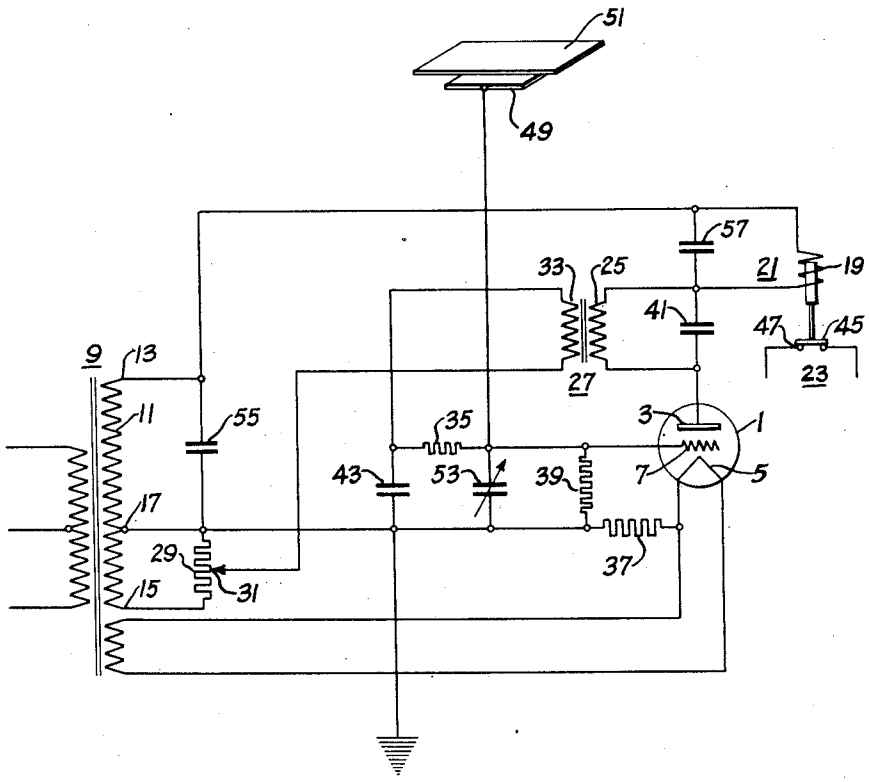
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ELECTRIC DISCHARGE APPARATUS

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ELECTRIC DISCHARGE APPARATUS

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Our invention relates to electric discharge apparatus and it has particular relation to the application of electric discharge devices to capacity-responsive relays.

It is an object of our invention to provide a sensitive relay for indicating changes in capacity.

Another object of our invention is to provide indicating apparatus in which the indicating signal occurs by reason of a small change in the electrical capacity of a region.

A further object of our invention is to produce highly sensitive detecting apparatus in which the trigger element operates by variation in capacity.

An additional object of our invention is to provide apparatus in which the operation of a work circuit shall be initiated by a small change in capacity.

More concisely stated, it is an object of our invention to provide apparatus in which a small change in capacity shall be indicated by an easily discernible physical manifestation.

According to our invention, we provide a detecting system incorporating an oscillation generator. The generator includes an electric discharge device having input and output circuits. The magnitude of the capacity in the input circuit is so adjusted that normally oscillatory impulses are transmitted through the output circuit and when the capacity in the input circuit is slightly increased, the oscillations are suppressed. A relay in the output circuit is provided for the purpose of responding to the difference in current which arises by reason of the suppression of the oscillations.

Our invention has numerous applications. It may be utilized, for example, in a burglar alarm system in which the capacity necessary to actuate the system is provided by the condenser which is established between the burglar and the object to be protected. The invention may also be applied for the purpose of sorting objects in accordance with their thickness. In such a case, the objects are transmitted between two plates which constitute a condenser coupled in the input circuit of the electric discharge device of an oscillation generator. Under normal circumstances, the constants of the oscillation generator are so adjusted that the oscillatory impulses are produced in the output circuit of the generator and a relay is maintained in an energized condition. When an object of greater thickness than a predetermined thickness is transmitted between the plates a change in capacity occurs, the oscillations are suppressed and the current transmitted through the output circuit of the oscillator is varied. By reason of this change, the necessary relays may be actuated to sort the article varying in thickness from the others.

Finally our invention may be utilized for display purposes. In such a case the work circuit utilized is an illuminating sytem. The trigger capacity may be formed betwen a person who approaches a display window for example and a piece of tin foil on the window. The illuminating units may thus be energized by the approach of a person to a display window and an interesting display effect produced.

