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W. A. LEWIN ET AL

THYRATRON EQUIPMENT

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Fig. 1.

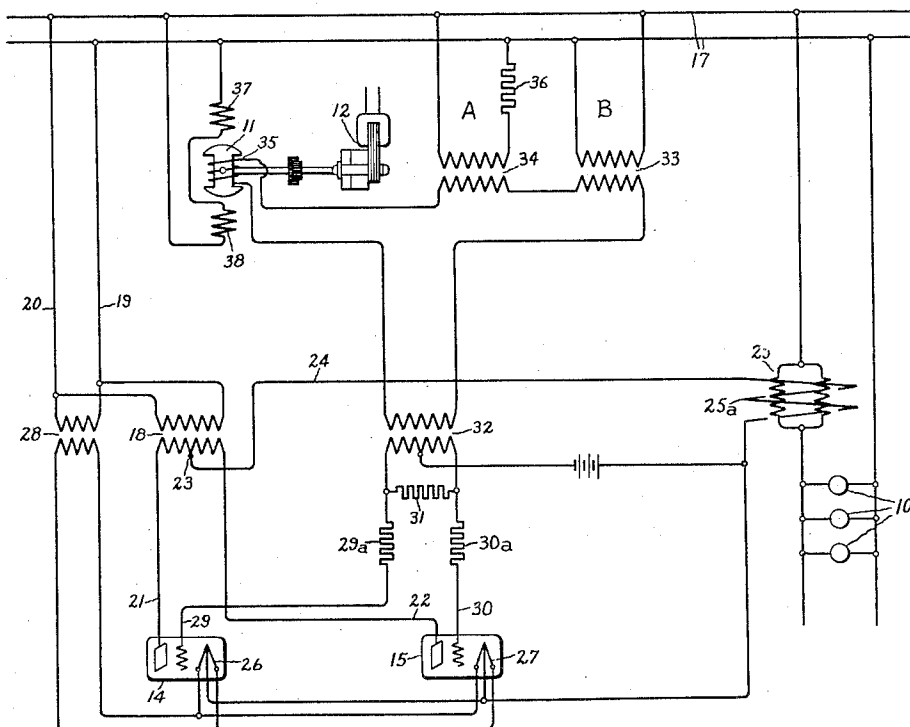
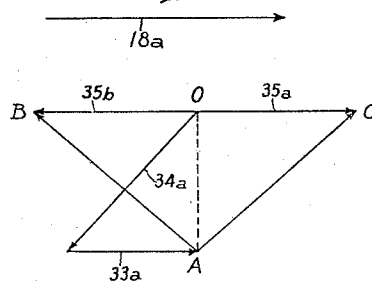


Fig. 2.



Inventors:
William A. Lewin,
Tracy E. Johntz,
by *Charles E. Tuller*
Their Attorney.

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THYRATRON EQUIPMENT

William A. Lewin and Tracy E. Johnitz, Chicago, Ill., assignors to General Electric Company, a corporation of New York

Application January 30, 1932, Serial No. 589,960

6 Claims. (Cl. 172-281)

Our invention relates to control systems for electric circuits and more particularly to control systems in which electric discharge devices are utilized, and has for an object the provision of a simple, inexpensive and reliable means giving great flexibility of control.

Our invention is particularly useful for the control of electric circuits containing incandescent lamps, although it has application to circuits containing various other types of devices. In using incandescent lamps for decorative lighting installation such as for show windows, flood lighting, electric signs, etc., mobile color lighting is often used to advantage.

In accordance with our system of control a particular group of decorative lights can be alternately dimmed and brightened in a predetermined cycle. The shape of the lighting or dimming wave can be readily varied so that the maximum brilliance of the lights will occur over a greater portion of the wave, or the lights may be more or less completely dimmed over the greater portion of the cycle and are fully brilliant during only a relatively short interval.

In carrying out our invention in one form thereof, we utilize electric discharge devices or valves of the vapor type for rectifying an alternating current for the control circuit. We control the discharge devices by varying the phase relation between the alternating input or grid voltage with respect to an alternating output or anode voltage by applying to the input circuit the vector sum of three alternating current voltages having a predetermined phase relation with respect to each other, one of these voltages being variable in magnitude between predetermined positive and negative limits, so as to vary the phase displacement of the input voltage. Two components of the input voltage are obtained by the use of the standard transformers, one of which has a section of resistance connected in series with its primary, while the third component of input voltage is obtained from an induction regulator.

For a more complete understanding of our invention reference should be had to the accompanying drawing, Fig. 1 of which is a diagrammatic representation of a system of control for a group of lamps embodying our invention; Fig. 2 is a diagrammatic view showing the vector relation of the various input and output voltages involved.

