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ELECTRIC VALVE TIME-DELAY RELAY

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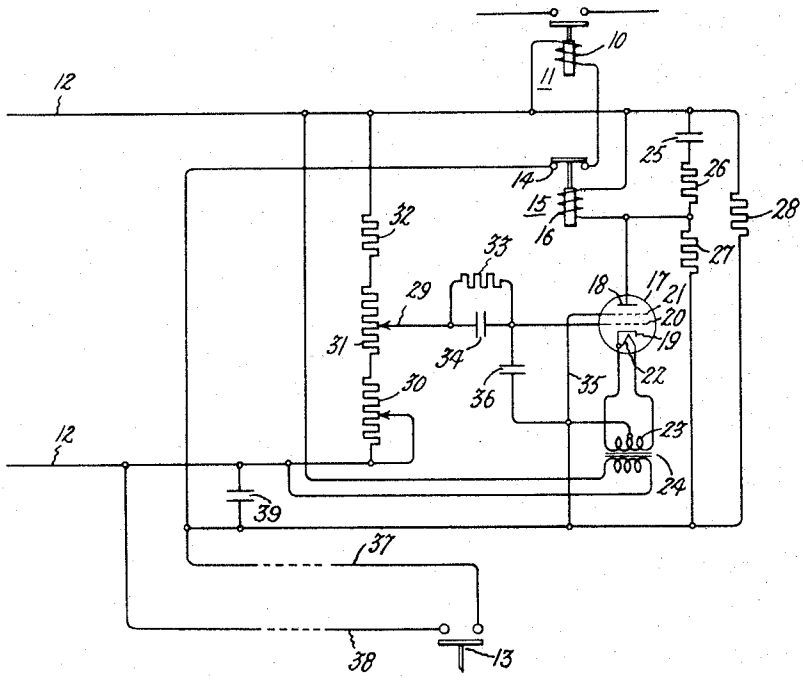

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ELECTRIC VALVE TIME-DELAY RELAY

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8 Claims. (Cl. 175—320)

My invention relates to time-delay relays of the type employing electric valves and more particularly to an improved circuit of this type which provides uniform operation for a given time setting.

Time-delay relays employing electric valves and some energy-storage means for controlling the conductivity thereof have been widely used in industrial applications. It has frequently occurred that these relays have functioned erratically when included in a particular installation. I have found that much of this erratic operation is due to transient voltages which are impressed on the control member of the electric valve. In accordance with the teachings of my invention, I provide an improved electric valve time-delay circuit which is characterized by the uniformity of its operation for a given time setting.

It is an object of my invention to provide a new and improved time-delay circuit.

It is another object of my invention to provide a new and improved electric valve time-delay relay circuit.

It is a still further object of my invention to provide a new and improved time-delay relay employing an electric valve in which erratic operation resulting from transient voltages introduced into the circuit of the control member is substantially eliminated.

In accordance with the illustrated embodiment of my invention, I provide an improved circuit for controlling the energization of a load circuit for a predetermined time interval after the closure of an initiating switch by means including an electric valve which is rendered conductive at the end of the time interval. The circuit is, in general, similar to the time-delay circuits described and claimed in my Patents 2,171,347 and 2,171,348, dated August 29, 1939, and assigned to the assignee of the present application. An energy-storage means, such as a capacitor, is connected across the conductors leading to the initiating switch which is often located remotely with respect to the remainder of the relay circuit. This capacitor has been found very effective in eliminating erratic operation of the relay which is believed to result from transient voltages appearing across the conductors connected with the initiating switch. It will be noted that the initiating switch is included in the cathode-to-control-member circuit of the electric valve and that the load current flows through the initiating switch immediately upon closure thereof. If there is momentary bouncing of the contacts of the initiating switch upon closure thereof, transient voltages will appear across the switch contacts to cause further charge of the timing capacitor and thereby change the operating time of the relay circuit. In applications where the initiating switch is remote from the remainder of the relay circuit, I have found that transient voltages may be induced in the conductors leading to the initiating switch which are of sufficient magnitude to cause erratic operation of the relay. These voltages are substantially eliminated by the use of the capacitor connected as shown in the illustrated embodiment.

