

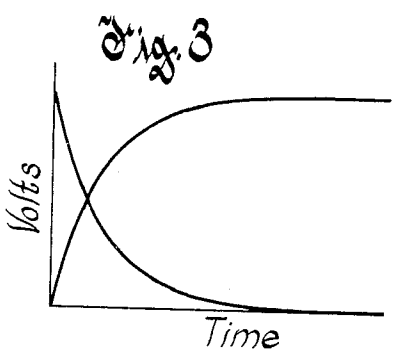
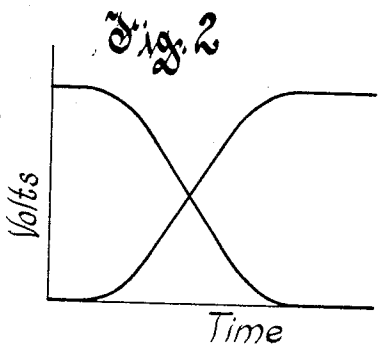
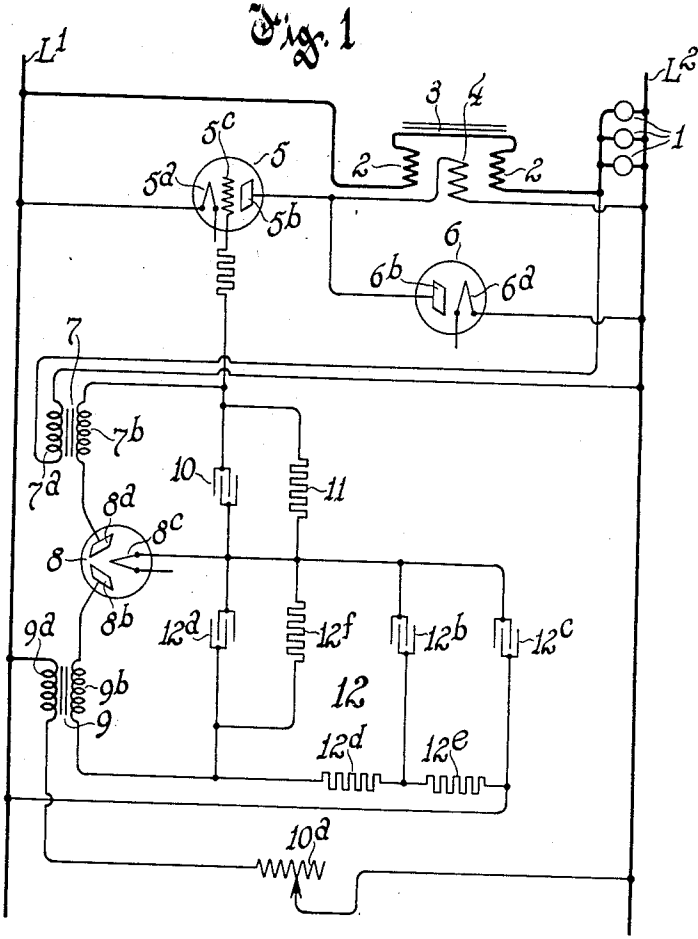
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ELECTRICAL CONTROL SYSTEM

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ELECTRICAL CONTROL SYSTEM

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This invention relates to control systems and more particularly to regulating systems, and has among its objects the provision of means for temporarily varying the relation between a variable standard of comparison forming part of a system which controls an operating condition of an electric circuit and the condition to be controlled.

In the regulation of an electrical translating device, it is often desirable to vary an operating condition thereof, so that the changes of its magnitude with time take place at a certain variable rate and a further object of this invention is to provide such a regulating system.

The control of the time-magnitude relation may be accomplished by means which cause the operating condition to vary directly in accordance with the variations of a standard of comparison and by so regulating the standard of comparison that its value varies in accordance with the desired time function and the provision of such a system is a more specific object of the present invention.

The introduction into controlled circuits of devices having inductance, capacity and hysteresis causes variations of the relations between the control standard and the condition to be regulated and it is a further object of the present invention to provide improved means to compensate for such variations.

Another object is to provide improved means for automatically varying the relation between a standard of voltage and another voltage regulated in accordance with variations of the former voltage, such relation varying as a function of time.

Another object is to provide means for varying the voltage of a light circuit by varying the control voltage of the circuit so as to obtain automatically the desired time-voltage relation of the lighting circuit.

