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LIGHT-SENSITIVE SYSTEM

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This invention relates to control devices, and particularly those in which the energization of a relay is made to depend upon the illumination of a photocell or other light device.

5 It is an object of this invention to obtain a greater degree of precision and permanence in the adjustment of the amplifier, and a consistently greater dependability in the behavior of the relay.

10 Heretofore, in devices of this kind, the adjustment of the amplifier must be very exact to be certain that the response of the relay to a particular change in the illumination of the light sensitive device will be constant. It has been
15 found that slow changes in the amplification constant, or in the internal resistance of the tube, or slow changes in the applied plate voltage or grid voltage, may occur with resulting unforeseen changes in the degree of illumination at which the relay will drop out or pick up. Other slow or
20 small changes in the conditions affecting the amplifier may produce similar uncertainty.

It is an object of the present invention to overcome these sources of unexpected behavior in de-
25 vices of this kind.

Particularly, it is an object of this invention to avoid changes in the requirement for alteration of illumination to cause the relay to act. That is to say, if a change of determined magnitude in
30 the illumination is required to make the relay pick up or to make it drop out, the purpose is to prevent that magnitude from changing. Also, if there is a degree of illumination which will cause the relay to pick up and another which will
35 cause it to drop out the object includes avoiding changes in said degrees.

Stated another way, it is an object of this device to eliminate changes of sensitivity with age.

I have accomplished this result by protecting
40 the relay from all direct-current changes in the output or in the character of the tube. For this purpose, I leave only the alternating-current element in the output of the tube to produce an effect upon the relay, and I control the alternat-
45 ing current constituent of the output by the illumination of the light-sensitive device; producing only a direct-current output below a certain illumination and changing the output to include an alternating-current constituent when the illu-
50 mination of the light-sensitive device is more than a certain degree; the magnitude of the alternating-current element being in accordance with the illumination.

Thus the output at zero illumination consists
55 only of direct current and at a higher illumina-

tion it contains an alternating constituent the magnitude of which is in accordance with the degree of illumination. The relay, on the other hand, is unresponsive to the direct current constituent of the output and is affected only by the
5 alternating-current element and in proportion to the amplitude of alternating-current constituent in the output.

It is an object of this invention to produce a device in which the control of the relay will be
10 dependent entirely upon the illumination of the photo-sensitive element and independent of all direct current changes.

Other objects of the invention and details of the proposed construction will be apparent from
15 the following description and the accompanying drawing, in which the single figure is a diagram of the apparatus and circuits employed.

The apparatus includes an amplifier 1 which in-
20 cludes a filament 2, a grid 3 and a plate 4. A source of alternating current supplies the primary 5 of which one secondary 7 is connected to the terminals of the filament 2. The center point of the secondary 7 is connected to one terminal
25 of a source 9 of direct current, the other terminal of which is connected through the primary 11 of a transformer to the plate 4.

The secondary 12 of the transformer is connected to a rectifying arrangement including four
30 rectifiers 14 arranged in the usual square, one pair of the corners of this square being connected to the terminals of this secondary 12. The other corners of the square will deliver uni-directional current. In the arrangement illus-
35 trated, the wire 15 will be the positive, and the wire 16 the negative terminals of the rectifying arrangement regarded as a source. A relay 18 is supplied therefrom, the current in the illustration chosen entering the relay at the top and
40 departing at the bottom.

The primary 5 energizes a second secondary 20,
45 one terminal of which is connected to the junction between a resistor 22 and the negative pole of a battery 21. The other pole of the battery is connected to the center tap of the secondary 7 and thus to the filament 2. The terminal of the resistor 22 which is not connected to the bat-
50 tery 21 is connected to the grid 3 of the amplifier. The terminal of the secondary 20 which is not connected to the battery 21 and the resistor 22 is connected to the anode 25 of the photocell 26. The cathode of said photocell is connected to the other terminal of resistor 22 and so to the grid 3.