My invention will be better understood by reference to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims. In the drawing, the single figure is a schematic representation of one embodiment of my invention.

In the single figure of the drawing, there is diagrammatically illustrated a time-delay circuit for effecting the energization of a load circuit, which, as illustrated, may comprise the coil 10 of an electromagnetic relay 11, from an alternating-current supply 12 for a predetermined interval of time after the closure of an initiating switch 13 which may be operated either manually or automatically. The initiating switch 13 and the operating coil 10 are connected in series relation with the contacts 14 of an electromagnetic relay 15 and across the alternating-current supply circuit 12. An operating coil 16 is provided for actuating the contacts 14. The energization of the coil 16 is controlled by an electric discharge device 17 which is preferably of the type employing an ionizable medium, such as a gas or a vapor, and which comprises an anode 18, a cathode 19, a control member or grid 20, a shield grid 21, and a cathode heater element 22. The midtapped secondary winding 23 of a transformer 24 energized from the supply circuit 12 provides means for energizing the heater element 22.

The anode-cathode circuit of the discharge device 17 is connected to the supply circuit in the following manner. The anode 18 thereof is connected to one side of the alternating-current circuit 12 through the operating coil 16 of the relay 15 which is parallelled by a series-connected capacitor 25 and resistor 26. The capacitor 25 provides means for energizing the coil 16 during the half cycles of the supply that the anode 18 is negative and the resistor 26 limits the

charging current of the capacitor 25 during the half cycles of supply voltage that valve 17 conducts current. A resistance 27 of a relatively high ohmic value is connected between the anode and cathode of the electric valve 17 and provides a path for energizing the winding 16 with an alternating-current of small magnitude after switch 13 is closed and before electric valve 17 is rendered conductive. The cathode of the electric valve is connected to one side of the alternating-current supply circuit through a resistor 28 and to the other side of the supply circuit through the initiating switch 13. The control member 20 of the electric valve is connected to an adjustable tap 29 on a voltage divider including resistance elements 30, 31, and 32, which are connected in series across the alternating-current supply circuit 12. Connected in series between the tap 29 and control member 20 is a biasing circuit including parallel connected resistor 33 and a capacitor 34. As illustrated in the drawing, the shield grid 21 is connected directly with the cathode by conductor 35 and a conventional transient-suppressing capacitor 36 is connected between the control member and cathode.

In installations causing the most trouble, from the standpoint of erratic operation, the initiating switch 13 is located remotely from the remainder of the relay and this has been illustrated in the drawing by interrupting the conductors 37 and 38 which lead to the initiating switch 13 by the dotted portions. The capacitor 39, which I have found substantially eliminates erratic operation of the timer, is connected across the conductors 37 and 38 close to the electronic relay.

In one timing circuit constructed in accordance with the teachings of the present application, resistor 28 is 500 ohms; resistor 30, 10,000 ohms; capacitor 34, .5 microfarad; capacitor 36, .002 microfarad, and capacitor 39, .05 microfarad. This timer was designed for operation from a 115 volt alternating current supply circuit.

A brief consideration of the operation of the illustrated embodiment of my invention will provide a better understanding of the objects and advantages thereof. When the initiating switch 13 is open, the capacitor 34 charges to a predetermined voltage by grid rectification. The voltage is determined by the position of the tap 29 on the voltage divider and is of a polarity to maintain the control member 20 negative. From an inspection of the drawing, it is seen that the charging circuit starts with the lower conductor of the alternating-current circuit 12 and includes resistor 30, a portion of resistor 31, tap 29, the grid-to-cathode circuit of the valve 17, and resistor 28 to the upper line of the alternating-current supply circuit. When it is desired to initiate energization of the load circuit 10, the switch 13 is closed and current immediately starts to flow through the coil 10 and normally closed contacts 14 of the relay 15. After the expiration of a predetermined time, the charge on the capacitor 34 is reduced sufficiently by discharge resistor 33 so that the alternating-current component of voltage appearing between the lower conductor 12 of the supply circuit and the tap 29 is sufficient to overcome the negative voltage of the capacitor to render the electric valve 17 conductive which, in turn, operates the relay 15 to terminate the energization of the load circuit. The relay may be reset by opening the initiating switch.