Control circuits for lighting purposes are known in which a variable inductance is introduced into an alternating current circuit which includes the lamps to be regulated. The variable inductance is provided with a separate exciting winding and variations of the current in such winding produce variations in the voltage drop in the inductance and thus variations of the lamp voltage. It has been the custom to control the current of such exciting winding by means of an electron tube whose impedance may be varied by impressing upon a control grid of such tube a voltage which is the resultant of a standard and a variable voltage derived, respectively,

from energy storage discharge circuits and a third voltage of an additional energy storage discharge circuit which depends upon and varies in accordance with the lamp voltage. Hence at any moment the lamp voltage is made to correspond to the voltage derived from the standard voltage provided that the variations in the standard voltage are not too rapid. If the standard voltage is changed too rapidly, the lag in the response of the variable impedance to the variations of the standard voltage due to the inductance of the former, produces undesirable effects in the variation of the lighting effect.

Systems have been proposed heretofore in which the lamp voltage varies in accordance with the logarithmic time-voltage function of a simple condenser-resistor energy storage circuit. In this case the voltage change during the first part of the charging or discharging period is too rapid and thus produces upon the observer the impression of a very abrupt change in luminosity and a resulting undesirable psychological effect, whereas it is desirable that the rate of change of luminosity gradually increase from zero to a maximum rate and then decrease again gradually to zero.

According to the present invention one or the other energy storage discharge circuits consists of a net work of reactances and resistances whose instantaneous discharge voltage is a function of time differing from the logarithm relation of the simple condenser discharge voltage, the impedance of the circuit being so adjusted and correlated to the time constant of the controlled circuit that a time-voltage relation is obtained at the lamps which produces the desired psychological effect upon the observer.

The accompanying drawing illustrates a system embodying my invention, but it should be understood that the same is capable of many modifications and variations, all coming within the scope of the present disclosure and appended claims.

In the drawing,

Figure 1 illustrates a lighting circuit in which the intensity of the lights is varied by varying the voltage of another circuit which operates as a standard of comparison.

Fig. 2 shows the time-voltage relation which should obtain at the terminals of incandescent electric lamps to create a desired psychological effect upon the observer thereof, while

Fig. 3 shows the time-voltage relation obtaining at the terminals of a simple energy storage

circuit when charging or discharging under certain conditions.

Referring to Fig. 1, L^1 and L^2 are the terminals of an alternating current constant potential source of supply, 1 indicates a number of lamps, the voltage of which is to be regulated. These lamps are connected in series with the coils 2 of a variable reactor 3 and across the lines L^1 and L^2 . Said reactor 3 has also an energizing coil 4 which is connected in series with the electron tube 5 across the lines L^1 and L^2 . Electron tube 5 has a cathode 5^a which may be heated in any well known manner, an anode 5^b and a control electrode 5^c . Connected in parallel with the winding 4 is a second electron tube 6 having a heated cathode 6^a and an anode 6^b . The purpose of this second tube is to smooth out in a well known manner the ripples of the current in the coil 4 as supplied through the electron tube 5. A transformer 7 has a primary winding 7^a connected in parallel with the lamps 1, while one terminal of its secondary winding 7^b is connected to the control grid 5^c and the other terminal to an anode 8^a of a double anode electron tube 8. The tube 8 has a second anode 8^b and a heated cathode 8^c . A second transformer 9 has its primary winding 9^a connected in series with an adjustable control resistor 10^a across the lines L^1 and L^2 , while one terminal of its secondary winding 9^b is connected to the anode 8^b .

Connected between the cathode 8^c and the anode 8^a and in series with the winding 7^b is an energy storage circuit consisting of a condenser 10 and a parallel resistor 11. A second energy storage discharge circuit 12 is connected in series with the winding 9^b between the anode 8^b and the cathode 8^c . This second energy storage discharge circuit consists of a network comprising condensers 12^a , 12^b , and 12^c which are connected in cascade through resistors 12^d and 12^e in a well known manner, while a third resistor 12^f is connected across the terminals of the condenser 12^a . The number of parallel condensers 12^b and 12^c may be selected to suit the conditions of the circuit, it being understood that for every parallel condenser a resistor corresponding to the resistors 12^d and 12^e has to be added to the chain.

I have found that to obtain the most desirable and pleasing lighting effect upon changing the voltage impressed upon incandescent lamps for theatre lighting, a relation should obtain as indicated by the curves shown in Fig. 2 for increasing and decreasing voltage, respectively. However, if a simple energy storage discharge circuit is employed as a standard of comparison for the lamp voltage and the latter responds directly in accordance with the characteristic of the energy storage circuit, a time-voltage relation as illustrated in Fig. 3 is obtained, since the charge and discharge voltage of a condenser varies logarithmically and the present system is designed to change the time-voltage characteristic of the energy discharge circuit 12 so that upon sudden change of the adjustment of the regulating resistor 10^a time-voltage curves are obtained on the lamps which are similar to the curves shown in Fig. 2.