A second photocell 27 which, as explained be-
55 low, may be omitted, has its cathode 28 connected

to the anode 25 of the photocell 26 and its anode 29 is connected to the cathode of the photocell 25 and to the terminal of the resistor 22 which has already been described as connected to the grid 3. The cathode 28 is connected, as is the anode 25, to that terminal of the secondary 20 which is not connected to the battery 21.

In the operation of the device, the direct-current source 9 establishes a direct-current potential between the cathode 2 and the plate 4. This supplies a direct current through the primary 11, the magnitude of which is controlled by the potential upon the grid 3. This potential depends upon the voltage of the battery 21 and the resistance of the resistor 22.

Assuming the photocell 27 omitted, when the photocell 26 is dark, or when the potential from the secondary 20 is in the sense for which the photocell 26 is non-conductive, the secondary 20 produces no result at the grid 3. Under these circumstances therefore the amplifier 1 delivers a direct current which is without effect upon the secondary 12, and therefore delivers no energy to the relay 18.

When the photocell 26 is illuminated, and the secondary 20 delivers positive potential to the anode 25, a current flows through the photocell 26 and the resistor 22. A drop is thereby produced over the resistor, and the grid 3 is somewhat more positive than before. When the light conditions remain the same as just described but the direction of the potential from the secondary 20 is reversed, no current therefrom will pass through the photocell 26 and, still assuming the photocell 27 is omitted, the potential of the grid 3 will return to the value fixed by the battery 21, and the current in the plate circuit will return to its direct-current value.

The changes just described in the value of the current in the plate circuit will cause currents to flow from the secondary 12, which currents will be rectified and will result in a pulsating current through the leads 15 and 16 and the energization of the coil of relay 18. If the light upon the photocell 26 is too feeble the pulsations just described may be too feeble to cause the relay 18 to pick up. As the light increases, the magnitude of these pulsations increases, and the portion of each cycle of the alternating current supplied from the primary 5 through which they endure also increases. The energy supplied to the relay 18 is thus increased with the result that the pick up point is reached and the relay picks up. Further increase in the light upon the photocell 26 results in further energization of the relay 18, but after the relay has picked up further energization is without effect.

If the photocell 27 be present and if both photocells be illuminated, the effect upon the potential of the grid 3 will continue throughout both half-cycles. When the potential delivered by the secondary 20 is such as to make the anode 25 positive, current is supplied therethrough over the resistor 22 and the grid 3 is more positive than when the photocells are dark and also more positive than when the electromotive force from the secondary 20 is in the opposite sense. If the photocells are illuminated during the other half-cycle of the voltage from the secondary 20, current passes through the photocell 27 and thus the drop in the resistor 22 is added to the potential upon the grid 3 from the battery 21. The effect upon the potential of the grid 3 is therefore opposite to the effect during the first described half-cycle of the voltage for the secondary 20.

The alterations in current in the output of the grid 1 are therefore twice as great when two photocells are used. Thus with two photocells with a slight change in illumination, a great change in the energization of the relay 18 will occur.

Whether one photocell be used or two, the energization of the relay 18 will be independent of the magnitude of the direct current output of the amplifier 1, it is necessary to have such a direct current output because it supplies the energy which is changed into alternating current by the action of grid 3 but when the potential of said grid is constant, the direct current output of the amplifier is without effect upon the relay 18. It is desirable that the resistor 22 and battery 21 be so adjusted that the changes in the plate current of the amplifier 1 with changes in the potential of the grid 3 are a maximum, but other adjustments are usable and their effect will be readily understood by those skilled in the art.

It is evident that the photocells 26 and 27 need not be in separate envelopes but an equivalent structure within a single one may be used.

Many modifications beside that specifically illustrated and described will occur to those skilled in the art, and a specific description and illustration of a single one is not to be regarded as a limitation. No limitations are intended except those expressly indicated in the accompanying claims, or required by the prior art.

