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TIME DELAY CIRCUIT

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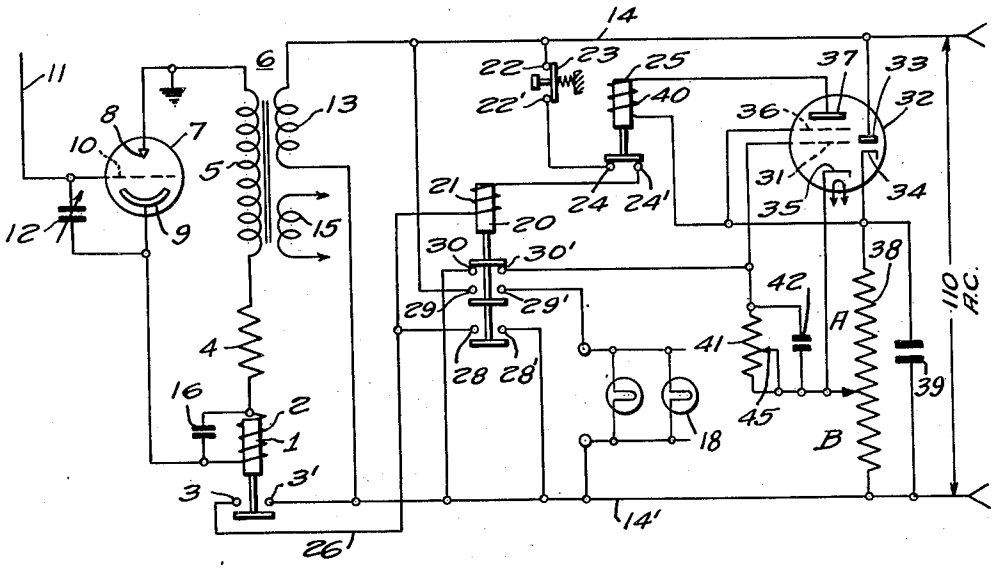

WITNESSES:

E. A. McCloskey.

Mrs. C. Goosie

INVENTOR

Frederick E. Bartholy.

BY

Hyman Diamond

ATTORNEY

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TIME DELAY CIRCUIT

Frederick E. Bartholy, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

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This invention relates to electrical relay circuits and more particularly to a time delay circuit operating in connection therewith.

In electrical and industrial operations sensitive relay devices are frequently employed for indicating the occurrence of certain phenomena. For example, capacity operated relays or photoelectric devices are used to indicate the presence or the passing of different objects, by the control of lights or by sounding an alarm. It is often desirable that the effect produced by the energization of the sensitive relay or the photocell be prolonged, particularly if the energization is of a very short duration.

In the control of lights for display purposes or in the sounding of alarms used in protective installations the control effect may only be momentary such as the passing of a person in front of a show window, etc. If lights are to be lit or an alarm is to be sounded, it is necessary to provide means whereby the above effects are produced not only during the energization of the relay system while the presence of the person within a narrow confine causes energization but also that after the cause is removed the effect shall persist for a predetermined time and thereafter the system shall again be responsive to repeated energizations.

A particular feature of this invention is that in relay systems of the type mentioned the desired effect caused by energization of short duration may be extended for a predetermined time and thereafter the system is restored automatically to a receptive condition for a successive energization.

Another feature of this invention is that while the desired effect is produced within the predetermined time interval energization of the system during such time will not interfere with its operation until and immediately after receptive condition is restored.

An advantage of the system in accordance with this invention is that the system may be restored at any time during operation to a receptive condition without interfering with the predetermined time for the ensuing operation.

The invention contemplates a circuit arrangement of a time delay device in combination with a sensitive relay whereby the actuation of the relay closes the circuit and simultaneously initiates the operation of the time delay device. The circuit is automatically held closed until the time delay device ceases to function whereupon the circuit is automatically opened and the time delay device restored. Means are provided for restoring the system at will at any time during the function of the time delay device to its starting condition without interfering with the predetermined time intervals of successive operations.

Other features and advantages will be apparent from the following description of the invention, pointed out in particularity by the appended claims, and taken in connection with the accompanying drawing in which the single figure diagrammatically illustrates an embodiment of the invention applied to a sensitive relay of the capacity operated type.

