

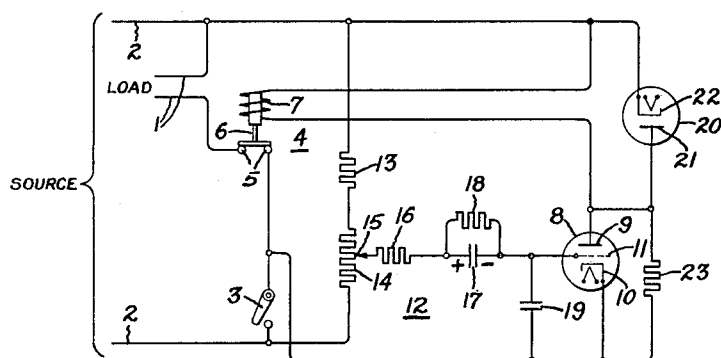
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ELECTRIC VALVE TIME DELAY RELAY

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ELECTRIC VALVE TIME DELAY RELAY

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My invention relates to electric valve circuits and more particularly to electric circuits comprising electric valve means for obtaining a predetermined time delay.

In electrical and industrial operations, it is frequently desirable to provide control apparatus which operates a predetermined time after an initiating operation. For example, it is sometimes desirable to effect energization of a load circuit for a predetermined interval of time and to effect deenergization of the load circuit at the expiration of a predetermined interval of time. Furthermore, it is important to provide apparatus which is simple in construction and arrangement and which uses only inexpensive devices without involving a sacrifice in the precision of control obtainable. Furthermore, where it is required to effect operation of contactor mechanism, it is important that the system operate in a manner to impose a minimum duty on the circuit closing and opening contacts so that these contacts may be employed for a reasonable period of time. In accordance with the teachings of my invention described hereinafter, I provide a new and improved electric valve time delay relay which is definite and precise in its operation and which functions in a manner to impose a minimum current interrupting duty on the contacts of an associated contactor mechanism.

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 circuit.

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

It is a still further object of my invention to provide a new and improved alternating current time delay relay employing an electric valve or an electronic discharge device of the type employing an ionizable medium such as a gas or a vapor.

In accordance with the illustrated embodiment of my invention, I provide a new and improved alternating current time delay relay which comprises an electronic discharge device of the controlled type having a control grid which renders the discharge device conductive. Means such as a voltage divider and a capacitance are connected across a source of alternating current to impress on the control grid a negative potential which tends to maintain the discharge device nonconductive. A load circuit is connected to be energized from the alternating current source through a contactor mechanism having normally

closed contacts connected in series relation with the load circuit and having an actuating coil. A switch is also connected in series relation with the load circuit and the contacts of the contactor mechanism. When in a conducting condition, the electronic discharge device energizes the actuating coil and opens the contacts which are normally maintained in the closed circuit position. A unidirectional conducting device, such as an electric valve, is connected across the actuating coil of the contactor mechanism so that a substantially uniform current is conducted through the coil to prevent chattering of the contacts. Upon closure of the switch, the load circuit is energized and remains energized until the expiration of a predetermined interval of time established by the period of discharge of the capacitance, at which time the electronic discharge device is rendered conductive effecting energization of the actuating coil to open the associated contacts and thereby effect deenergization of the load circuit. Upon opening of the switch, the electronic discharge device is rendered nonconductive. Suitable adjustments are provided so that the contacts are opened at a zero point of the current wave, thereby imposing substantially no current interrupting duty on the contacts of the contactor mechanism.

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 accompanying drawing diagrammatically illustrates an embodiment of my invention as applied to an arrangement for effecting energization of a load circuit for a predetermined interval of time upon the operation of a switch.

In the single figure of the drawing there is diagrammatically illustrated an embodiment of my invention as applied to an alternating current time delay relay arrangement. A load circuit 1 is arranged to be energized from an alternating current source 2 for a predetermined interval of time after the closure of switch 3. Connected in series relation with the load circuit 1 and the switch 3, I provide a contactor mechanism 4 comprising stationary contacts 5, an armature 6 and an actuating coil 7. The load circuit 1, the contacts of mechanism 4 and the switch 3 are all connected in series relation across the alternating current source 2.

I provide an electronic discharge device 8 which is preferably of the type employing an ionizable medium, such as a gas or a vapor, and

which comprises an anode 9, a cathode 10 and a control grid 11 which renders the electronic discharge device conductive when a suitable positive potential relative to the cathode is impressed thereon. The anode-cathode circuit of the discharge device 8 controls the energization of the actuating coil 7 of the contactor mechanism 4 and is shown as being connected in series relation therewith. When the discharge device 8 is in a conducting condition, the actuating coil 7 is energized from the alternating current source 2 through the discharge device 8. As a means for impressing on the control grid 11 a negative biasing potential tending to maintain the discharge device 8 nonconductive, I provide a circuit 12 comprising a voltage divider including resistances 13 and 14 which are connected in series relation across the alternating current source 2. The resistance 14 is provided with an adjustable contact 15 to control the component of alternating potential derived from the source 2 which is impressed on the control grid 11. A current limiting resistance 16 may be connected in series relation with the control grid 11. A capacitance 17 is connected in series relation with the control grid 11 and provides a negative unidirectional biasing potential which is impressed on the grid 11. A resistance 18 is connected across the capacitance 17 and controls the rate at which the capacitance 17 discharges. As a means for suppressing extraneous transient voltages which may be present in the system, I connect a capacitance 19 across the control grid 11 and the cathode 10.