Referring to Fig. 1 of the drawing, we have shown our invention in one form as applied to the control of a plurality of lamps 10, the degree

of brilliance of each of which is varied in accordance with a predetermined time cycle as determined by the speed of rotation of an inductive voltage regulator device 11. This device is driven by a substantially constant speed electric motor 12, preferably of the type described and claimed in U. S. Patent No. 1,546,269 to H. B. Warren, dated July 14, 1925. More specifically, the lamp circuit is controlled by a pair of three element electric discharge devices or valves of the vapor type, these devices acting as rectifiers. As is well known in the art, the sealed envelope of the discharge device of this type contains a small amount of an inert gas such as mercury vapor, and the time at which current starts to flow through the device is controlled by the voltage applied to its grid. The discharge devices 14 and 15 are connected to rectify both halves of the alternating-current wave supplied to their output circuit from a suitable alternating-current source of supply 17. The output or anode circuits of the discharge devices 14 and 15 are supplied with alternating current from the source 17 through a suitable transformer 18, the primary of which is connected by conductors 19 and 20 to the alternating source of supply 17, while its secondary is connected to the anodes 21 and 22 of the respective discharge devices 14 and 15. A central point 23 of the secondary of transformer 18 is connected by conductor 24 through a winding 25a of a saturable core reactor 25 to the cathodes 26 and 27 of the discharge devices. The cathodes are also connected to a suitable heating current transformer 28. It will be understood by those skilled in the art that the output circuit through the reactor 25 is completed through the cathodes and anodes of the discharge devices alternately when they are in operation so as to rectify a predetermined portion of both halves of the cycle as determined by the control of the grids 29 and 30 of the discharge devices.

The voltage applied to the grids 29 and 30 of the respective discharge devices is obtained through a grid transformer 32, the secondary of which is connected through the resistances 29a and 30a to the respective control grids 29 and 30 of the discharge devices 14 and 15. The resistances 29a and 30a serve to limit the grid current of the discharge devices while a resistance 31 connected in shunt with the secondary of the transformer 32 serves to control the magnitude of the voltage applied to the respective grids 29 and 30. The primary of the trans-

former 32 is connected in series with the secondary of the transformer 33, the secondary of the transformer 34 and the rotor winding 35 of the induction regulator 11. The primary of the transformer 33 is directly connected to the supply line 17 while the primary of transformer 34 is connected to the supply line 17 through a variable resistance 36. The stator coils 37 and 38 of the inductance device 11 are also directly connected to the supply line 17. It will be observed that a voltage is induced in the rotor winding 35 of the induction regulator 11, by reason of its inductive relation with the windings 37 and 38, which voltage varies in magnitude from a maximum value in one direction to a maximum value in the opposite direction, as the rotor 35 is rotated through 180 degrees. This voltage when added to or subtracted from the voltages introduced into the circuit by the secondary transformers 33 and 34 gives a resultant voltage across the grid transformer 32, the phase relation of which is dependent upon the angular position of the rotor winding 35 with respect to its stator winding. In other words, with the winding 35 in the position shown, a maximum voltage is introduced in one direction in the winding 35. If the rotor 35 is moved through 90 degrees, the minimum voltage is induced which is substantially zero, while a displacement of 180 degrees from the position shown induces a maximum voltage in the opposite direction.

Referring to Fig. 2 the manner in which the transformers 33 and 34, and the inductive device 11 controls the voltage impressed on the grid transformer 32 may be easily understood. For a reference vector, the anode voltage has been selected and this voltage is represented by the vector 18a. The vector 35a represents the maximum voltage induced in the winding 35 when occupying the position shown in Fig. 1 while the vector 35b represents the maximum voltage induced in the winding 35 when it is displaced 180 degrees with respect to the position shown. The reason for introducing the variable resistance 36 in the primary winding of the transformer 34 is to cause a displacement of the voltage induced in the secondary of this transformer with respect to the voltage induced in the transformer 33. The vector 34a, therefore, represents the voltage produced by the secondary winding of the transformer 34 for a given value of resistance 36. The voltage induced in the secondary winding of transformer 33 will have the same phase relation as the voltage produced in the winding 35 and its magnitude is selected so that when it is added to the component of voltage produced by the secondary winding of the transformer 34 the resultant voltage OA is displaced 90 degrees with respect to the voltage vectors 35a and 35b. The direction and magnitude of this voltage is represented by the vector 33a. If the rotor winding 35 of the inductance device 11 is now rotated through 180 degrees it will be observed that the phase relation of the voltage applied to the grid transformer 32 varies with respect to the anode voltage through the angle identified by the broken line BAC. It is by reason of this variation in the phase relation between the grid voltage and anode voltage that the discharge devices 14 and 15 are rendered conductive over varying portions of each half cycle.

