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ELECTRIC CONTROL CIRCUIT

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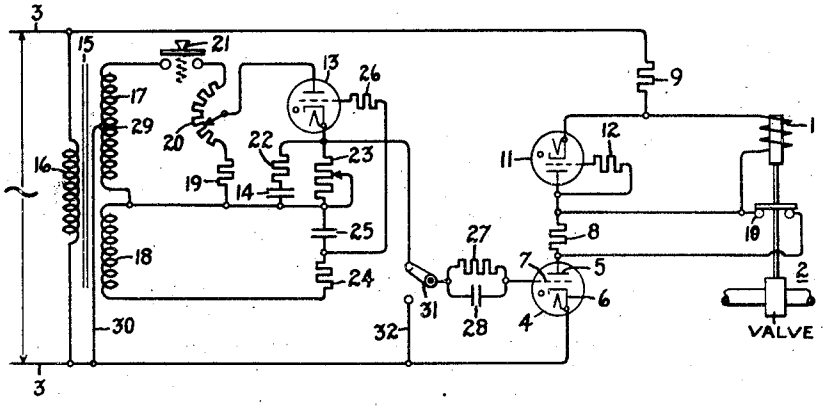

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ELECTRIC CONTROL CIRCUITS

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6 Claims. (Cl. 250—27)

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My invention relates to electric control circuits and more particularly to improved electronic time delay circuits.

It is an object of my invention to provide a new and improved electric control circuit.

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

It is a further object of my invention to provide a new and improved electronic time delay relay particularly adapted for controlling a load circuit having appreciable energy requirements.

In accordance with the illustrated embodiment of my invention, I have illustrated an electronic time delay relay for effecting the energization of the operating solenoid of a solenoid valve for a predetermined interval of time after closure of an initiating switch. The time interval is determined by the decay of voltage across a circuit including a capacitor connected in the control member circuit of an electric valve having an anode and cathode connected in series with the solenoid and across an alternating current supply circuit. The capacitor is charged from the voltage supply through an electric valve and a resistor. The time constant of the charging circuit is small so that the capacitor charges to the voltage of the supply in a very short interval of time. The capacitor is connected in the control member circuit of the electric valve in the charging circuit so that this valve is maintained nonconducting for at least the interval of the time delay so that the initiating switch, which controls the application of voltage to the charging circuit, may be closed for any interval ranging from a momentary closure to the full duration of the timing interval without altering the duration of the timing interval or the instant at which the timing interval is initiated.

For a better understanding of my invention, reference may be had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims. The single figure of the drawing diagrammatically illustrates an embodiment of my invention as applied to a system for effecting energization of a load circuit for a predetermined interval of time after the operation of an initiating switch.

Referring to the drawing, a load circuit, such as the operating coil 1 of a solenoid valve 2, is connected for energization from an alternating current supply circuit 3 under the control of an electric discharge device 4. The electric discharge device may be any of the types well known

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in the art, and, as illustrated, comprises an anode 5, a cathode 6, and a control member or grid 7. These electrodes are mounted within an envelope containing an ionizable medium, such as a gas or a vapor. The operating coil 1 of the solenoid valve 2 is connected in series with the anode-cathode circuit of electric valve 4, resistors 8 and 9, and across the alternating current supply line 3. The resistor 8 is short circuited by a normally closed contact 10 controlled by the solenoid 1 and is inserted in circuit with the coil 1, upon energization thereof, to decrease the energizing current. An electric valve 11, preferably also of the gas filled type, is connected across the terminals of the operating coil of the solenoid 1 and is poled oppositely with respect to the electric valve 4 to provide a path for current flow upon reversal of voltage across the terminals of the operating coil. This provides for smoother flow of energizing current through the coil 1 from the alternating current source. The electric valve 11 operates as a diode with the control member thereof connected with the anode through a resistor 12.

