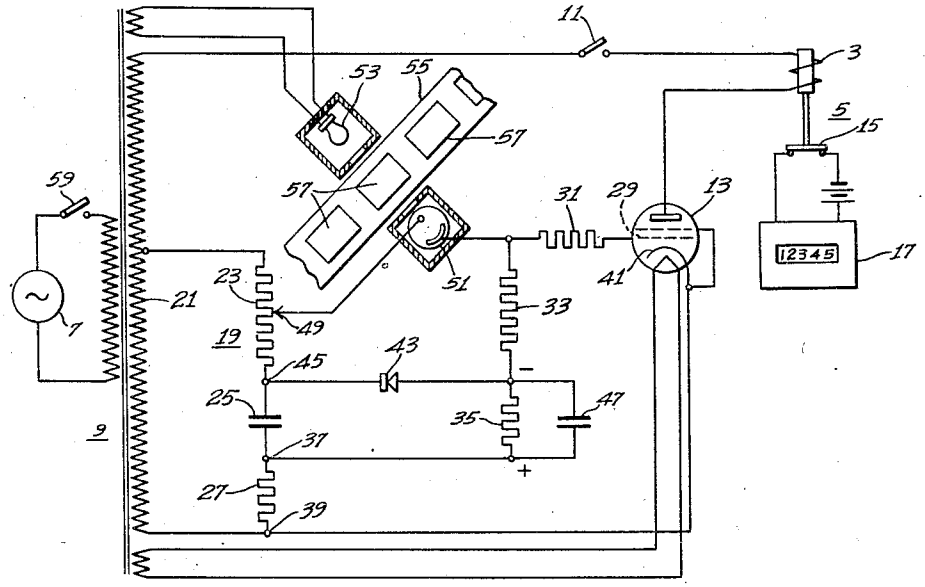
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PHOTOELECTRIC CONTROL SYSTEM

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PHOTOELECTRIC CONTROL SYSTEM

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This invention relates to a photoelectric control system and has particular relation to a system for controlling the flow of current from a source to a load.

In certain photoelectric control systems constructed in accordance with the teachings of the prior art, an electric discharge valve of the arc-like type, preferably a thyratron, is interposed between a source of alternating current and a load to control the flow of current to the load. A photoelectric device is associated with the control circuit of the valve so that the latter conducts current in each positive half period of the source while light of a predetermined intensity impinges upon the photoelectric device. The load in many cases comprises a relay of the type which remains in its energized position as long as current is supplied thereto in alternate half periods of the source. However, it is necessary that the discharge valve be rendered conductive early in each positive half period to insure the flow of sufficient current to maintain the relay in its energized position. In addition, because of the highly competitive nature of this field, a commercially successful system must be simple and inexpensive in construction and reliable in operation.

It is accordingly an object of our invention to provide a new and improved photoelectric control system which is simple and inexpensive in construction and reliable in operation.

More specifically, it is an object of our invention to provide novel apparatus in which a discharge valve of the arc-like type is arranged to control the flow of current to a load from a source of alternating current and a photoelectric device is associated with the control circuit of the valve to render the latter conductive early in a positive half period of the source.

In accordance with our invention, a potential is impressed in the control circuit of the valve while the photoelectric device is non-conductive. This impressed potential is made up of an alternating potential leading in phase with respect to the main source potential, superimposed on a continuous potential. The valve is of the arc-like type which is rendered conductive in a positive half period of the main source when the resultant potential impressed in the control circuit rises above a predetermined critical value. The continuous potential impressed in the control circuit is of such polarity and magnitude that the resultant potential remains below the critical value while the photoelectric device is non-conductive.

A resistor in the control circuit of the valve is connected through the photoelectric device to an auxiliary source of potential. The photoelectric device is arranged to permit current flow from the auxiliary source through the resistor in such a direction that the potential developed across the resistor opposes the continuous potential during the early portion of a positive half period of the source. The magnitude of the potential thus developed across the resistor depends upon the degree of conductivity of the photoelectric device. When light of a predetermined intensity impinges upon the photoelectric device, the potential developed across the resistor is of such magnitude that the resultant potential in the control circuit rises above the critical value early in a positive half period of the source to render the discharge valve conductive.

The novel features that we consider characteristic of our invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with further objects and advantages thereof, will best be understood by reference to the following description and to the drawing, the single figure of which is a diagrammatic view showing a preferred embodiment of our invention.

In the drawing, the apparatus is shown as applied to a counting system for purposes of explanation only. It becomes apparent upon a detailed examination of the apparatus that it may be advantageously employed in many other applications. As shown, the energizing coil 3 of a relay 5 is supplied with power from an alternating current generator 7 through a transformer 9, a hand switch 11 and an electric discharge valve 13 of the arc-like type. The contactor 15 of the relay 5 is positioned to open and close the energizing circuit of a counter 17. The arrangement is such that when the relay is deenergized and then reenergized, a single count is recorded on the counter.