It will also be seen that the rate of change of the phase relation in one direction from the

vector OA is exactly equal to the rate of change in the other direction. Therefore, there is a gradual rise and fall of the brilliancy of the lamps, or in other words, a uniform wave of control voltage is obtained for each revolution of the induction regulator 11.

While we have described what we at present consider the preferred embodiment of our invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from our invention, and we, therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States, is:

1. The combination in a system of control of an electric discharge device provided with input and output circuits, means for applying a single phase alternating-current voltage to said output circuit, means including a transformer and a resistance connected in the circuit of said transformer for producing a voltage having a predetermined phase relation with respect to said output voltage, a second transformer arranged to produce a voltage of a predetermined magnitude substantially in phase with said output voltage, movably mounted means inductively associated with a stator winding arranged to produce a voltage varying with the position of said movably mounted means with respect to said stator winding and means for applying the resultant of said voltages to the input circuit of said discharge device.

2. In combination in a system of control, an electric discharge device provided with input and output circuits, means for applying single phase alternating voltage to said output circuit, means including a transformer with a resistance connected in the primary circuit of said transformer for producing a voltage having a predetermined phase relation with respect to said output voltage, a second transformer arranged to produce a voltage of such magnitude that when added to the voltage of said first transformer the resultant voltage is substantially ninety degrees out of phase with said output voltage, means for producing a third voltage in phase with said output voltage but varying in magnitude first in one direction and then in the other direction, and means for applying the resultant of said voltages to said input circuit of said discharge device so as to control the current flow in said output circuit.

3. In combination a single phase alternating supply circuit, a direct-current load circuit and means for transmitting energy from said supply circuit to said load circuit including a pair of electric valves each provided with an anode, a cathode, and a control grid, a pair of transformers, a resistor, a primary winding of one of said transformers being connected across said supply circuit through said resistor, the primary of said other transformer being connected directly to said supply circuit, an induction regulator having a secondary winding, and a primary winding connected across said supply circuit, and grid circuits for each of said valves excited by the vector sum of the voltages derived from said transformer secondary windings and a voltage derived from said secondary winding of said induction regulator, the phase relation between said grid and output voltages determining the current flow in said output circuit.

4. In combination, a single phase alternating current supply circuit, a direct current load circuit and means for transmitting energy from said supply circuit to said load circuit including
 5 an electric valve provided with an anode, a cathode and a control grid, a pair of transformers, a resistor, connections for connecting the primary winding of one of said transformers across said supply circuit and in series with said resistor,
 10 connections for connecting the primary winding of said other transformer directly to said supply circuit, an induction regulator having a rotor winding and a stator winding connected across said supply circuit, transformer
 15 means for applying to the grid circuit of said valve the vector sum of the voltages derived from said transformer secondary winding and the voltage derived from said induction regulator rotor winding, and means for continuously
 20 rotating said rotor winding to produce a repetition of a control cycle.

5. A control system for electric discharge devices provided with input and output circuits comprising single phase alternating current
 25 supply lines, means for energizing said output circuit from said supply lines, means for producing a dephased voltage for said input circuit comprising a pair of transformers the primaries of which are connected to said supply lines, a
 30 resistance connected in circuit with one of said primary windings, connections for connecting the secondary windings of said transformers in series circuit relation, means for varying the magnitude of the voltage of said transformer
 35 secondary circuit, and means for applying the voltage of said transformer secondary circuit to the input circuit of said electron discharge devices.

6. In combination, a single phase alternating current supply circuit, a direct current load circuit, and means for transmitting energy from said supply circuit to said load circuit comprising an electric valve provided with a cathode,
 80 an anode output circuit including said direct current load circuit and a grid control circuit, a pair of transformers provided with primary and secondary windings, a voltage dephasing resistor,
 85 means connecting the primary winding of one transformer directly to said supply circuit, means connecting said other transformer primary winding in series with said resistor and to said supply circuit for dephasing the voltage
 90 produced by the secondary winding of said transformer, an induction device responsive to the energization of said supply circuit for producing a voltage in phase with said supply circuit out of variable magnitude, transformer
 95 means for applying to said grid circuit the vector sum of the voltages derived from the said secondary windings and said induction device, means for applying to said anode circuit the
 100 voltage of said supply circuit, the phase relationship between said anode load circuit and said grid control circuit controlling the operation of said valve and the current flow in said direct current load circuit, and means for operating said induction device to vary the magnitude and polarity of its voltage with respect to
 105 said transformer secondary voltages so as to control the magnitude of the current flow in said direct current circuit between predetermined values.

WILLIAM A. LEWIN. 110
 TRACY E. JOHNTZ.

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