July 16, 1935. M. M. MORACK 2,008,512

CONTROL SYSTEM

Filed March 22, 1934

Fig. 1.

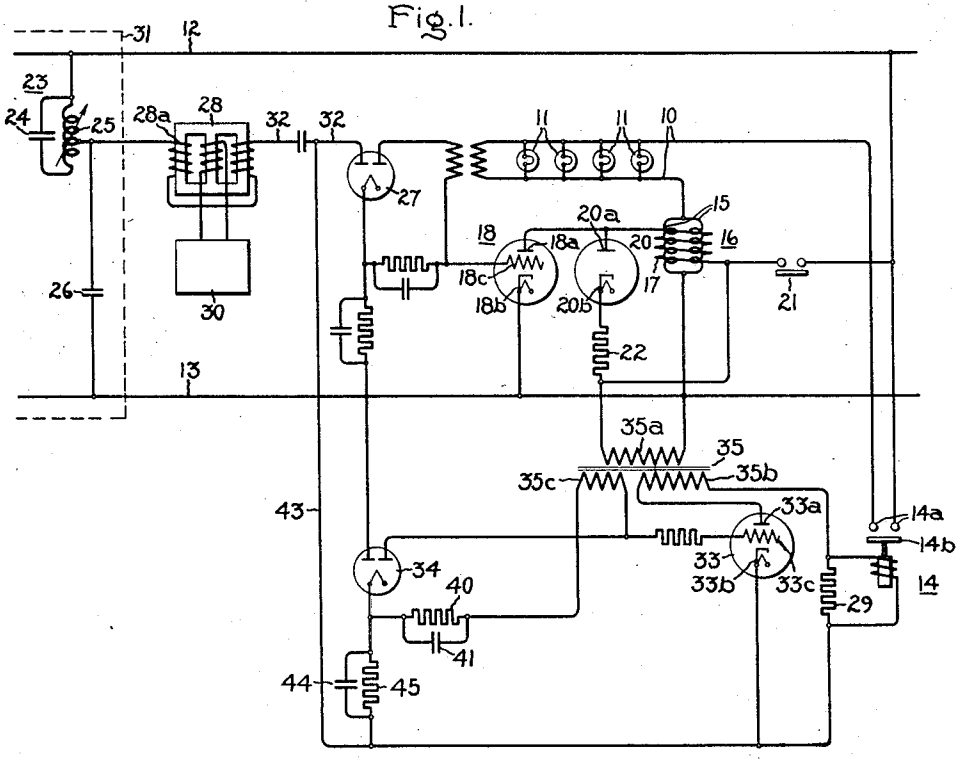


Fig. 2.

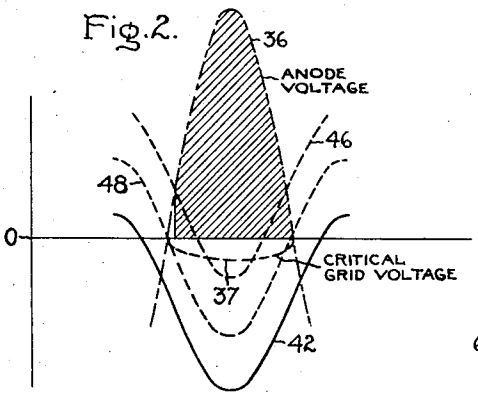
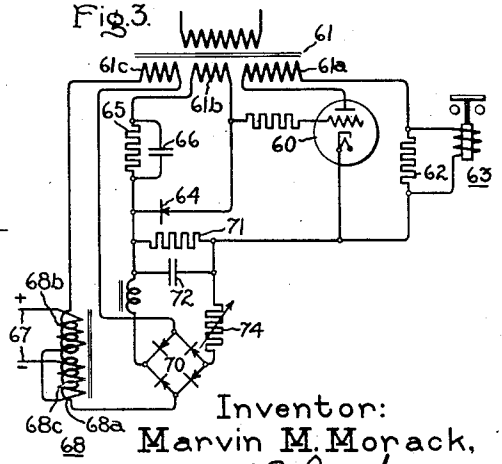


Fig. 3.



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His Attorney.

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UNITED STATES PATENT OFFICE

2,008,512

CONTROL SYSTEM

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Application March 22, 1934, Serial No. 716,817

8 Claims. (Cl. 175—320)

This invention relates to control systems, more particularly to systems for controlling the operation of electroresponsive devices and the like, and it has for an object the provision of a simple, reliable and improved system of this character.