The novel features which we consider characteristic of our invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawing in which the single figure is a diagrammatic view showing the essential elements of a system constructed according to our invention.

The apparatus shown in the drawing comprises an electric discharge device 1 having an anode 3, a cathode 5 and a control electrode 7. The electric discharge device 1 may be of the high vacuum type or of the gas-filled type. In practice, we have found that for many applications a high vacuum electric discharge device of a type similar to the Westinghouse RJ-550 may be utilized.

The electric discharge device 1 is energized from a suitable power source (not shown) through a transformer 9, a secondary section 11 of which is equipped with a plurality of terminal taps 13 and 15 and an intermediate tap 17. One terminal tap 13 of the secondary section 11 is connected to the anode 3 of the electric discharge device 1 through the exciting coil 19 of a relay 21 whereby the necessary work circuit 23 may be energized and through the primary 25 of another transformer 27 which is of the usual type incorporated in thermionic oscillation generators. The windings of a potentiometer 29 are connected between the intermediate tap 17 and the other tap 15 of the secondary section 11 of the power supply transformer 9. The movable tap 31 of the potentiometer 29 is connected to the control electrode 7 of the electric discharge device 1 through the secondary 33 of the last named transformer 27 and through a resistor 35 of suitable magni-

tude. The intermediate tap 17 of the secondary section 11 of the power supply transformer 9 is also connected to the cathode 5 of the electric discharge device 1 through a second resistor 37, while a third resistor 39 of comparatively large magnitude is connected between the control electrode 7 and the cathode 5.

The transformer 27 coupling the input and output circuits of the electric discharge device 1 is preferably of the iron core type. We have found that if the air gap in the core of the transformer 27 is properly adjusted, maximum sensitivity may be obtained for the system.

To increase the oscillations in the plate circuit of the electric discharge device 1 and to approximately tune the system, capacitors 41 and 43 are provided. One of the capacitors 41 is connected directly across the primary 25 of the oscillation transformer 27 while the other capacitor 43 is connected in series with the secondary 33 of the oscillation transformer 27 and between the control electrode 7 and the cathode 5. By the cooperation of the transformer 27 and the capacitors 41 and 43, oscillatory current impulses are produced in the output circuit of the electric discharge device 1 and the relay 21 in this circuit is normally maintained in energized condition by the oscillatory current.

We have found that when the capacity in the input circuit is suitably increased, the oscillations may be suppressed and if the relay 21 in the output circuit is of suitable character it may be operated by reason of the decrease in current. As is shown in the drawing, the relay 21 is equipped with a movable contactor 45 which engages a plurality of fixed contacts 47 to operate the necessary signalling or work circuit 23 when a change occurs in the condition of the oscillation generator.

The change in capacity which is necessary to produce the change in the oscillatory condition of the system is illustrated symbolically by a plurality of plates 49 and 51, the lower one 49 of which is connected to the control electrode 7 of the electric discharge device 1 and the upper one 51 of which is potentially free. It is apparent that if the upper plate 51 is connected to ground, as for example by the touch or approach of a burglar, additional capacity is connected between the control electrode 7 and the cathode 5. The constants of the circuit are so adjusted that it is normally in oscillatory condition and the addition of the capacity is of sufficient magnitude to suppress the oscillations.

The change in capacity for which the system operates may, of course, be adjusted to any desired value. The adjustment may be made by varying the magnitude of the resistor 35 connected in series with the control electrode 7 and the secondary 33 of the oscillation transformer 27. The last-named resistor must be so small that the current drawn by any fixed capacitors present in the system will not sufficiently reduce the oscillating current in the input circuit of the electric discharge device to suppress the oscillations.

In the practical application of our invention the magnitude of this resistor must necessarily be varied for various ambient conditions of the region in which the system is utilized for various dispositions and locations of the elements of the system. Since it is rather inconvenient to vary a high resistor of the type in question here, we have found it desirable to utilize the combination of the resistor 35 with a variable capacitor 53. The capacitor 53 is connected between the control electrode 7 and the cathode 5 of the electric discharge device 1 and may be varied to adapt the system to various conditions of operation.