The system operates in the following manner: Current flows between the lines L^1 and L^2 through the coils 2 and lamps 1. The voltage drop through the coils 2 varies in accordance with the energization of the coil 4 in a well known manner. The current in the coil 4 is

controlled by controlling the instantaneous voltage of the grid 5^c during the positive half cycle, during which the tube 5 permits current flow therethrough, provided that the voltage of the grid 5^c is more positive than the critical grid voltage. It will be noted that the voltage of the grid 5^c with respect to the cathode 5^a at any moment is the resultant of the instantaneous voltage of the condenser 10 and of the energy storage discharge circuit 12,—the two being in series. The condenser 10 is charged by a voltage impressed upon it by the secondary winding 7^b of the transformer 7 through the electron tube 8, said voltage being proportional to the lamp voltage. The rate of discharge of the condenser 10 is determined by the value of the resistance 11. By proper adjustment of the resistance 11 and the condenser 10 the voltage component of the latter will attain a certain desired value at a given moment during the positive half cycle.

A voltage is impressed upon the energy storage circuit 12 through the secondary winding 9^b of the transformer 9, this voltage being a function of the adjustment of the regulating resistor 10^a . The rate of voltage change of this circuit is determined by the design of its condensers and resistors and, as stated above, this rate of change is adjusted in such a manner that the time voltage relation is as indicated in Fig. 2.

In normal operation the resistor 10^a is set to the desired point corresponding to a given value of the lamp voltage. This causes a difference between the voltage of the energy discharge circuit 12 and the voltage of the condenser 10, the voltage of the latter corresponding at the first moment of change to the initial voltage of the lamps. Thus the resultant voltage from the two circuits which is impressed upon the grid 5^c is varied, causing a change in the current of the coil 4 and thus a change in the voltage supplied to the lamps. As the lamp voltage approaches the newly selected value, the voltage impressed on the condenser 10 varies due to the influence of the transformer 7 until when the desired lamp voltage is attained the voltage of the two circuits aforescribed balance again to a value at which no further change takes place in the current flowing through the tube 5 and the winding 4.

If the resistor 10^a should be suddenly adjusted from one extreme value to the other, the lamp voltage has a tendency to vary as quickly as the voltage of the energy storage circuit 12 and if this circuit consisted only of the condenser 12^b and the resistance 12^f , that is, if it was a simple energy storage discharge circuit, its time-voltage relation would be as illustrated in Fig. 3 and the lamp voltage would therefore vary in accordance therewith. By modifying the circuit 12 through modification of the value and character of the reactances and resistances the time-voltage relation is changed so as to conform to the curves in Fig. 2, thus resulting in a lamp regulation which automatically produces the desired result of a lamp voltage change from a given starting value to the final desired value.

It is to be understood of course that the scale of Fig. 2 varies and that the two extreme values of the voltage curves depend upon the initial and the final adjustment of the regulating means. Thus the effective voltage of the lamps is varied from a given value to a desired value

in such a manner that the rate of change of such variation is substantially zero at the beginning of the period of change, then gradually increases and finally decreases again gradually to zero, this variation in rate of change being desirable to produce the proper psychological effect upon the observer of the lights as explained heretofore. Without the specific arrangement described the initial rate of change of the voltage of the lamps would be a maximum and this abrupt effect upon the observer would produce an unpleasant sensation.

It is obvious that the system may also be used for other regulating purposes. Thus the coil 4 may be replaced by any type of translating circuit such as lamps or a winding of a dynamo electric machine. In this case it would, of course, be necessary to modify the voltage impressed upon the primary 7' of the transformer 7 in accordance with the voltage of such circuit. In all other respects the system would operate as aforesaid.

What I claim as new and desire to secure by Letters Patent is:

1. In an electrical control system the combination of an electric valve having an element for controlling its conductivity in accordance with a voltage impressed on said element, means for impressing different selected voltages upon said element and means having an inherent time function for effecting changes of said voltage at a varying rate whose initial value is substantially zero.

2. In an electrical control system the combination of an electric valve having an element for controlling its conductivity in accordance with a voltage impressed on said element, means for impressing different selected voltages upon said element and means having an inherent time function for effecting changes of said voltage at a varying rate whose initial and final values are substantially zero.

3. In an electrical system the combination of an electric valve having an element for controlling its conductivity in accordance with the voltage impressed on said element, a circuit having an operating condition which varies in accordance with the conductivity of said valve, means to impress different selected voltages upon said element and means having an inherent time function for effecting changes of said voltage at a varying rate whose initial and final values are substantially zero.