More specifically this invention relates to control systems in which a variable controlling voltage or current is utilized to control a remotely located electroresponsive device, such for example as a relay or contactor, and it has for a further object the provision of means for causing the device to operate in one manner at a certain value of control voltage, and to operate in another manner at a substantially similar but slightly different value of control voltage; e. g. to cause a relay or contactor to "pick up" and "drop out" at substantially the same value of control voltage.

In one aspect this invention relates to illumination control systems and the like. For example, in certain modern theatre dimming systems, the dimming apparatus comprising electric valves and saturable reactors are located behind or beneath the stage, and the dimming controllers are remotely located on a panel or control desk in the auditorium from which the operator has a view of the performance. Electrical connections are of course provided between the controllers and the dimming apparatus. These systems usually incorporate "black-out" contactors for disconnecting a bank of lamps and its associated saturable reactor from the power supply when a rapid darkening or black-out is desired. These black-out contactors are located near the dimming apparatus. The provision of additional control connections between these black-out contactors and the control desk, which are undesirable because of circuit complications and added expense, are averted by utilizing an electrical characteristic, e. g. the varying voltage or current of the control desk connections or of the dimming apparatus for actuating the contactor. This necessitates a contactor which will pick up and drop out at substantially the same value of the controlling characteristic. Otherwise there would be a range of the controlling characteristic over which the contactor might be either open or closed depending on the previous operation. Accordingly a further and more specific object of this invention is the provision of a remote control system in which means are provided for causing a contactor to pick up and drop out at substantially the same value of an electrical characteristic of a controlled device or existing connections between a controlling and a controlled device.

A further object of the invention is the provision of means for causing a large contactor to pick up and drop out at substantially the same value of the controlling characteristics in systems in which the control power is very limited.

In carrying the invention into effect in one form thereof, an electroresponsive device is connected in the output circuit of an electric valve, which is capable, when fully conducting, of passing sufficient current to operate the electroresponsive device. A bias voltage is applied to the control grid of the valve and means are provided for applying an alternating voltage to the output circuit and an alternating voltage of reverse phase is applied to the grid so that at a critical value of bias voltage the valve is either fully conducting and the electro-responsive device operated or the valve is non-conducting and the device is not operated. A variable control voltage is utilized to vary the bias through a range including this critical value.

In illustrating the invention in one form thereof, it is shown as embodied in a remote control theatre dimming system for controlling the black-out contactor.

For a better and more complete understanding of the invention reference should be had to the following specification and to the accompanying drawing in which Fig. 1 is a simple diagrammatical illustration of an embodiment of the invention, Fig. 2 is a chart of operating characteristics of a portion of the circuit, which facilitates an understanding of the invention, and Fig. 3 is a modification.

Referring now to the drawing, a translating circuit, such for example as the circuit 10 across which is connected a plurality of load devices illustrated as a bank of lamps 11 is supplied with power from a suitable source of alternating voltage represented in the drawing by the two supply lines 12, 13. The circuit 10 is connected to the conductor 12 through the contacts 14*a* of the black-out contactor 14 when the latter is energized and the contacts 14*a* are bridged by the movable contact member 14*b*. The other side of the lamp circuit 10 is connected through the alternating current winding 15 of a saturable reactor 16 to the lower side 13 of the supply source. As shown, the saturable reactor is provided with a direct current saturating winding 17 to which direct current of variable magnitude is supplied by suitable means illustrated as an electric valve 18. Although this valve may be of any suitable

type it is preferably of the three-electrode type into the envelope of which a small quatity of an ionizable medium such for example as mercury vapor is introduced after exhaust. The presence of this ionizable medium within the tube serves to convert the usual electronic discharge into an arc stream thus constituting the tube an electrostatically or grid controlled arc-rectifier. The anode 18a is connected through the direct current winding 17 of the reactor to the upper supply line 12 by means of a switching device 21 when the stationary contacts of the latter are bridged by the movable contacts.

The cathode 18b is connected to the lower supply line 13, as shown. As thus connected, the valve 18 rectifies alternate halves of the alternating voltage, e. g. it rectifies the positive half cycles and this rectified voltage is supplied to the direct current winding 17 of the reactor. Current flow is sustained in the reactor winding during the inverse half cycles by means of a two electrode valve 20, the anode 20a of which is connected to one terminal of the winding 17 and the cathode 20b of which is connected to the opposite terminal through a current limiting resistance 22.