The sensitive relay to which this invention is applied in the grid-glow tube described in U. S. Patent No. 2,062,269 to Dewey D. Knowles. While the circuit in accordance with this invention is particularly applicable to relays of this type, it is to be understood that it may be applied to all types of relays such as those operating from a photoelectric cell or other sensitive devices.

Referring to the drawing, the sensitive relay portion of the circuit includes the relay 1 having a winding 2 and contacts 3 and 3'. The winding 2 is in series with a current limiting resistor 4, the secondary winding 5 of the transformer 6 and the space current path of the grid-glow tube 7. The latter includes as elements an anode 8, which may be grounded as shown, a cathode 9 and a control electrode 10. A conductor 11 is shown connected to the control electrode 10 and a condenser 12 is connected between the last mentioned electrode and the cathode 9. The primary winding 13 of the transformer 6 is connected by means of conductors 14 and 14' to a source of current as indicated. The transformer 6 may also have a third winding 15 which may be utilized for supplying the heating current for the vacuum tube 32 to be described later.

The operation of the capacitive relay is fully described in the patent above-mentioned. For the complete understanding of this invention, it will suffice to say that relay 1 will be actuated when there is a capacitive unbalance between the anode and control electrode capacitance and between the capacitance formed by the condenser 12 of the glow tube 7. The capacity between control electrode 10 and the anode 8 is an inherent one formed by the capacity of the conductor 11 to ground, whereas the balancing capacity is that of the condenser 12. The latter is usually adjusted until both capacities are of substantially equal value, in which case the glow tube 7 is inoperative and no current flows through the winding 2 of the relay 1. A change of the capacity between the conductor and ground, such

as caused by the presence of an object or a body, will unbalance the existing capacitive relation and the glow tube becomes conductive and the space current will energize the relay winding 2. A condenser 16 shunts the winding 2 in order to supply current to the winding at each half cycle of alternating current when the glow tube is non-conducting.

In accordance with this invention, the circuit energized by the closure of the contacts 3 and 3' not only energizes a desired utilization circuit or load elements, shown here by way of example as the lamps 18, but also maintains this energization for a predetermined time irrespective of whether the contacts 3 and 3' remain closed or open during this period. To this end, the winding 21 of the electromagnetic switch 20 is so connected that the circuit to conductors 14 and 14' is completed through the contacts 22 and 22' of a reset switch 23, the contacts 24 and 24' of a relay 25 and through conductor 26. The switch 20 has a plurality of contacts of which 28 and 28' short circuit the contacts 3 and 3' upon closure, 29 and 29' complete the connection of the lamps 18 to the conductor 14, and 30 and 30' connect the conductor 14', when closed, to the grid 31 of an electron discharge device 32. The latter may be of the type including a rectifier portion comprising an anode 33 and cathode 34 and a tetrode portion comprising the cathode 35, control grid 31, screen grid 36 and the anode 37. This type of tube, due to its compactness, is suitable for the application here intended, although other tubes may as well be used, and it is not necessary that the rectifier portion and the tetrode portion be in one envelope.

The rectifier portion is utilized to provide direct current potential for the elements of the tetrode portion and is connected between conductors 14 and 14' in series with a load resistor 38, which is shunted by a filter condenser 39 of suitable size. The cathode 35 is connected to a point on the load resistor 38. The anode 37 is connected in series with the winding 40 of the relay 25 to the cathode 34, which is the highest positive potential of the rectified voltage output. The screen grid 36 is also connected to this point. The potential for the anode supply will be in effect the portion of the resistor designated by the letter A between the cathode 34 and the cathode 35 where as the portion between the conductor 14' and the cathode 35 designated by the letter B will be of a potential more negative than the cathode 35. Consequently, the connection through the contacts 30 and 30' will place the grid 31 at a potential which is negative with respect to the cathode 35. The grid 31 is also connected through a resistance capacity network comprising the resistor 41 shunted by the condenser 42 to the cathode 35.

Describing the operation of the relay circuit, let it be assumed that capacitive balance exists so that the glow tube is deenergized and the contacts 3 and 3' are open. Under such conditions the switch 20 is in the position shown in the figure, the winding 21 being deenergized inasmuch as the circuit is open to conductor 14' by the contacts 3 and 3' of the relay 1, and also by the contacts 28 and 28' of the switch 20. Only contacts 30 and 30' are closed whereby the grid 31 is connected to the negative terminal of the anode supply source, that is, the resistor 38. The voltage drop across portion B of the resistor 38 is so chosen that the grid is biased sufficiently negative to reduce the plate current flow either to zero or such a small value which will not energize the winding 40 of the relay 25. The contacts 24 and 24' of the latter are, normally, closed similarly as the contacts 22 and 22' of the push button switch 23. The load circuit to be controlled comprising the lamps 18 is deenergized from the line 14 and 14' due to the open contacts 29 and 29' of the switch 20. The entire system is at rest.