To transmit a substantially uniform current to the actuating coil 7 when it is desired to energize the actuating coil and to prevent thereby chattering of the contacts of the mechanism 4, I provide a suitable unidirectional conducting device, such as an electric valve 20, which may be of the high vacuum type or of the type employing an ionizable medium and comprises an anode 21 and a cathode 22. A suitable impedance element, such as a resistance 23, is connected across the anode and the cathode of the electronic discharge device 8.

The operation of the embodiment of my invention shown in the single figure of the drawing will be explained by considering the system when it is desired to effect energization of the load circuit 1 during a predetermined interval of time after the closure of switch 3. When the switch 3 is in the open circuit position, the upper terminal of the alternating current source 2 is connected to the cathode 10 of the electronic discharge device 8 through resistance 23 and the operating coil 6 of the contactor mechanism 4. The capacitance 17 is charged to the polarity indicated during the half cycles when the lower terminal of circuit 2 is positive relative to the upper terminal and through a circuit including the lower portion of resistance 14, resistance 16, capacitance 17, the grid-cathode circuit of discharge device 8, resistance 23 and coil 7 of contactor mechanism 4. The magnitude of the charge is dependent upon the voltage obtained from that part of the circuit including the upper terminal of the alternating current source 2 and the adjustable contact 15 of resistance 14. The cathode 10 of the electronic discharge device 8 is also connected to the upper terminal of the source 2 through contacts 5 of the contactor mechanism 4 and the load circuit 1. The manner in which the capacitance 17 assumes the negative charge, as indicated in the drawing, will be well understood. This charge is accumulated on the plates

of the capacitance 17 by virtue of the electron current which flows between the cathode 10 and the control grid 11.

Upon closing of the switch 3, the load circuit 1 is energized from the alternating current circuit 2 through the contacts 5 of mechanism 4 and switch 3. The voltage then applied to the grid 11 and the cathode 10 of the electronic discharge device 8 consists of two components. One of these components is the alternating current voltage derived from the lower terminal of source 2 and the adjustable contact 15 of the resistance 14. This component of voltage is derived from circuit 2 through resistance 13, the upper portion of resistance 14, contactor 15, resistance 16, capacitance 17, the grid-cathode circuit of discharge device 8 and switch 3. The other component is the unidirectional component of voltage appearing across the capacitance 17. Immediately after the closure of switch 3, and for a predetermined interval of time thereafter depending upon the setting of the circuit, the negative unidirectional component provided by the capacitance 17 predominates and, therefore, maintains the electronic discharge device 8 nonconductive. So long as the electronic discharge device 8 is maintained nonconductive, the load circuit 1 is energized. However, the negative unidirectional component of voltage produced by capacitance 17 immediately commences to decrease because capacitance 17 discharges through resistance 18. After a predetermined interval of time the control grid 11 becomes more positive with respect to the critical control voltage of the discharge device 8 and the discharge device 8 conducts current due to the establishment of an arc discharge between the cathode 10 and the anode 9. The decrease in the potential of grid 11 is due to the discharge of the capacitance 17 through resistance 18. Owing to the conduction of current by the discharge device 8, the actuating coil 7 of the contactor mechanism 4 is energized, thereby raising the armature 6 and opening the contacts 5. Upon such operation, the load circuit 1 is deenergized a predetermined interval of time after the operation of switch 3. The length of the period of time delay may be adjusted by positioning adjustable contact 15 of resistance 14. As the contact 15 is moved upward along the resistance 14, the period of time delay is reduced and attains a minimum value in the uppermost position. Conversely, as the adjustable contact 15 is moved downward, the period of time delay is increased and attains a maximum value in the lowermost position. The length or duration of the minimum and maximum time delay intervals depends upon a number of factors, the principal ones being the capacitance 17, and the resistance 18. The minimum time delay also depends upon the value of resistance 13 and the resistance 14.

Upon opening the switch 3, the electronic discharge device 8 is again rendered nonconductive, effecting deenergization of the actuating coil 7 and thereby closing the contacts 5. Of course, the load circuit is deenergized since the switch 3 is in the open position.