By varying the magnitude of the current flowing in the control winding 17, the reactance of the reactor and the reactive drop across the alternating current winding 15 thereof are varied in proportion. This of course results in varying the voltage drop across the lamp bank 11 and hence the intensity of illumination of the lamp. In order to vary the current in the direct current winding of the reactor, it is necessary to vary the voltage of the grid 18c of the electric valve. This is accomplished by means of a variable voltage device 23 illustrated as an inductance capacitance potentiometer comprising a condenser 24 and a variable inductance 25 connected in parallel relationship with each other and in series relationship with a condenser 26 to the supply source 12, 13. The grid 18c of the electric valve 18 is connected through a rectifying device 27 and the alternating current winding of a scene fading saturable reactor 28 to an intermediate point of the variable inductance 25. Since the rectifying device 27 is included in the grid connections, the voltage supplied to the grid 18c is partially rectified. The magnitude of this voltage may be varied as desired by varying the inductance 25. Thus, by varying the inductance 25, the grid voltage and anode current of the valve 18 are varied, which as previously pointed out results in varying the intensity of illumination of the lamp bank 11.

In certain installations a plurality of control devices similar to the device 23 are utilized for presetting a number of lighting scenes. In such installations, a "scene fader" 30 controlling the fader reactor 28 is utilized for fading or merging the present scene into the next succeeding scene. Since the details of the scene fader 30 do not constitute any part of the present invention it is merely illustrated conventionally in the drawing.

An illumination control system similar to the foregoing is fully disclosed and claimed in U. S. Patent 1,904,485, Livingston. The present invention may however be applied to other forms of illumination control systems. When a rapid darkening or black-out of the lamp 11 is desired, the black-out contactor 14 is utilized to disconnect the lamp 11 and the saturable reactor 16 from the supply source 12, 13. In certain installations, the dimming apparatus, such for example as the saturable reactors, electric valves and fading reactors illustrated in the drawing on the right hand side of the dotted line 31 is located in some convenient place behind the stage or beneath it, whereas the control devices 23 shown at the left-hand side of the dotted line 31 are usually arranged on a control panel or desk in the auditorium. With the arrangement shown in the drawing only a single conductor 32 is required between each control device 23 and its associated dimming apparatus. If independent control of the black-out contactors 14 were provided this would require an additional conductor from each black-out contactor to the control panel. This is undesirable because of the added cost and complication of circuits. If dependent control of the black-out contactors is provided it must not interfere with the normal control of dimming apparatus by the control device 23. To meet these requirements the operation of the black-out contactors 14 is controlled in accordance with the magnitude of the voltage existing in the grid control connections 32 at a point physically near the dimming apparatus and remote from the control devices 23. In order to insure the necessary non-interference with the regular dimming operation, the control of the black-out contactors is so arranged that it does not become effective until near a limit of the range of the variable control voltage by means of which the regular dimming operation is accomplished. Obviously, the contactor 14 should pick up and drop out at substantially the same value of control voltage or otherwise there would be a range of control voltages within which the contactor 14 might either be open or closed depending upon the previous operation. If this were the case the control would be erratic, uncertain and unsatisfactory. It is, therefore, a requirement that the black-out contactors 14 shall pick up and drop out at substantially the same critical value of the control voltage.

Since direct current contactors are less noisy than alternating current contactors, the former are greatly preferred in theatres and similar installations. The contactor 14, therefore, is a direct current contactor. Since the control voltage is alternating, means are provided for translating the effect of this alternating control voltage to the operating coil of the black-out contactor. As shown, direct current is supplied to the operating coil of the black-out contactor by means of an electric valve 33 which is of the three-electrode type into the envelope of which a small quantity of an ionizable medium such for example as mercury vapor or other inert gas is introduced after exhaust. The presence of this ionizable medium serves to convert the usual electronic discharge into an arc stream thereby constituting the valve an electrostatically or grid controlled arc rectifier. The valve is provided with an output circuit which includes the anode 33a, a resistance 29 with which the operating coil of the black-out contactor 14 is connected in parallel, and the cathode 33b. The grid 33c of valve 33 is connected to the control conductor 32 through suitable rectifying means illustrated as a two electrode rectifying valve 34.