The magnitudes of the capacitor 53, the resistor 35 and the capacity between the plates 49 and 51 whereby the work circuit is energized are interrelated. If the resistor 35 is of considerable magnitude the sum of the capacity of the capacitor 53 and the trigger capacity must necessarily be small and by reason of the necessary allowance for adjustment in the capacitor 53, the trigger capacity must be small. However, a system in which this situation exists is highly sensitive. Where high sensitivity is not essential the magnitude of the resistor 35 may be decreased and the magnitude of the trigger capacity may be correspondingly increased. In certain modifications of our invention we have found that the sensitivity adjustment may be made by a variable resistor connected in a manner similar to the resistor 35. In such systems the capacitor 53 may be entirely omitted. In other modifications of our invention we have found desirable the use of both a variable resistor 35 and a variable capacitor 53 for adjustment purposes. The former is utilized for coarse adjustment and the latter for fine adjustment.

In addition to the elements above mentioned, a capacitor 55 is connected between the intermediate tap 17 of the secondary section 11 of the power supply transformer 9 and the tap 13 which is connected to the anode 3 of the electric discharge device 1. The capacitor 55 is provided for the purpose of by-passing high frequency current and preventing the high frequency current from the output circuit of the device 1 being transmitted through the secondary section 11.

Still another capacitor 57 is connected across the exciting coil 19 of the relay 21. This capacitor functions to reduce the impedance of the exciting coil 19 of the relay 21 to pulsating current transmitted through the output circuit of the electric discharge device 1, and also, of course, prevents the relay from chattering.

Particular attention is called to the resistor 37 connected between the intermediate tap 17 of the secondary section 11 of the power supply transformer 9 and the cathode 5. We have found that this resistor 37 functions to highly increase the sensitivity of the system. This phenomenon may be taken as an experimental fact, since the functioning of the system is so complicated that it would be difficult to explain the effect of the resistor 37 by theoretical analysis.

In a system which we have found to operate satisfactorily the electric discharge device 1 is the Westinghouse RJ 550 vacuum tube. Between the anode 3 and the cathode 5 200 volts R. M. S. is impressed. The capacitor 41 connected across the primary 25 of the oscillation transformer 27 has a magnitude of .002 microfarad while the capacitor 43 connected in series with the secondary 33 has a capacity of .0005 microfarad. The variable capacitor 53 may vary from 10 to 70 micromicrofarads while its associated resistor 35 has a magnitude of 1.5 megohms. The capacitor 55 connected between the terminals 13 and 17 of the secondary section 11 has a magnitude of .03 microfarad while the capacitor connected across the exciting coil 19 of the relay 21 has a magnitude of .25 microfarad. The resistor 39 connected between the control electrode 7 and the cathode 5 has a magnitude of 5 to 25 megohms while the resistor 37 connected in series with the cathode 5 has a magnitude of 2500 ohms. The potentiometer 29 has a resistance of 10,000 ohms.

The operation of the system is simple. Under

normal circumstances, oscillatory impulses are transmitted through the primary 25 of the oscillation transformer 27 and through the circuit associated with it. The relay 21 in this circuit is, therefore, maintained in an energized condition. When a change of capacity in the control circuit of the electric discharge device occurs, as for example of the approach of a burglar to a safe to be protected, the oscillations are suppressed and the relay 21 is deenergized.

It is to be noted that while our invention has been shown as particularly applied to a system in which the transition is necessarily from an oscillatory to a non-oscillatory condition, a reversely operating system in which, when the disturbance to be detected occurs, the transition is from a non-oscillatory to an oscillatory condition may also be utilized. In such a system is an equivalent lying within the scope of our invention.

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

We claim as our invention:

1. In combination an electric discharge device having an anode, a cathode and a control electrode, power-supply means including a plurality of taps between which a difference of potential exists, a transformer, means for connecting a terminal of the primary of said transformer to said anode, means for connecting one of said taps to the other terminal of said primary, means for connecting a terminal of the secondary of said transformer to said control electrode, means for connecting another of said taps to the other terminal of said secondary, means including a resistor for connecting still another tap to said cathode, a capacitor connected across said primary, capacitative means connected between said control-electrode and said cathode, said last-named capacitative means being of such magnitude that under normal circumstances oscillatory impulses are transmitted through said primary, means for increasing the capacity between said control electrode and said cathode to suppress said oscillatory impulses and translating means to respond to the presence or absence of oscillatory impulses in said primary.