I claim as my invention:

1. In combination, an amplifier, a source of alternating potential in the grid circuit of said amplifier and a direct-current source of potential in series therewith, the grid circuit also including a photocell and a resistor in series with said alternating source and photocell, whereby when said photocell is conductive both sources affect the grid potential and when said cell is non-conductive the direct current source alone affects the grid potential.

2. In combination, an amplifier, a transformer primary in the output circuit of said amplifier, a direct-current source in series therewith, a secondary associated with said primary, a rectifier in the output of said secondary, a relay energized by the output of said rectifier, and photo-responsive means in the input circuit of said amplifier for causing the output from said amplifier to be periodic.

3. In combination, a transformer, a relay in the secondary thereof, an amplifier in the primary, means for producing a difference of potential between the cathode and the grid of said amplifier, said means including a source and connections for supplying direct-current potential to the grid and another source with additional connections for supplying periodic potential to said grid, said last-named connections including photo-responsive elements.

4. In combination, a transformer, a rectifier and a relay in the secondary thereof, an amplifier in the primary, means for producing a difference of potential between the cathode and the grid of said amplifier, said means including a source and connections for supplying direct-current potential to the grid and another source with additional connections for supplying periodic potential to said grid, said last-named connections including photo-responsive elements.

5. In a system including an amplifier and a load, means for controlling the current through the load including a photocell, two sources one

of which is periodic and connections functioning to impress a potential on the grid of the amplifier from one of said sources if said photocell is non-conductive and from both of said sources if said photocell is conductive.

6. In a system including an amplifier and a load, means for controlling the current through the load including a photocell, two sources one of which is periodic and connections whereby the potential of the grid of the amplifier is supplied from one of said sources if said photocell is dark and from both of said sources if said photocell is illuminated.

7. Apparatus for controlling the supply of power to a load comprising an electric discharge device having a control electrode and a plurality of principal electrodes, means for electrically coupling said principal electrodes to said load, said coupling means including means for impressing a potential between said principal electrodes and means for permitting only the flow of such power to said load as arises from the transmission of periodic current between said principal electrodes; and means responsive to a physical disturbance for impressing periodic potentials of a periodicity independent of the periodicity, if any, of said disturbance between said control electrode and one of said principal electrodes of sufficient magnitude to cause the transmission of periodic current between said principal electrodes.

8. Apparatus for controlling the supply of power to a load comprising an electric discharge device having a control electrode and a plurality of principal electrodes, means for electrically coupling said principal electrodes to said load, said coupling means including means for impressing a substantially steady direct current potential between said principal electrodes and means for permitting only the flow of such power to said load as arises from the transmission of periodic current between said principal electrodes; and means responsive to a physical disturbance for impressing periodic potentials of a periodicity, if any, independent of the periodicity of said disturbance between said control electrode and one of said principal electrodes of sufficient magnitude to produce the transmission of periodic current between said principal electrodes.

9. Apparatus for controlling the supply of power to a load comprising an electric discharge device having a control electrode and a plurality of principal electrodes, means for electrically coupling said principal electrodes to said load, said coupling means including means for impressing a potential between said principal electrodes and means for permitting only the flow of such power to said load as arises from the transmission of periodic current between said principal electrodes; and means responsive to a physical disturbance for impressing periodic potentials of a periodicity independent of the periodicity, if any, of said disturbance between said control electrode and one of said principal electrodes of sufficient magnitude to produce the transmission of periodic current between said principal electrodes, the last said means including a photo-sensitive device having electrodes and means for impressing a periodic potential between the electrodes of said photo-sensitive device of sufficient magnitude to cause the transmission of current of the same periodicity between said principal electrodes.

10. Apparatus for controlling the supply of power to a load comprising an electric discharge

device having a control electrode and a plurality of principal electrodes, means for electrically coupling said principal electrodes to said load, said coupling means including means for impressing a potential between said principal electrodes and means for permitting only the flow of such power to said load as arises from the transmission of periodic current between said principal electrodes; and means responsive to a physical disturbance for impressing periodic potentials of a periodicity independent of the periodicity, if any, of said disturbance between said control electrode and one of said principal electrodes of sufficient magnitude to produce the transmission of periodic current between said principal electrodes, the last said means including an electrode capable of emitting electrons when subjected to the influence of light and an electrode for collecting said electrons and means for impressing an alternating potential between the last said electrodes whereby under the influence of light said photo-sensitive device passes periodic current.