Alternating voltage is supplied to the output circuit of the valve 33 by means of a supply transformer 35, the primary winding 35a of which is connected to the supply source 12, 13, through the switching device 21 and the terminals of the secondary windings 35b of which are connected

to the output circuit of the valve as illustrated. This voltage is represented in the chart of Fig. 2 by means of the sinusoidal curve **36**. In this chart the critical grid voltage of the valve **33** is represented by the curve **37**. This critical grid voltage curve is a succession of the instantaneous values of grid voltage which if exceeded in a positive direction will initiate a discharge in the anode and cathode. In other words, if at any instant during the positive half cycle of anode voltage the grid becomes more positive than the critical grid voltage for that instant, the valve will fire and remain conducting through the remaining positive half cycle of anode voltage. It will thus be seen that by applying an alternating voltage to the grid and varying its phase relationship with respect to the anode voltage the instant at which the valve becomes conducting during each positive half cycle can be controlled and the average value of the current flowing in the output circuit can be similarly controlled and varied as desired.

In the present case, however, variation of the output current is undesirable because the contactor **14** does not have substantially identical pick-up and drop-out characteristics. This is averted by arranging the connections such that the valve is either fully conducting or non-conducting at a critical value of control voltage. Thus, when the valve is fully conducting the black-out contactor **14** is operated, and when the valve is non-conducting the black-out contactor **14** is entirely deenergized. To accomplish this an alternating voltage of substantially reverse phase with respect to the anode voltage is supplied to the grid **33***c* of the valve by means of the secondary bias winding **35***c*, which is energized from the primary winding **35***a*. The right hand terminal of the secondary winding **35***c* is connected both to the grid **33***c* of the valve **33** and to the right hand anode of the rectifying device **34**, whilst its opposite terminal is connected through a filter comprising a resistance **40** and a parallel condenser **41** to the cathode of the valve **34**. The rectifying valve **34** furnishes negative half waves of voltage which are partially smoothed out by the filter **40**, **41** and the secondary winding **35***c* supplies an alternating voltage to the grid. If the instantaneous value of this alternating voltage and the partially rectified voltage are added, the resultant voltage wave will have a form similar to that represented by the curve **42**. It will thus be seen that this grid voltage represented by the curve **42** may be considered as consisting of an alternating voltage superimposed upon a negative D. C. bias voltage. Thus, as shown, the grid voltage **42** is always more negative than the critical grid voltage **37** during the positive half cycle of anode voltage. Consequently, there is no point during the positive half cycle of anode voltage at which the valve **33** will fire and thus it remains non-conducting as long as this condition of grid voltage obtains.

However, as previously pointed out, the grid of valve **33** is connected through the rectifying valve **34** and conductor **43** to the control conductor **32**. The connections are so chosen that positive half cycles of the alternating voltage of the control conductor **32** are rectified by the rectifying valve and this rectified voltage is smoothed by the filter shown as comprising the condenser **44** and parallel connected resistance **45**. When the instantaneous values of this rectified voltage are added to the instantaneous values of the grid voltage **42**, the net effect is to make the grid voltage more positive. As shown, diagrammatically, the net effect is to displace the grid voltage curve **42** upwardly. If the magnitude of the control voltage is sufficiently high, the grid voltage curve **42** will be displaced to a position indicated by the curve **46**. It will be noted that during the positive half cycle of anode voltage, the grid voltage represented by curve **46** is always more positive than the critical grid voltage and consequently the valve **33** conducts during the entire positive half cycle of anode voltage. This means that the valve **33** is conducting the maximum amount of current and the black-out contactor **14** is operated to its closed position.

With the above understanding of the apparatus and its organization in the completed system in mind, the operation of the system itself will readily be understood from the following description:

It is assumed that the switching device **21** is operated to its closed position, thereby completing the output circuit of the electric valve **18** which supplies saturating current to the reactor **16**. If the lamp bank **11** is to have a high intensity of illumination, the variable voltage device **23** is operated to increase the control voltage in the conductor **32** to a high value and thus to cause a large current to flow in the saturating winding of the reactor **16**. This produces a decrease in the voltage drop across the alternating current winding **15** of the reactor and increases the voltage across the lamp bank **11**. Since the voltage winding **15** of the reactor and increases the voltage of the valve **33** as represented by the voltage curve **46** is positive at the beginning of the positive half cycle of anode voltage, represented by curve **36**. Consequently, the valve **33** conducts maximum current, the black-out contactor **14** is operated to its closed position thereby completing the connection of the lamp bank **11** and the saturable reactor **16** to the source **12**, **13**.