The energization of the control member 7 of electric valve 4 is accomplished by a control circuit including an electric valve 13, a capacitor 14 and a supply of alternating current voltage including a transformer 15. The transformer 15 is provided with a primary winding 16 connected for energization from the alternating current supply lines 3, and with a pair of secondary windings 17 and 18. Voltage dividing resistors 19 and 20 are connected in series with a normally open initiating switch 21 and across winding 17 to provide a supply of alternating voltage for the anode-cathode circuit of electric valve 13. The capacitor 14 with a series current limiting resistor 22 is connected in series with the anode-cathode circuit of electric valve 13 and across resistor 19 and an adjustable portion of resistor 20 to provide a charging circuit for capacitor 14 controlled by the conduction of valve 13 in response to closure of the operating switch 21. An adjustable resistor 23 connected in parallel with the capacitor 14 and series resistor 22 establishes a discharge circuit for the timing capacitor 14. The resistor 23 is of large magnitude compared with resistor 22 so that capacitor 14 may be charged in a very small interval of time compared with the timing interval as determined by the discharge of capacitor 14 through resistors 22 and 23. A dephased component of alternating voltage for energizing the control member of valve 13 is provided by a series connected re-

sistor 24 and capacitor 25 energized from the transformer secondary winding 18. The control member of the valve 13 is connected with the cathode thereof through a circuit including a current limiting resistor 26, the capacitor 25 and the resistor 23. As a result of this connection there is supplied to the control member of valve 13 the component of alternating voltage appearing across capacitor 25 and the voltage across resistor 23 in the discharge circuit of capacitor 14. As will be described later, the voltage across capacitor 25 lags the voltage of the anode of valve 13 to render the valve conducting at an early point in the positive anode voltage following closure of initiating switch 21. Capacitor 14 immediately charges to the full voltage of the charging circuit and maintains electric valve 13 non-conducting for succeeding half cycles of the supply circuit independently of the operating position of the initiating switch 21.

The voltage of the control member or grid 7 of electric valve 4 is energized by the resultant of three voltages including a negative component of voltage provided by the self-biasing component including a parallel resistor 27 and capacitor 28, the voltage of resistor 23 as determined by the voltage of capacitor 14 and an alternating current hold-off voltage provided by the portion of the winding 17 below the intermediate terminal 29 which is connected with the cathode of the electric valve 4 through conductor 30. A single-pole, double-throw switch 31 is connected in the circuit of the control member between the self-biasing circuit and resistor 33 which may be employed to connect the control member of valve 4 to the cathode thereof through a conductor 32 to energize the solenoid 1 continuously from the alternating current source 3 independently of the control circuit including electric valve 13.

A brief consideration of the operation of the illustrated embodiment of my invention will provide a better understanding of the features and advantages characterizing my invention. When it is desired to effect energization of the solenoid 1 for a predetermined interval of time, the initiating switch 21 is closed. Immediately upon closure of the switch, the alternating voltage appearing across the lower portion of the voltage dividing resistor 20 and resistor 19 is impressed on the anode-cathode circuit of electric valve 13. The electric valve 13 is rendered conductive in the early portion of the first positive half wave of anode voltage because of the lagging component of alternating voltage impressed on the control member by capacitor 25. Since the resistor 22 is small and the time constant of the charging circuit of capacitor 14 is short, the capacitor 14 reaches the full peak value of voltage impressed on the anode-cathode circuit of the electric valve in a small portion of a half cycle. As soon as the capacitor 14 becomes charged, it impresses a positive voltage component on control member 7 of electric valve 4 sufficient to overcome the voltage components impressed on this control member by the self-biasing circuit and the lower portion of winding 17 to render valve 4 conducting and initiate a period of energization of solenoid 1. Following each half cycle of conduction by electric valve 4, the voltage across the terminals of the winding of the solenoid reverses and energizing current continues to flow through the shunt path established by electric valve 11. The duration of the energization of solenoid 1 is determined by

the interval required for capacitor 14 to discharge through resistor 23 sufficiently to render the voltage of control member 7 less positive than the critical voltage. The duration of the interval may be adjusted by adjusting the position of the movable contact of voltage dividing resistor 20 or adjusting the effective magnitude of resistor 23. As previously mentioned, the voltage of resistor 23 also appears in the circuit of the control member of electric valve 13 as a negative voltage to maintain this valve nonconducting after the first half cycle of conduction for a period at least as great as the timing interval, so that the moment of initiation and the duration of the timing interval are independent of the length of time that the initiating switch is closed. This double function of the capacitor 14 in controlling both the electric valves 4 and 13 contributes to the simplicity and effectiveness of the illustrated embodiment of my invention.

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. An alternating current supply circuit, an electric valve having an anode, a cathode and a control member, a load circuit, means connecting said load circuit in series with the anode-cathode circuit of said electric valve and for energization from said supply circuit, an excitation circuit for controlling the energization of said control member including means for impressing a voltage on said control member tending to maintain said valve nonconducting, means for impressing a transient voltage on said control member to render said valve conducting for a predetermined interval and including a capacitor and a resistor connected in parallel therewith for establishing a discharge circuit for said capacitor, means for charging said capacitor including a second electric valve having a control member, and means for connecting said capacitor in the cathode-to-control member circuit of said second electric valve to prevent conduction by said second electric valve during the timing interval and after initial charge of said capacitor.