The electric valve 20 serves to transmit current to the actuating coil 7 during the half cycles when the electronic discharge device 8 is nonconductive during the desired period of energization, thereby effecting a transmission of a relatively uniform current to the actuating coil 7 and preventing chattering of the contacts 5 and the armature 6. The electric valve 20 connected

across the actuating coil 7 provides a path for current during the half cycles in which the electronic discharge device 8 does not pass current. Energy is stored in the inductance of the coil 7 on the half cycles of one polarity during which the discharge device 8 is conductive. Some of this energy is dissipated during the half cycles of opposite polarity by discharging through the electric valve 20. The result is the transmission of a substantially continuous current through the actuating coil 7.

The embodiment of my invention shown in the single figure of the drawing is susceptible of accurate timing. Although the switch 3 may be closed at random points during the cycles of alternating voltage of circuit 2, the armature 6 of the contactor mechanism 4 is raised at a definite point during the cycles for a given setting of the adjustable contact 15. Thus, the voltage divider may be set so that the contacts 5 are opened when the current is substantially zero, consequently reducing the wear on the contacts 5 and the armature 6. In this manner, substantially no current interrupting duty is imposed on the contacts 5.

While I have shown and described my invention as applied to a particular system of connections and as embodying various devices diagrammatically shown, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention, 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 circuit, a load circuit, a contactor mechanism having a pair of normally closed contacts and an actuating coil therefor, an electronic discharge device having an anode, a cathode and a control grid, the anode-cathode circuit of said discharge device being connected in series relation with said actuating coil to effect energization thereof from said source when in a conducting condition, and means tending to maintain said discharge device nonconductive comprising a voltage divider connected across said source and a capacitance connected between a point of said voltage divider and said control grid, a switch connected in series relation with said load circuit and said contacts across said source, said capacitance impressing on said control grid a negative potential tending to maintain said discharge device nonconductive for a predetermined interval after the closure of said switch.

2. In combination, a source of alternating current, a load circuit, a contactor mechanism having a pair of normally closed contacts and an actuating coil therefor, a switch, said load circuit, said contacts and said switch all being connected in series relation across said source, an electronic discharge device having an anode, a cathode and a control grid, the anode-cathode circuit of said discharge device being connected in series relation with said actuating coil and being connected across said source, a voltage divider connected across said source, a capacitance connected to be charged from said source through said load circuit, said contacts, a portion of said voltage divider and said electronic discharge device when said switch is in the open circuit position to maintain said electronic discharge device non-conductive, said capacitance

being discharged when said switch is moved to the closed circuit position to render said discharge device conductive a predetermined time after the closing of said switch.

3. A time delay relay comprising a source of alternating voltage, an electronic discharge device having an anode, a cathode and a control grid and being connected to be energized from said source, means energized from said source for impressing on said control grid a negative potential with respect to said cathode, a load circuit, a contactor mechanism having normally closed contacts connected in series relation with said load circuit and having an actuating coil which is connected in series relation with the anode-cathode circuit of said discharge device, and a switch connected in series relation with said load circuit and said contacts across said source.

4. A time delay relay comprising a source of alternating voltage, an electronic discharge device having an anode, a cathode and a control grid, means energized from said source and comprising a capacitance for impressing on said control grid a negative biasing potential tending to maintain said discharge device nonconductive, a load circuit, a contactor mechanism having normally closed contacts connected in series relation with said load circuit and having an actuating coil connected in series relation with the anode-cathode circuit of said discharge device, and a switch connected in series relation with said load circuit and said contacts across said source and being arranged to effect charging of said capacitance when in the open position and to initiate discharge of said capacitance when in the closed position to render said discharge device conductive a predetermined time after the closure thereof.

5. A time delay relay comprising a source of alternating voltage, an electronic discharge device having an anode, a cathode and a control grid and being connected to be energized from said source, means comprising a capacitance energized from said source for impressing on said control grid a negative potential with respect to said cathode tending to maintain said discharge device nonconductive, a load circuit, a contactor mechanism having normally closed contacts connected in series relation with said load circuit and having an actuating coil connected in series relation with the anode-cathode circuit of said discharge device, a switch connected in series relation with said load circuit and said contacts across said source and being arranged to effect charging of said capacitance when in the open position and to initiate discharge of said capacitance when in the closed position to render said discharge device conductive a predetermined time after the closure thereof, and a unidirectional conducting device connected across said actuating coil.

6. A time delay relay comprising a source of alternating voltage, an electronic discharge device having an anode, a cathode and a control grid and being connected to be energized from said source, means comprising a capacitance energized from said source for impressing on said control grid a negative potential with respect to said cathode tending to maintain said discharge device nonconductive, a load circuit, a contactor mechanism having normally closed contacts connected in series relation with said load circuit and having an actuating coil connected in series relation with the anode-cathode

5 circuit of said discharge device, a switch connected in series relation with said load circuit and said contacts across said source and being arranged to effect charging of said capacitance when in the open position and to initiate discharge of said capacitance when in the closed position to render said discharge device conduc-

tive a predetermined time after the closure thereof, a unidirectional conducting device connected across said actuating coil, and an impedance element connected across the anode and cathode of said discharge device.

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