If it is now desired to dim the lamps **11** rapidly to a complete black-out, the variable voltage device **23** is operated to decrease the voltage in the control conductor **32**. This decreases the saturating current of the reactor, thereby increasing its reactance and the voltage drop across its alternating current winding which in turn results in decreasing the voltage across the lamp bank **11**. The decreasing voltage in the control connection **32** decreases the positive voltage supplied to the grid **33***c* of the valve **33**. This has the effect of displacing the grid voltage curve **46** in a downward direction. However, the current flowing in the output circuit of the valve **33** is not decreased, but on the contrary the valve **33** remains fully conducting and the black-out contactor **14** remains picked up. The explanation of this is that although the grid voltage of the valve **33** is being decreased which is represented by displacing the grid voltage curve **46** downwardly, the grid voltage is still positive at the beginning of the half cycle of anode voltage and consequently the valve conducts during the entire half cycle. The electrical constants of the circuit are so chosen that when the control voltage in the conductor **32** has been reduced sufficiently to reduce the intensity of illumination of the lamp blank **11** to approximately 10% of full intensity, the grid voltage of the valve **33** is represented by the curve **48**.

It will be observed that this curve crosses the critical grid voltage curve at the beginning of the positive half cycle of anode voltage. Consequently, the valve **33** is still fully conducting and

the black-out contactor is maintained in its closed position.

However, if the control voltage of the connection 32 is now reduced a very slight amount the grid voltage of the valve 33 will also be reduced in proportion and the curve 48 will now lie below the critical voltage curve during the entire positive half cycle of anode voltage. In other words, at no time during the positive half cycle of anode voltage, does the grid become sufficiently positive to initiate a discharge and consequently the valve 33 is non-conducting and the black-out contactor 14 is deenergized causing its movable contact member 14b to descend to its lower open position to disconnect the reactor 16 and the lamp bank 11 from the supply source 12, 13.

It will thus be seen that the operation of the valve 33 is extremely critical at a predetermined value of the control voltage of the conductor 32, that is to say, a very minute change in the voltage at this critical value varies the conductivity of the valve 33 from "full-on" to "full-off".

Similary during the reverse operation, i. e. increasing the intensity of illumination of the lamp bank 11, the operation of the valve 33 is also very critical at this same predetermined value of control voltage. As long as the control voltage is so low that the grid voltage of the valve 33 lies beneath the curve 48 the valve 33 remains entirely non-conducting and the black-out contactor remains unoperated. However, when the control voltage is increased to the point at which the grid voltage of the valve 33 is represented by curve 48, the valve 33 becomes fully conducting and the contactor 14 is operated to its closed position to connect the reactor 16 and the lamp bank 11 to the supply source.

The arrangement illustrated also improves the operation of the illumination system in the following respect: The alternating current winding 28a of the scene fading reactor 28 is connected to the source 12, 13 through the rectifying device 27 and consequently in the absence of a provision of further means only half cycles of current would pass through the reactive winding of the fader reactor. The best operating characteristics of the reactor are obtained, however, when a full wave alternating current flows through the reactive winding. By connecting the rectifying valve 34 across the conductor 32 and the side 13 of the supply source in the manner illustrated the inverse half cycle of alternating voltage is rectified and consequently both half cycles of alternating current flow through the reactor winding 28a thereby improving its operation.

The modification illustrated in Fig. 3 is similar to the system of Fig. 1, but differs therefrom primarily in the provision of means for effecting operation of the controlled device in response to a D. C. control voltage. In certain electrical systems, such as rectifiers and direct current transmission systems, there is a need for a relay which will effect certain control operations as a function of the direct current. It is desirable, particularly in high voltage systems of this character, to insulate the controlling relays from the system voltage. A simple arrangement for accomplishing this object is illustrated in the modification of Fig. 3. In this modification, it will be observed that the electric valve 60 and its output circuit including the secondary winding 61a of the supply transformer 61, resistor 62 and contactor 63 are identical with the electric valve 33 of Fig. 1 and its output circuit. The grid circuit of the electric valve 60 is substantially identical with the grid circuit of the electric valve 33 of Fig. 1. An alternating voltage of reverse phase with respect to the anode voltage is supplied to the grid circuit by means of the biasing secondary winding 61b. This bias voltage is partially rectified by means of a suitable rectifying device, conventionally illustrated as a surface contact type rectifying device 64, such for example as a copper oxide rectifier. A filter device, illustrated as comprising a resistance 65 and a condenser 66 connected in parallel with each other, is provided for the purpose of smoothing the rectified bias voltage.