2. In combination an electric discharge device having an anode, a cathode and a control electrode, power-supply means including a plurality of terminal taps and a grounded intermediate tap between which a difference of potential exists, a transformer, means for connecting one terminal of the primary of said transformer to said anode, means for connecting one of said terminal taps to the other terminal of said primary, means for connecting one terminal of the secondary of said transformer to said control electrode, means for connecting another of said terminal taps to the other terminal of said secondary, means including a resistor for connecting said intermediate tap to said cathode, a capacitor connected across said primary, capacitative means connected between said control-electrode and said intermediate tap, said last-named capacitative means being of such magnitude that under normal circumstances oscillatory impulses are transmitted through said primary, means for increasing the capacity between said control electrode and said cathode to suppress said oscillatory impulses and translating means to respond to the presence or absence of oscillatory impulses in said primary.

3. In combination an electric discharge device having an anode, a cathode and a control electrode, power-supply means including a plurality of terminal taps and an intermediate tap between which a difference of potential exists, a transformer, means for connecting one terminal of the primary of said transformer to said anode, means for connecting one of said terminal taps to the other terminal of said primary, means including a resistor for connecting one terminal of the secondary of said transformer to said control electrode, means for connecting another of said terminal taps to the other terminal of said secondary, means including another resistor for connecting said intermediate tap to said cathode, a capacitor connected across said primary, still another resistor connected between said control electrode and said cathode, capacitative means connected between said control-electrode and said cathode, said last-named capacitative means being of such magnitude that under normal circumstances oscillatory impulses are transmitted through said primary, means for increasing the capacity between said control electrode and said cathode to suppress said oscillatory impulses and translating means to respond to the presence or absence of oscillatory impulses in said primary.

4. In combination an electric discharge device having an anode, a cathode and a control electrode, power-supply means including a plurality of terminal taps and a grounded intermediate tap between which a difference of potential exists, a transformer, means for connecting one terminal of the primary of said transformer to said anode, means for connecting one of said terminal taps to the other terminal of said primary, means including a resistor for connecting one terminal of the secondary of said transformer to said control electrode, means for connecting another of said terminal taps to the other terminal of said secondary, means including another resistor for connecting said intermediate tap to said cathode, a capacitor connected between said intermediate tap and said first-named terminal tap, a capacitor connected across said primary, still another resistor connected between said control electrode and said intermediate tap, capacitative means connected between said control-electrode and said intermediate tap, said last-named capacitative means being of such magnitude that under normal circumstances oscillatory impulses are transmitted through said primary, means for increasing the capacity between said control electrode and said cathode to suppress said oscillatory impulses and translating means to respond to the presence or absence of oscillatory impulses in said primary.

5. In combination an electric discharge device having an anode, a cathode and a control electrode, power-supply means including a plurality of terminal taps and a grounded intermediate tap between which a difference of potential exists, a transformer, means for connecting one terminal of the primary of said transformer to said anode, means for connecting one of said terminal taps to the other terminal of said primary, means including a resistor for connecting one terminal of the secondary of said transformer to said control electrode, means for connecting another of said terminal taps to the other terminal of said secondary, means including another resistor for connecting said inter-

mediate tap to said cathode, a capacitor connected across said primary, still another resistor connected between said control electrode and said intermediate tap, capacitative means including a fixed capacitor and a variable capacitor connected between said control-electrode and said intermediate tap, said last-named capacitative means being of such magnitude that under normal circumstances oscillatory impulses are transmitted through said primary, means for increasing the capacity between said control electrode and said cathode to suppress said oscillatory impulses and translating means to respond to the presence or absence of oscillatory impulses in said primary.

6. Apparatus for detecting small changes in capacity comprising an electric discharge device having a control electrode and a plurality of principal electrodes, a circuit for supplying potential between said principal electrodes, another circuit coupled to said first-named circuit to absorb energy therefrom, a network coupled to said last-named circuit and including the discharge path between said control electrode and one of said principal electrodes, whereby energy is supplied between said control electrode and the last said principal electrode, said network including means for limiting the energy supplied thereto to a value just sufficient to produce electrical oscillations in said circuits, means to be coupled to said network for absorbing energy from said network thereby to interrupt said electrical oscillations and means to respond to the transition from the oscillatory to the non-oscillatory condition of said circuits.