From a consideration of the drawing and the foregoing description of the operation of the illustrated embodiment, it will be apparent that the initiating switch 13 is connected in the cathode-to-control-member circuit of the electric valve 17 and also in series with load circuit 10 which, as illustrated, is inductive. When the switch 13 is closed, current immediately begins to flow through the load circuit 10 and any bouncing or momentary opening of the contact of switch 13 may cause transient voltages of considerable magnitude to appear across the contacts thereof. The introduction of this voltage in the circuit of the capacitor 34 causes it to charge to a voltage of different magnitude than would ordinarily be established by the position of the slider 29 and, therefore, cause erratic operation of the timer for a given setting of the slider. This tendency is substantially eliminated by the use of capacitor 39. In installations where conductors 37 and 38 are relatively long and are in proximity to other equipments such as relay contactors, the voltage induced in the cathode-to-control-member circuit of the electric valve 17 is sometimes sufficient to charge the capacitor 34 negatively and of a magnitude which resets the relay after the valve 17 has been rendered conductive or, expressed in another way, after the relay is timed out. These voltages are also substantially eliminated by the capacitor 39.

While I have shown and described a particular embodiment of my invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention in its broader aspects, and I, therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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

1. In combination, an alternating-current supply circuit, a load circuit, a relay including an actuating coil and a normally closed contact for controlling the energization of said load circuit, an electric valve including an anode, a cathode, and a control member, means for establishing a predetermined negative bias on said control member, means connecting the actuating coil of said relay to one side of said alternating-current circuit and to the anode of said electric valve, means including an initiating switch for connecting said cathode with the other side of said alternating-current supply circuit and for completing a circuit between the cathode and control member of said electric valve, and capacitance means connected across said initiating switch to eliminate from said cathode-to-control-member circuit transient voltages appearing across said initiating switch.

2. In combination, an alternating-current supply circuit, a load circuit, an electric valve including an anode, a cathode, and a control member, means connecting said anode for energization in accordance with the voltage of one side of said alternating-current circuit, means for connecting said cathode to the same side of said alternating-current circuit, a capacitor, means connecting said control member through said capacitor to a voltage intermediate the voltage of the lines of said alternating-current circuit to establish a predetermined negative voltage on said control member, an initiating switch connected between said cathode and the other line of said alternating-current supply circuit for completing the anode-cathode circuit of said electric valve for energization from said supply circuit

and for completing an external circuit between the cathode and control member of said electric valve to include the voltage of said capacitance and an alternating-current component of voltage dependent upon the voltage at said intermediate point, a discharge circuit for said capacitor, and capacitance means connected across the contacts of said initiating switch for eliminating the effect of transient voltages on the charge of said capacitor.

3. In combination, a supply circuit, an electric valve including an anode, a cathode, and a control member, a voltage divider connected across said supply circuit, a timing capacitor, means connecting said capacitor between a point on said voltage divider and said control member, means connecting said anode for energization from one side of said alternating-current circuit, means connecting said cathode through an impedance element to said one side of said alternating-current circuit to establish a charging circuit for said capacitor including the internal cathode-to-control-member circuit of said electric valve, a discharge circuit parallelling said capacitor, an initiating switch for connecting said cathode to the other side of said alternating-current supply circuit and thereby preventing further charge of said capacitor, said initiating switch also completing the external cathode-to-control-member circuit of said electric valve to impress thereon an alternating-current component of voltage and the voltage of said capacitor, the discharge of said capacitance determining the time after closure of said initiating switch that said electric valve is rendered conductive, means responsive to conduction of said valve for terminating the energization of said load circuit, and energy-storage means connected across said initiating switch for rendering the operation of said electric valve independent of transient voltages induced in the leads to said initiating switch or caused by closure of said initiating switch.