The direct current circuit, the current of which is to be utilized for controlling the operation of the relay 63, is represented by the plus and minus lines 67. As shown, the grid circuit of the electric valve 60 is connected to this direct current circuit, but insulated therefrom, by means of a saturable core type reactance device 68. The alternating current winding 68a of the saturable core reactor is supplied with alternating voltage from the secondary winding 61c of the supply transformer. A suitable rectifying device, illustrated as a surface contact rectifying bridge 70 is included in circuit between the secondary winding 61c and the alternating current winding 68a of the reactor. In order to prevent an alternating voltage from being induced in the saturating winding of the reactor, this winding is divided into two coils 68b and 68c connected in series opposition with each other.

The output terminals of the rectifying bridge 70 are connected across a load resistor 71 in the grid circuit of the valve 60. A filter condenser 72 is connected in parallel with the load resistor 71.

In operation, the impedance of the alternating current winding 68a of the reactor varies inversely with the direct current flowing in the saturating windings 68b and 68c. For example, as the current in the saturating winding increases the impedance of the alternating current winding decreases and the rectified voltage appearing across the resistance 71 increases. The increase in the voltage across the resistance 71 has the same effect as an increase in voltage across the resistance 45 has in the system of Fig. 1. In other words, a variation in the current flowing in the D. C. circuit 67 has the same controlling effect on the electric valve 60 and its associated relay 63 that a variation in the voltage of the control connection 32 in the system of Fig. 1 has on the electric valve 33 and its associated contactor 14. For currents in the saturating winding of the reactor which are lower than the desired trip value of the relay, the actual grid voltage of the electric valve 60 is more negative than the critical grid voltage. As the current which flows in the saturating winding increases, the positive bias across the resistor 71 increases until the actual grid voltage curve intersects the critical grid voltage, thereby causing the valve 60 to become ionized at the beginning of each positive half cycle of anode voltage. The valve 60, therefore, becomes fully conducting and energizes the relay 63, causing it to close its contacts. Similarly, when the current flowing in the saturating winding becomes less than the critical value, the grid voltage of the valve 60 is always less than the critical grid voltage and thus, the valve becomes non-conducting and the relay 63 is deenergized and its contacts open.

A variable resistance 74 is included in the cir-

cuit between the rectifying bridge and the load resistance 71 of the grid circuit. This variable resistance 74 serves to vary or adjust the setting of the relay, i. e. the current in the saturating winding of the reactor at which the relay is energized.

Although in accordance with the provisions of the patent statutes, this invention is embodied in concrete form, it will be understood that the apparatus and connections shown are merely illustratve and the invention is not limited thereto since alterations and modifications will readily suggest themselves to persons skilled in the art without departing from the true spirit of the invention or from the scope of the annexed claims.

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

1. A control system comprising an electroresponsive device, an electric valve having an ionizable medium, a control grid and an output circuit connected to said device capable of passing sufficient current to operate said device when said valve is fully conducting, means for supplying a negative bias voltage to said grid, means for supplying an alternating voltage to said output circuit and an alternating voltage of reverse phase to said grid, and means for supplying a positive bias voltage to said grid to reduce said negative bias voltage so that said valve is rendered fully conducting and said electroresponsive device is operated for certain values of said bias and said valve is rendered non-conducting and said electroresponsive device is not operated for all other values.

2. A control system comprising an electric valve containing an ionizable medium, and having an output circuit and a control grid, an electroresponsive device connected to said output circuit and capable of actuation when said valve is fully conducting, a half wave rectifier connected in the grid circuit for supplying a negative bias voltage thereto, means for supplying an alternating voltage to said output circuit and an alternating voltage of reverse phase to said grid, and means for supplying a positive voltage to said grid to oppose said negative bias voltage so that said valve is fully conducting and said electroresponsive device actuated for certain values of said bias and said valve is non-conducting and said electroresponsive device not actuated for all other bias values, and means for varying said positive voltage thereby to vary said bias through all said values.

