 increases to about 100 volts.

Due to the characteristics of the tube 30, the voltage on its grid 54, which is the voltage across the condenser, increases faster than the voltage on the cathode 50, with the result that when the condenser has been charged from zero to 100 volts, the cathode voltage will have increased from 20 to 110 volts. The voltage across the phototube is the difference between the voltage across the condenser, and the cathode voltage. At the start of the exposure this difference was 20 volts. At the end of the exposure the difference was 10 volts.

When the cathode voltage of the tube 30 has increased, as described, to 110 volts, the voltage on the grid 44 of the Thyatron tube 33 increases to about 103 volts. Its cathode 41 has a voltage of 105 volts so that its grid voltage is minus two volts with respect to its cathode, causing the tube to become conductive and to energize the relay 15 whereby the solenoid 11 and the relay 12 are deenergized, stopping the exposure.

The time-voltage characteristics according to this invention are illustrated by the continuous lines E_s , E_c and E_{pr} of Fig. 2. E_s is the variable voltage supplied across the cathode bias resistors 47 and 48; E_c is the voltage across the condenser 56, and E_{pr} is the voltage across the phototube. It is to be noted that at no time during the exposure does the voltage across the phototube exceed the critical voltage of 20 although the condenser is charged to 100 volts. The long time interval results from the low charging rate, this resulting in turn, from the low voltage across the phototube.

The dashed lines of Fig. 2 marked E_s , E_c and E_{pr} illustrate the corresponding charging characteristics of the prior devices using the same capacity condenser. Since the condenser can be charged to only ten volts, the charging interval is only one-tenth of that of the illustrated embodiment of this invention.

When less than the maximum exposure is desired, the slider 58 of the potentiometer 37 is moved to the left with respect to Fig. 1 of the drawing, to a selected position corresponding to the quantity of illumination desired. This results in a portion of the resistance of the potentiometer being placed across the condenser 56, and in an initial charging voltage being placed thereacross, with an initial charge above zero volts being placed across the condenser. This results in a shortening of the exposure since the voltages E_s , E_c and E_{pr} on the continuous lines of Fig. 2 will, at the start of the shortened exposure, be to the right with respect to Fig. 2 of the drawing, of the corresponding voltages at the start of a maximum exposure.

In case of replacements of tubes or other components causing errors in the calibration of the timing control comprising the potentiometer 37, the maximum exposure setting can be corrected by the adjustment of the slider 46 along the resistor 47. Then correction for the minimum exposure position can be provided by adjustment of the resistor 36.

While one embodiment of the invention has

been described for the purpose of illustration, it should be understood that the invention is not limited to the exact apparatus and arrangement of apparatus illustrated, since modifications thereof may be suggested by those skilled in the art, without departure from the essence of the invention.

What is claimed is:

1. An electronic light integrator for controlling the quantity of illumination supplied by a light source, comprising a phototube exposed to light from said source; a thermionic tube having a control grid, a cathode and an anode; a direct current power supply having its positive side connected to said anode; a cathode resistor connecting said cathode to the negative side of said power supply; a condenser connected at one side to said grid and connected at its other side to said negative side of said power supply, and means connecting said phototube to said cathode and to said side of said condenser connected to said grid.

2. An electronic light integrator for controlling the quantity of illumination supplied by a light source, comprising a phototube exposed to light from said source; a thermionic tube having a cathode, an anode and a control grid; a direct current, variable voltage supply source; a condenser connected at one side to said control grid and connected at its other side to the negative side of said supply source; means connecting said anode to the positive side of said source; means connecting said cathode to said negative side of said supply source, and means connecting said phototube to said cathode and to the side of said condenser connected to said grid.

3. An electronic light integrator according to claim 1 in which means is provided for placing an initial charge in said condenser when a light quantity below maximum desired.

4. An electronic light integrator according to claim 2 in which means is provided for placing an initial charge in said condenser when a light quantity below maximum is desired.

5. An electronic light integrator according to claim 1 in which exposure starting means is provided for starting an exposure to light from said light source, means is provided for placing a

short across said condenser when a maximum exposure is desired, and means is provided for concurrently removing said short and for actuating said exposure starting means for starting an exposure to light from said source.

6. An electronic light integrator according to claim 2 in which exposure starting means is provided for starting an exposure to light from said light source, means is provided for placing a short across said condenser when a maximum exposure is desired, and means is provided for concurrently removing said short and for actuating said exposure starting means for starting an exposure to light from said source.

7. An electronic light integrator for controlling the quantity of illumination supplied by a light source, comprising a phototube exposed to light from said source; a thermionic tube having a cathode, a control grid and an anode; a direct current power supply having its positive side connected to said anode; a cathode resistor connecting said cathode to the negative side of said supply, a condenser connected at one side to said grid and at its other side to the negative side of said supply; means connecting said phototube to said cathode and to said side of said condenser connected to said grid; a variable resistor connected to said power supply, and means connecting said variable resistor to said condenser for applying an initial charge therein when a light quantity below maximum is desired.

8. An electronic light integrator according to claim 7 in which exposure starting means is provided, and means is provided for concurrently disconnecting said variable resistor from said condenser and for actuating said starting means for starting an exposure to light from said source.

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