A momentarily unbalance due to a capacitive change between the electrodes 10 and 8 of the glow tube 7 will cause closure of the relay 1 bridging the contacts 3 and 3'. Instantaneously the winding 21 becomes energized and contacts 28 and 28' close the circuit permanently to the winding 21 so that further opening of the contacts 3 and 3' have no effect as far as the switch 20 is concerned, which now is locked in position, being energized directly from the line. Simultaneously the contacts 29 and 29' are also closed and the lamps 18 are now supplied with current from the conductors 14 and 14'. The closure of contacts 28 and 28' and 29 and 29' is accompanied by the opening of contacts 30 and 30', whereby the grid 31 is disconnected from the negative side of the supply source. The grid circuit is now completed to the cathode 35 through the resistor 41. The latter in combination with the condenser 42 provides the necessary time constant since the charge accumulated by the condenser 42 when the contacts 30 and 30' were closed must first discharge through the resistor 41, and until such time as the discharge takes place there is a negative bias on the grid 31. The time of discharge of the condenser can be regulated by the slider 45 of the resistor 41 which will vary the effective resistance through which the capacity 42 must discharge. As the condenser discharges the negative bias on the grid 31 will be progressively diminished and plate current of the tube 32 will correspondingly rise until a value is reached which is sufficient to actuate the winding 40 of the relay 25 which will open the contacts 24 and 24'. When these contacts are opened the winding 21 of the switch 20 is deenergized being disconnected from the conductor 14 and the switch will resume the position shown in the drawing, closing the contacts 30 and 30' and opening the others. Closure of these contacts instantaneously puts a negative bias on the grid 31. The opening of the other contacts disconnects the short circuit of the contacts 3 and 3' and removes the load circuit from the line 14 and 14'. The system is again at rest until successive action of the glow tube repeats the operating cycle. The delay circuit may at any time be reset to its starting position by the push-button switch 23 which opens the circuit to the winding 20 in the same manner as does the relay 25.

In a practical embodiment of the invention, the following circuit constants were utilized:

Resistor 41	megohms	5
Portion A of resistor 38	ohms	15,000
Portion B	do	5,000
Condenser 42	microfarads	12
Condenser 39	do	16

The tube used was an RCA type 12A7, diode-pentode. A maximum delay of approximately one hour was obtained between the time of operation of the relay 1 to the resetting of the system.

I claim as my invention:

1. In a time delay circuit, an electron discharge device, an input circuit connected be-

tween grid electrode and cathode and an output circuit connected between anode and cathode thereof, a relay energized from said output circuit having normally closed contacts, a capacity in said input circuit, means for charging said capacity to a potential sufficiently negative to bias said grid electrode to a space current value ineffective for the energization of said relay, said means including a source of voltage, certain closed contacts of a switch having a plurality of open contacts an actuating winding and an energizing circuit for said switch including said normally closed contacts of said relay, and circuit closing contacts, closure means for said last mentioned contacts momentarily operable whereby upon energization of said winding said open contacts of said switch are closed and said closed contacts are open, one of said first mentioned contacts being operable to close said circuit to said winding and others to close a circuit to an energy utilization element, said open contacts being operable to disconnect said capacity, resistance means for discharging said capacity upon disconnection of said last mentioned contacts at a predetermined rate, whereby upon current flow in said output circuit said relay becomes energized opening said normally closed contacts and restoring said switch to its initial position.

2. A time delay circuit in accordance with claim 1 in which the circuit for the energization of said winding includes in series a manually operable switch for restoring said relay circuit to a succeeding operating cycle.

3. A time delay circuit in accordance with claim 1 in which said discharge device includes rectifier elements connected in series with a load resistor in said energizing circuit of said winding, said load resistor connected in circuit with the anode of said discharge device and a connection between said cathode to an intermediate point of said resistor.

FREDERICK E. BARTHOLY.