A voltage divider 19 is connected to be energized from the secondary 21 of the transformer 9 and comprises a potentiometer 23, a capacitor 25 and a resistor 27. The control circuit of the discharge valve 13 may then be traced from the grid 29 through a grid resistor 31, a pair of resistors 33 and 35 to an intermediate tap 37 on the divider 19 and from the lower terminal 39 of the divider to the cathode 41 of the valve. The construction of the divider is such that the potential obtainable therefrom leads the poten-

tial of the secondary 21 by approximately ninety degrees. Thus the portion of the divider between the intermediate tap 37 and the lower terminal 39, which as shown is the resistor 27, impresses in the control circuit an alternating control potential leading in phase with respect to the alternating current source.

A dry rectifier 43 is connected between the junction of the pair of resistors 33 and 35 and another intermediate tap 45 on the divider and a capacitor 47 is connected in parallel with the resistor 35. The direction of conductivity of the rectifier 43 is such that the capacitor 47 is charged with its negative plate connected to the grid of the discharge valve during the negative half period of the source. During the positive half period, the capacitor 47 discharges through the resistor 35 in such a direction that the polarity of the potential developed across the resistor 35 remains the same. The magnitude of the continuous potential across the resistor 35 is such that it prevents the alternating control potential supplied from the resistor 27 of the divider from rising above the predetermined critical value necessary to render the valve conducting.

The junction between the other resistor 33 and the grid resistor 31 is connected to the movable tap 49 on the potentiometer 23 through a photoelectric device 51. The photoelectric device 51 is so arranged that when light of a predetermined intensity impinges thereon, current is conducted through the resistor 33 during each positive half period of the alternating control potential. The path of this current may be traced from the movable tap 49 of the potentiometer 23 through the photoelectric device 51, the resistor 33 and the rectifier 43 to the intermediate tap 45 on the divider. It is thus apparent that the potential developed across the resistor 33 by the current flowing therethrough opposes the continuous potential across the resistor 35. The resultant potential in the control circuit then rises above the predetermined critical value early in the positive half period of the source to render the valve conductive.

An incandescent lamp 53 is energized from the secondary 21 and is positioned to direct a ray of light of the predetermined intensity on the photoelectric device 51. A conveyor belt 55 is positioned to carry a series of spaced objects 57 between the lamp 53 and the photoelectric device 51. The objects 57 are of such size as to interrupt the ray of light from the lamp to the photoelectric device.

To initiate operation of the apparatus, a handswitch 59 is closed causing the lamp 53 to be illuminated and capacitor 47 to be charged. The switch 11 in circuit with the coil 3 of the relay 5 is then closed and the discharge valve 13 is energized in each positive half period of the source. As a result, the contactor 15 of relay 5 maintains the circuit of the counter 17 open. The counter is then set at zero and the conveyor belt is placed in motion. When the first object 57 interrupts the ray of light to the photoelectric device 51, the continuous negative potential across the resistor 35 in the control circuit assumes control of valve 13 and prevents it from being rendered conductive. The relay 5 is deenergized and the contactor 15 thereof closes the circuit of the counter 17. When the first object 57 moves to a position permitting the ray of light to impinge on the photoelectric device, the latter conducts current which passes through resistor 33. The resultant potential in the control circuit rises above the critical value and the discharge valve is rendered conductive early in each positive half period of the source until the next object interrupts the ray of light.

Although we have shown and described a specific embodiment of our invention, we are fully aware that many modifications thereof are possible. Our invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and the spirit of the appended claims.

We claim as our invention:

1. In an electric control system, a load device, means adapted to function as a source of alternating current connected to said load device, an electric discharge valve of the arc-like type interposed between said source and load device for controlling the flow of current to the load device, a control circuit connected to said valve for rendering said valve conductive when the potential impressed in said circuit first rises above a predetermined critical value in a positive half period of said source, means connected to said control circuit for impressing in said circuit an alternating potential tending to render said valve conductive, superimposed on a continuous potential of such polarity and magnitude as to prevent the resultant potential from rising above said critical value, a resistor connected in said control circuit, and means connected across said resistor and including a photoelectric device for passing current through said resistor under the control of said photoelectric device to develop a potential thereacross which opposes said continuous potential.

2. In an electric control system, a load device, means adapted to function as a source of alternating current connected to said load device, an electric discharge valve of the arc-like type interposed between said source and load device for controlling the flow of current to the load device, a control circuit connected to said valve for rendering said valve conductive when the potential impressed in said circuit first rises above a predetermined critical value in a positive half period of said source, means connected to said control circuit for impressing in said circuit an alternating potential leading in phase relative to said source superimposed on a continuous potential of such polarity and magnitude as to prevent the resultant potential from rising above said critical value, a resistor connected in said control circuit, and means connected across said resistor and including a photoelectric device for passing current through said resistor during an early portion of a positive half period of the source under the control of said photoelectric device to develop a potential thereacross which opposes said continuous potential.