3. A control system comprising an electric valve having an output circuit and a control grid, an electroresponsive device connected to said output circuit, means for supplying a negative bias to said grid, means for supplying an alternating voltage to said output circuit and an alternating voltage of reverse phase to said grid circuit so that said valve is fully conducting and said electroresponsive device is operated for certain values of said bias and said valve is non-conducting and said device is not actuated for all other values, and means for supplying a variable positive voltage to said grid to decrease said negative bias to the value at which said valve becomes fully conducting.

4. A control system comprising an electric valve containing an ionizable medium, a cathode, an anode and a control grid, an electroresponsive device connected in the anode circuit of said valve, a source of alternating voltage, connections from said source to said anode circuit for supplying an alternating voltage thereto, connections from said source to said grid including a rectifying device for supplying a negative bias and a superimposed alternating voltage of reverse phase with respect to the anode voltage so that said valve is conducting and said electroresponsive device is actuated for certain values of said bias voltage less negative than a predetermined critical value and said valve is non-conducting and said device not actuated for all other values of said bias, and means for supplying a variable positive voltage to said grid to vary said bias voltage through all of said values.

5. A control system comprising an electric valve containing cathode, anode, control grid and an ionizable medium, an electroresponsive device connected in the anode circuit of said valve, a source of alternating voltage, connections from said source to the anode circuit of said valve for applying an alternating voltage thereto, connections from said source to said grid including a half wave rectifying device for supplying to said grid a negative bias and a superimposed alternating voltage of reverse phase with respect to said anode voltage whereby said valve is non-conducting for certain values of said bias and fully conducting for all other values, and means for supplying an alternating current of variable effective value to said rectifying device whereby a variable positive voltage is supplied to said grid for decreasing said bias to cause said valve to become conducting.

6. A control system comprising an electric valve containing cathode, anode, control grid and an ionizable medium, an electroresponsive device connected in the anode circuit of said valve, a source of alternating voltage, connections from said source to said anode for supplying an alternating voltage thereto, a rectifying device having a plurality of anodes, connections including one of the anodes of said rectifying device from said source to said grid for supplying to said grid a negative bias and a superimposed alternating voltage of reverse phase with respect to the anode voltage of said valve so that said valve is fully conducting for certain values of said bias and non-conducting for all other values, and connections from another anode of said rectifying device to a source of alternating voltage of variable effective value for decreasing said negative bias to render said valve conducting.

7. A relay control system comprising a source of alternating voltage, an electric valve containing cathode, anode, control grid and an ionizable medium, a source of alternating voltage, a relay having its operating coil connected in the anode circuit of said valve, a rectifying device in the ternating voltage thereto, connections from said source to said anode circuit for supplying an alternating voltage thereto, connections from said source to said grid and said rectifying device for applying to said grid a negative bias voltage and a super-imposed alternating voltage of reverse phase with respect to said anode voltage so that said valve conducts sufficient current to actuate said relay for certain values of said bias and is non-conducting for all other values of said bias, a source of variable control voltage and connections from said control voltage source to said grid for supplying a variable positive voltage to said grid to vary said bias through all of said values so that said relay is actuated for certain values of said control voltage and deenergized for all other values.

8. A control system comprising a source of variable control voltage, a remotely located device

to be controlled by said voltage, connections from said source to said device, an electric valve containing an ionizable medium and having a control grid and an output circuit, an electroresponsive device connected in said output circuit and operable to exert control over said controlled device when said valve is fully conducting, means for supplying a negative bias to said grid, means for supplying an alternating voltage to said output circuit and an alternating voltage of reverse phase to said grid so that said valve is fully conducting for certain values of said bias and nonconducting for all other values, and connections from said grid to said control voltage connections for supplying a variable positive voltage to said grid to vary said bias to provide actuation of said electroresponsive device for certain values of said control voltage and deactuation for all other values.

MARVIN M. MORACK.

CERTIFICATE OF CORRECTION.

Patent No. 2,008,512. July 16, 1935.

MARVIN M. MORACK.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 33, for the words "winding 15 of the reactor and increases the" read in the control conductor 32 is high, the grid; and line 68, for "blank" read bank; page 5, line 11, first column, for "illustratve" read illustrative; and second column, line 57, claim 7, strike out the syllable and words "ternating voltage thereto" and insert instead grid circuit of said valve; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 27th day of August, A. D. 1935.

(Seal)

Leslie Frazer
Acting Commissioner of Patents.

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