4. In an electrical system the combination of an electric valve having an element for controlling its conductivity in accordance with the voltage impressed on said element, a circuit having reactance and having an operating condition which varies in accordance with the conductivity of said valve, means to impress different selected voltages upon said element and means having an inherent time function for effecting changes of said voltage to provide for changes of said operating condition at a varying rate whose initial and final values are substantially zero.

5. In an electrical control system the combination of an electric valve having a control element for controlling its conductivity in accordance with the voltage impressed on said element, a translating device connected to said valve, and a circuit connected to said control element, said circuit including means to impress different selected voltages upon said element and energy storage means and means hav-

ing an inherent time function for controlling the voltage changes at a varying rate whose initial and final values are substantially zero.

6. In an electrical control system the combination of a power supply, an electrical valve having a grid, a translating device connected to said supply and said valve and responding to the conductivity of the latter and a circuit connected to said grid, said circuit including means to impress different selected voltages upon said grid, an energy storage circuit and means having an inherent time function for controlling the voltage changes at a varying rate whose initial and final values are substantially zero.

7. In an electrical control system the combination of a power supply, an electric valve having a grid, a translating device connected to said supply and said valve and responding to the conductivity of the latter, means to impress different selected voltages upon said grid, an energy storage element connected to said grid and consisting of a resistor and a plurality of condensers having one of their respective terminals connected together and the other of their respective terminals connected to different taps of said resistor and means to charge and discharge said element.

8. In an electrical control system the combination of an electric valve, an energy storage element, means for controlling the energy stored in said element, means for changing the conductivity of said valve including means to impress different selected voltages upon said grid, a second energy storage element responsive to the energy stored in said first mentioned storage element having an inherent time function and adapted to control the conductivity of said valve to vary it between given values at a varying rate which rate starts at substantially zero, then gradually increases to a maximum and thereafter decreases again to zero, and a circuit including means to vary the operating conditions thereof continuously in accordance with the conductivity of said valve.

9. The combination of an electric valve having an element for controlling its conductivity in accordance with the voltage impressed on said element, a lamp circuit whose voltage varies in accordance with the conductivity of said valve, means to impress different selected voltages upon said element and means having an inherent time function for effecting changes of said voltage at a varying rate whose initial and final values are substantially zero.

10. The combination of an electric valve having a control element for controlling its conductivity in accordance with the voltage impressed on said element, a lamp circuit connected to said valve and a circuit connected to said control element, said latter circuit including energy storage means having an inherent time function and means for effecting voltage changes of said storage means at a varying rate whose initial and final values are substantially zero.

11. The combination of a power supply, an electric valve having a grid, a lamp circuit connected to said supply and said valve and responsive to the conductivity of the latter, an energy storage circuit connected to said grid having an inherent time function and adapted to vary the voltage impressed by the former upon the latter at a varying rate whose initial and final values are substantially zero and means to control the

initial and final values of the voltage impressed upon said grid.

12. The combination of a power supply, an electric valve having a grid, a lamp circuit connected to said supply and said valve and responding to the conductivity of the latter, an energy storage element connected to said grid and consisting of a resistor and a plurality of condensers having one of their respective terminals connected together and the other of their respective terminals connected to different taps of said resistor and means to charge and discharge said element.

13. The combination of an electric valve, an energy storage element, means for controlling the energy stored in said element, means for changing the conductivity of said valve including a second energy storage element responsive to the energy stored in said first mentioned storage element having an inherent time function and adapted to control the conductivity of said valve to vary between given values at a gradually varying rate which is initially substantially zero, then increases to a maximum rate and thereafter decreases again to zero, and a lamp circuit including means to vary its operating conditions continuously in accordance with the conductivity of said valve.

14. The combination of an electric valve, an energy storage element, means for controlling the energy stored in said element, means for

changing the conductivity of said valve including a second energy storage element responsive to the energy stored in said first mentioned storage element having an inherent time function and adapted to control the conductivity of said valve to vary between given values at a gradually varying rate which is initially substantially zero, then increases to a maximum rate and thereafter decreases again to zero, a lamp circuit, including means to vary its operating conditions continuously in accordance with the conductivity of said valve, and a circuit connected to said lamp circuit and said second mentioned means to effect the latter in accordance with the voltage of said lamp circuit.

15. A method for controlling an operating condition of a circuit between given values through the medium of an electric valve having a grid for controlling its conductivity and a circuit having an operating condition varying in accordance with the conductivity of said valve, which method consists in impressing a voltage on said grid corresponding to one of said given values and thereafter gradually varying said voltage at a varying rate to a value corresponding to another of said given values, said rate starting at substantially zero then gradually increasing to a maximum and thereafter decreasing again to substantially zero.

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