3. In an electric control system, a load device, means adapted to function as a source of alternating current connected to said load device, an electric discharge valve of the arc-like type interposed between said source and load device for controlling the flow of current to the load device, a control circuit connected to said valve for rendering said valve conductive when the potential impressed in said circuit first rises above a predetermined critical value in a positive half period of said source, said control circuit including at least three series connected resistors, means connected across the first of said resistors for developing an alternating control potential thereacross tending to render said valve conductive, means connected across the second of said resistors for developing a continuous potential

thereacross of a polarity and magnitude to prevent said control potential from rendering said valve conductive, and means connected across the third of said resistors and including a photoelectric device for developing a potential across said third resistor of such polarity as to oppose said continuous potential at the beginning of a positive half period of said source, the magnitude of said third resistor potential depending upon the degree of conductivity of said photoelectric device.

4. In an electric control system, a load device, means adapted to function as a source of alternating current connected to said load device, an electric discharge valve of the arc-like type interposed between said source and load device for controlling the flow of current to the load device, a control circuit connected to said valve for rendering said valve conductive when the potential impressed in said circuit first rises above a predetermined critical value in a positive half period of said source, said control circuit including at least three series connected resistors, means connected across the first of said resistors for developing an alternating control potential displaced in phase relative to said source thereacross tending to render said valve conductive, means connected across the second of said resistors for developing a continuous potential thereacross of a polarity and magnitude to prevent said control potential from rendering said valve conductive, and means connected across the third of said resistors and including a photoelectric device for developing a potential across said third resistor of a polarity to oppose said continuous potential during each positive half period of said control potential, the magnitude of said third resistor potential depending upon the degree of conductivity of said photoelectric device.

5. In an electric control system, means adapted to function as a source of alternating current, a load device connected to said source, an electric discharge valve of the arc-like type having a plurality of principal electrodes connected between said source and load and having a control electrode, a voltage divider connected to said source and including elements effecting displacement of the phase of the current flowing therethrough relative to the source, a pair of resistors, said resistors and a portion of said divider being connected in series between said control electrode and one of said principal electrodes, a capacitor connected in parallel with one of said resistors, means including a rectifier for connecting said one resistor across a second portion of said divider, and means including a photoelectric device for connecting the other resistor across a third portion of said divider.

6. In an electric control system, means adapted to function as a source of alternating current, a load device connected to said source, an electric discharge valve of the arc-like type having a plurality of principal electrodes connected between said source and load and having a control electrode, a voltage divider connected to said source and including elements effecting displacement of the phase of the current flowing therethrough relative to the source, a pair of resistors, said resistors and a portion of said divider being connected in series between said control electrode and one of said principal electrodes, a capacitor connected in parallel with one of said resistors, means including a rectifier for connecting said one resistor across a second portion of said divider to develop a continuous potential across said one resistor, and means including a photoelectric device for connecting said other resistor across a third portion of said divider to develop a potential across said other resistor of a polarity opposite that of said potential across said one resistor.

7. In an electric control system, means adapted to function as a source of alternating current, a load device connected to said source, an electric discharge valve of the arc-like type having a plurality of principal electrodes connected between said source and load and having a control electrode, a voltage divider connected to said source and including elements effecting displacement of the phase of the current flowing therethrough relative to the source, a pair of resistors, said resistors and a portion of said divider being connected in series between said control electrode and one of said principal electrodes, a capacitor connected in parallel with one of said resistors, means including a rectifier for connecting said one resistor across a second portion of said divider to develop a potential across said one resistor tending to maintain said control electrode negative with respect to said one principal electrode, and means including a photoelectric device for connecting said other resistor across a third portion of said divider to develop a potential across said other resistor opposing the potential developed across said one resistor to an extent depending upon the conductivity of said photoelectric device.

8. In an electric control system, means adapted to function as a source of alternating current, a load device connected to said source, an electric discharge valve of the arc-like type having an anode and a cathode interposed between said source and load and having a control electrode, a voltage divider connected to said source and including elements effecting displacement of the phase of the current flowing therethrough relative to the source, said divider having four output terminals, the first of which is an end terminal which is negative when said anode is positive, said second, third and fourth terminals being successively less negative, means connecting said first terminal to said cathode, a pair of resistors, means connecting said resistors in series between said second terminal and said control electrode, a capacitor connected in parallel with the one of said resistors nearest said second terminal, a rectifier connected between said third terminal and the junction of said resistors, and a photoelectric device connected between said fourth terminal and the end of the other of said resistors nearest the control electrode.

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