4. In combination, an alternating-current supply circuit, a relay having an actuating coil, an electric valve having an anode, a cathode, and a control member, an initiating switch, means connecting said initiating switch, the operating coil of said relay, and the anode-cathode circuit of said electric valve in series relation and for energization from said supply circuit, a voltage divider energized from said supply circuit, a timing capacitor connected between a point on said voltage divider and the control member of said electric valve, means connected with said cathode for completing a circuit from said point on said voltage divider through the internal cathode-to-control-member circuit of said valve to one side of said supply circuit to charge said capacitor to a predetermined value when said initiating switch is in the open position, said initiating switch being located to connect said cathode to the other side of said alternating-current circuit so that the contacts thereof are in the external cathode-to-control-member circuit of said electric valve, and capacitance means connected across said initiating switch to suppress transient voltages appearing across said switch and thereby eliminate erratic operation of said electric valve resulting from the effect of said transient voltages on said control member.

5. In combination, a supply circuit, a load circuit, an electric valve including an anode, a cathode, and a control member, an initiating switch, means for impressing a predetermined negative voltage on the control member of said electric valve when said initiating switch is open, a source of turn-on voltage, closure of said initiating switch being effective to connect said load circuit for energization from said supply circuit and said turn-on voltage in circuit with said control member, means for effecting reduction of said negative voltage at a predetermined rate so that said turn-on voltage renders said electric valve conductive after a predetermined interval of time, means responsive to conduction of said electric valve for interrupting the supply of energy to said load circuit, and capacitive means connected across the contacts of said initiating switch for suppressing transient voltages in the cathode-to-control-member circuit of said electric valve.

6. A control circuit for rendering an electric valve conductive after a predetermined interval of time comprising an electric valve having an anode, a cathode, and a control member, a supply circuit, a capacitor, means connecting said capacitor with said supply circuit and with said control member, means for connecting the cathode of said electric valve with said supply circuit so that said capacitor is charged to a predetermined voltage through the discharge path from control member to cathode of said electric valve, a source of turn-on voltage, an initiating switch operable when closed to alter the connection of said cathode with said supply circuit and for impressing said turn-on voltage on said control member so that said electric valve is rendered conductive when said capacitance has discharged a predetermined amount, and capacitance means connected across the contacts of said initiating switch to suppress transient voltages in the cathode-to-control-member circuit of said electric valve.

7. In combination, a supply circuit, an electric valve including an anode, a cathode, and a control member, an initiating switch for connecting the anode-cathode circuit of said valve for energization from said supply circuit, means for impressing a predetermined negative voltage on the control member of said electric valve when said initiating switch is open, a source of turn-on voltage, closure of said initiating switch being effective to connect said turn-on voltage in circuit with said control member, means for effecting reduction of said negative voltage at a predetermined rate so that said turn-on voltage renders said electric valve conductive to perform a controlling function a predetermined interval of time after closure of said initiating switch, and capacitance means connected between the cathode of said electric valve means and a point on the external cathode-to-control-member circuit of said valve means electrically more remote from said control member than said means for impressing a negative voltage on said control member.

8. In combination, an alternating-current supply circuit, a load circuit, an electric valve including an anode, a cathode, and a control member, means connecting said anode for energization in accordance with the voltage of one side of said alternating-current circuit, means for connecting said cathode to the same side of said alternating-current circuit, a capacitor, means connecting said control member through said capacitor to a voltage intermediate the voltage of the lines of said alternating-current circuit to establish a predetermined negative voltage on said control member, an initiating switch connected between said cathode and the other line of said

alternating-current supply circuit for completing the anode-cathode circuit of said electric valve for energization from said supply circuit and for completing the external cathode-to-control-member circuit of said electric valve to include the voltage of said capacitance and an alternating-current component of voltage dependent upon the voltage of said intermediate point, a discharge circuit for said capacitor, and capacitance means connected between said cathode and a point on the external cathode-to-control-member circuit of said electric valve more remote from said control member than said capacitor.

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