2. A supply circuit, an electric valve having an anode, a cathode and a control member, a load circuit, means connecting said load circuit in series with the anode-cathode circuit of said electric valve and for energization from said supply circuit, means for energizing said control member to effect conduction of current from said supply circuit by said electric valve for a predetermined interval including means for impressing a voltage on said control member tending to maintain said valve non-conducting, means for impressing a transient voltage on said control member for overcoming the effect of said first mentioned voltage for a predetermined interval including a capacitor having charging and discharging circuits, said discharging circuit including a resistor connected in circuit with said control member, said charging circuit including a supply of alternating current voltage and a second electric valve of the gas-filled type having a control member, means for impressing a voltage component on the control member of said second electric valve to render said valve conducting,

means connecting said capacitance in the control member circuit of said second electric valve to prevent conduction of said second electric valve after the initial half cycle of conduction during which said capacitor is charged, and initiating means for initiating an interval of energization of said load circuit including a switch for controlling the application of alternating current to the anode-cathode circuit of said second electric valve.

3. In combination, a capacitor, a supply of alternating current voltage, an electric valve including an anode, a cathode and a control member, means for connecting said capacitor in circuit with said supply of alternating current voltage and the anode-cathode circuit of said electric valve to establish a charging circuit for said capacitor, a discharge circuit for said capacitor including a resistance element connected in parallel with said capacitor, a second electric valve including a control member, means for impressing a voltage on said control member tending to maintain said second electric valve nonconductive, means for impressing a voltage on the control member of said second electric valve dependent upon the charge on said capacitor and having a polarity tending to render said second electric valve conductive, and means connecting said capacitor in circuit with the control member of said first electric valve to maintain said first electric valve nonconducting for at least the interval of conduction of said second electric valve, the time constant of said charging circuit being sufficiently short to permit full charging of said capacitor during a portion of a half cycle of voltage of said alternating current supply.

4. A supply circuit, an electric valve having an anode, a cathode and a control member, means for energizing said control member to effect conduction of current from said supply circuit by the anode-cathode circuit of said electric valve for a predetermined interval including means for impressing a voltage on said control member tending to maintain said valve nonconducting, means for impressing a transient voltage on said control member for overcoming the effect of said first mentioned voltage for a predetermined interval including a capacitor having charging and discharging circuits, said discharging circuit including a resistor connected in circuit with said control member, said charging circuit including a supply of alternating current voltage and a second electric valve of the gas-filled type having a control member, means for impressing a voltage component on the control member of said second electric valve to render said valve conductive, and means connecting said capacitance in the control member circuit of said second electric valve to prevent conduction of said second electric valve for a predetermined interval after charging of said capacitor.

5. In combination, a capacitor, a supply of alternating current voltage, an electric valve including an anode, a cathode and a control member, means for connecting said capacitor in circuit with said supply of alternating current voltage and the anode-cathode circuit of said electric valve to establish a charging circuit for said capacitor, a discharge circuit for said capacitor including a resistance element connected in parallel with said capacitor, a second electric valve including a control member, means for impressing a voltage on said control member tending to maintain said second electric valve nonconductive, means for impressing a voltage on the control member of said second electric valve dependent upon the charge of said capacitor and having a polarity tending to render said second electric valve conductive, and means connecting said capacitor in circuit with the control member of said first electric valve to maintain said first electric valve nonconducting for at least the interval of conduction of said second electric valve.

6. An alternating current supply circuit, a first electric valve having an anode, a cathode and a control member, means connecting the anode-cathode circuit of said first electric valve for energization from said supply circuit, an excitation circuit for controlling the energization of said control member including means for impressing a voltage on said control member tending to maintain said first valve nonconducting, means for impressing a transient voltage on said control member to render said first valve conducting for a predetermined interval and including a capacitor and a discharge circuit therefor, means for charging said capacitor including a second electric valve having a control member, and means for connecting said capacitor in the cathode-to-control member circuit of said second electric valve to prevent conduction by said second electric valve for at least the duration of the interval of conduction by said first electric valve and after initial conduction by said second electric valve to charge said capacitor.

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