11. Apparatus for controlling the supply of power to a load comprising an electric discharge device having a control electrode and a plurality of principal electrodes, means for electrically coupling said principal electrodes to said load, said coupling means including means for impressing a substantially steady direct current potential between said principal electrodes and means for permitting only the flow of such power to said load as arises from the transmission of periodic current between said principal electrodes; and means responsive to a physical disturbance for impressing periodic potentials of a periodicity independent of the periodicity if any of said disturbance between said control electrode and one of said principal electrodes of sufficient magnitude to produce the transmission of periodic current between said principal electrodes, the last said means including a circuit comprising an electrode capable of emitting electrons under the influence of light, an electrode for collecting said electrons, impedance means, and means for impressing a periodic potential between the last-said electrodes whereby when said emitting electrode is under the influence of light a periodic current is supplied to said impedance means.

12. Apparatus for controlling the supply of power to a load comprising an electric discharge device having a control electrode and a plurality of principal electrodes, means for electrically coupling said principal electrodes to said load, said coupling means including means for impressing a substantially steady direct current potential between said principal electrodes and means for permitting only the flow of such power to said load as arises from the transmission of periodic current between said principal electrodes; and means responsive to a physical disturbance for impressing periodic potentials of a periodicity independent of the periodicity if any of said disturbance between said control electrode and one of said principal electrodes of sufficient magnitude to produce the transmission of periodic current between said principal electrodes, the last said means including a circuit comprising an electrode capable of emitting electrons under the influence of light, an electrode for collecting said electrons, impedance means, and means for impressing an alternating potential between the last-said electrodes whereby when said emitting electrode is under the in-

fluence of light a current is supplied to said impedance means, and electrical coupling means for impressing the potential arising across said impedance means by reason of the flow of current therethrough between said control electrode and said one principal electrode.

13. Apparatus for controlling the supply of power to a load comprising an electric discharge device having a control electrode and a plurality of principal electrodes, means for electrically coupling said principal electrodes to said load, said coupling means including means for impressing substantially steady direct current potential between said principal electrodes and means for permitting only the flow of such power to said load as arises from the transmission of periodic current between said principal electrodes; and means responsive to a physical disturbance for impressing periodic potentials of a periodicity independent of the periodicity if any of said disturbance between said control electrode and one of said principal electrodes of sufficient magnitude to produce the transmission of periodic current between said principal electrodes, the last said means including a circuit comprising a first electrode capable of emitting electrons under the influence of light, a first electrode for collecting said electrons, a second electrode capable of emitting electrons under the influence of light connected to said first collecting electrode, a second electrode for collecting the electrons emitted by said second emitting electrode connected to said first emitting electrode, impedance means, and means for impressing a periodic potential between said collecting

and emitting electrodes whereby when said emitting electrodes are under the influence of light an alternating current is supplied to said impedance means.

14. Apparatus for controlling the supply of power to a direct current load comprising an electric discharge device having a control electrode and a plurality of principal electrodes, means for electrically coupling said principal electrodes to said load, said coupling means including means for impressing a substantially steady direct current potential between said principal electrodes and means for permitting only the flow in the form of alternating current of such power to said load as arises from the transmission of periodic current between said principal electrodes and means for rectifying said alternating current; and means responsive to a physical disturbance for impressing periodic potentials of a periodicity if any independent of the periodicity of said disturbance between said control electrode and one of said principal electrodes of sufficient magnitude to produce the transmission of periodic current between said principal electrodes, the last said means including a circuit comprising an electrode capable of emitting electrons under the influence of light, an electrode for collecting said electrons, impedance means, and means for impressing a periodic potential between the last said electrodes whereby when said emitting electrode is under the influence of light a current is supplied to said impedance means.

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