7. Apparatus for detecting small changes in capacity comprising an electric discharge device having a control electrode and a plurality of principal electrodes, a circuit for suppling potential between said principal electrodes, another circuit coupled to said first-named circuit to absorb energy therefrom, a network coupled to said last-named circuit and including the discharge path between said control electrode and one of said principal electrodes, whereby energy is supplied between said control electrode and the last said principal electrode, said network including means for limiting the energy supplied thereto to a predetermined value just sufficient to produce electrical oscillations in said circuits, a capacitor to be coupled to said network for absorbing energy from said network, said capacitor being of such character and so disposed that the energy absorbed thereby is of sufficient magnitude to interrupt said electrical oscillations, and means to respond to the transition from the oscillatory to the non-oscillatory condition of said circuits.

8. Apparatus for observing small changes in capacity comprising an electric discharge device having a control electrode and a plurality of principal electrodes, a circuit for supplying potential between said principal electrodes, another circuit coupled to said first-named circuit to absorb energy therefrom, a network coupled to said last-named circuit and including the discharge path between said control electrode and one of said principal electrodes, whereby energy is supplied between said control electrode and the last said principal electrode, said network including means incorporating a capacitor as an element thereof, for limiting the energy supplied thereto to a value just sufficient to produce electrical oscillations in said circuits, means to be coupled to said network for absorbing energy from said network thereby to interrupt said electrical oscillations, and means to respond to the transition from the oscillatory to the non-oscillatory condition of said circuits.

9. Apparatus for observing small changes in capacity, an electric discharge device having a control electrode and a plurality of principal electrodes, a circuit for supplying potential between said principal electrodes, another circuit coupled to said first-named circuit to absorb energy therefrom, a network coupled to said last-named circuit and including the discharge path between said control electrode and one of said principal electrodes, whereby energy is supplied between said control electrode and the last said principal electrode, said network including means, incorporating a resistor as an element thereof, for limiting the energy supplied thereto to a value just sufficient to produce electrical oscillations in said circuits, means to be coupled to said network for absorbing energy from said network, thereby to interrupt said electrical oscillations and means to respond to the transition from the oscillatory to the non-oscillatory condition of said circuits.

10. In combination, an electric discharge device having an anode, a cathode and a control electrode, power-supply means including a plurality of terminal taps and a grounded intermediate tap between which a difference of potential exists, a transformer, means for connecting one terminal of the primary of said transformer to said anode, means for connecting one of said terminal taps to the other terminal of said primary, means including a resistor for connecting one terminal of the secondary of said transformer to said control electrode, means for connecting another of said terminal taps to the other terminal of said secondary, means including another resistor for connecting said intermediate tap to said cathode, a capacitor connected across said primary, still another resistor connected between said control electrode and said intermediate tap, capacitative means connected between said control-electrode and said intermediate tap, said last-named capacitative means being of such magnitude that under normal circumstances oscillatory impulses are transmitted through said primary, means for increasing the capacity between said control electrode and said cathode to suppress said oscillatory impulses and translating means to respond to the presence or absence of oscillatory impulses in said primary.

11. In combination, an electric discharge device having an anode, a cathode and a control electrode, power-supply means, a transformer, means for connecting a terminal of the primary of said transformer to said anode, means for connecting to said power-supply means the other terminal of said primary, means for connecting a terminal of the secondary of said transformer to said control electrode, means for connecting to said power-supply means the other terminal of said secondary, means including a resistor for connecting said cathode to said power-supply means in such manner that a difference of potential is impressed between said anode and said cathode, impedance means connected between said control electrode and said cathode, said last-named impedance means being adjusted to just such magnitude that under normal circumstances oscillatory impulses are transmitted through said primary, means for increasing the capacity between said control electrode and said cathode to suppress said oscillatory impulses and translat-

ing means to respond to the presence or absence of oscillatory impulses in said primary.

12. In combination, an electric discharge device having an anode, a cathode and a control electrode, periodic power-supply means, a transformer, means for connecting a terminal of the primary of said transformer to said anode, means for connecting to said power-supply means the other terminal of said primary, means for connecting a terminal of the secondary of said transformer to said control electrode, means for connecting to said power-supply means the other terminal of said secondary, means including a resistor for connecting said cathode to said power-supply means in such manner that a difference of potential is impressed between said anode and said cathode, impedance means connected between said control electrode and said cathode, said last-named impedance means being adjusted to just such magnitude that under normal circumstances oscillatory impulses are transmitted through said primary, means for increasing the capacity between said control electrode and said cathode to suppress said oscillatory impulses and translating means to respond to the presence or absence of oscillatory impulses in said primary.

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