

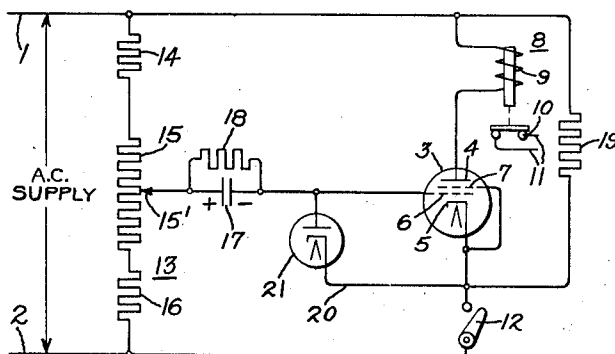
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TIME DELAY RELAY

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TIME DELAY RELAY

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My invention relates to electric valve time delay circuits, or time delay relays, in which an electric discharge device and associated equipment are provided for obtaining a precise timing interval.

Electric valve equipment has been employed for obtaining precise and definite time intervals and has found considerable application in those fields where it is desired to effect energization or de-energization of an associated load circuit, or an electrical device, a predetermined interval of time after the occurrence of a circuit controlling operation. In accordance with the teachings of my invention described hereinafter, I provide a new and improved electric valve timing circuit, or time delay relay, which is susceptible of greater speed of operation between the timing intervals than that afforded by prior art arrangements.

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

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

It is a further object of my invention to provide a new and improved electric valve system in which the energization or de-energization of an associated circuit may be controlled a predetermined interval of time after a controlling operation.

Briefly stated, in the illustrated embodiment of my invention I provide an electric valve timing circuit, or an electric valve time delay relay, which effects energization or de-energization of an associated circuit a predetermined interval of time after the operation of an associated circuit controlling means, such as a switch. I provide a means for accelerating the operation of the relay so that it may be reset between timing intervals in a more rapid manner than that provided heretofore.

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 an associated circuit, or load device, a predetermined interval of time after the operation of an associated control switch.

In the single figure of the drawing there is diagrammatically illustrated an embodiment of my invention as applied to an electric valve time

delay circuit or an electric valve time delay relay, which may be energized from an alternating current supply circuit, such as a source of alternating voltage comprising conductors 1 and

2. The time delay relay comprises an electric discharge device 3 which may be of the type employing an ionizable medium and comprising an anode 4, a cathode 5, and a control member such as a control grid 6. If desired, the electric discharge device may also be provided with an additional control member 7 which may be connected to the cathode 5. The anode-cathode circuit of the electric discharge device 3 may be connected to a load circuit, or a load device, such as a relay 8 comprising an actuating coil 9 and including contacts 10 which may be connected to control the energization of an associated circuit 11.

I provide a suitable circuit controlling means, such as a switch 12, which is connected to the cathode of the electric discharge device 3 and to one terminal of the alternating current source, such as conductor 2. As will be apparent in view of the description appearing hereinafter, the timing operation of the relay is initiated by closure of the switch 12 and the relay is reset by opening this switch.

I also provide across the source of alternating voltage a voltage divider 13 which may include resistances 14, 15 and 16, one of which, such as resistance 15, being provided with an adjustable contact 15'. The position of the adjustable contact 15' determines the timing interval of the relay. As the contact 15' is moved upward along the resistance 15, 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.

As an energy storage means for providing a negative potential which is impressed on grid 6 of electric discharge device 3 for maintaining this discharge device nonconducting for a predetermined interval of time after the closure of switch 12, I provide a capacitance 17 connected between the intermediate point of the voltage divider 13, as indicated on the drawing, and the grid 6. A discharge path including a resistance 18 is connected across the capacitance 17.

To provide a path for the charging of the capacitance 17 from the alternating current source during the time when the switch 12 is in the open circuit position, I provide an electric path which may include an impedance element,

such as a resistance 19, which is connected preferably between the cathode 5 and a point of the voltage divider 13 opposite the contact 15', as viewed from the cathode connection of the electric discharge device 3. In the particular embodiment of the invention illustrated, the resistance 19 is shown as being connected to the uppermost terminal of voltage divider 13. It is to be understood that the resistance 19 may be connected at any point along the resistance 14, or to any point of resistance 15 lying above the position of contact 15'. When the switch 12 is open, the timing capacitance 17 is charged to the polarity indicated through a circuit including the cathode-grid circuit of electric discharge device 3. As will be appreciated, the rate at which the capacitance 17 is charged depends in a measure on the impedance of the cathode-grid circuit of the electric discharge device 3.

In order to increase the rate at which the capacitance 17 is charged after opening switch 12 and, hence, as a means for increasing the reset speed of the relay, I provide an additional charging path 20 which is preferably connected to the cathode 5 and the common juncture of capacitance 17 and grid 6. The charging circuit 20 preferably includes a unidirectional conducting means, such as an electric valve 21, poled to establish a negative charge on the right-hand plate of capacitance 17 when the switch 12 is open. The unidirectional conducting means is preferably arranged to offer a substantially lower impedance than the cathode-grid impedance of the electric discharge device 3. That is, the unidirectional conducting means offers a substantially lower impedance to the flow of current than that offered by the cathode-grid circuit to the flow of grid-rectification current. In this manner, the reset speed of the relay is substantially increased, thereby increasing the field of application of the time delay relay.

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 operation of relay 8 a predetermined interval of time after the closure of the control switch 12. Prior to closure of switch 12, the capacitance 17 is charged to the polarity indicated during the half cycles of voltage of the alternating current source when the conductor 2 is positive in potential relative to conductor 1 through a circuit including resistance 16, the lower portion of resistance 15, capacitance 17, the cathode-grid circuit of electric discharge device 3, and resistance 19. A portion of the negative charge of the capacitance 17 is accumulated on the plates of capacitance 17 by virtue of the grid rectification current which flows between cathode 5 and grid 6.

Due to the presence of the additional charging circuit including electric valve 21, an additional path is provided in parallel with the cathode-grid circuit of the electric discharge device, thereby decreasing the resultant or net impedance of the path for charging the capacitance 17 during the time when the switch 12 is open. It will be noted that the electric valve 21 is poled to establish a charge on the capacitance 17 of the same polarity as that provided by the portion of the circuit including the cathode-grid circuit.

Upon closing switch 12, the electric discharge device 3 will not conduct current for a predetermined interval of time established by the constants of the circuit. The length or duration of the minimum and maximum time delay intervals

depends upon a number of factors, the principal ones being the value of the capacitance 17 and the value of resistance 18. The minimum time delay also depends upon the value of resistance 14 and resistance 15. The electric discharge device 3 is maintained nonconducting for a predetermined interval of time due to the negative voltage impressed on grid 6 by virtue of the charge of capacitance 17. There are two components of voltage impressed on grid 6 of the electric discharge device; one of these components is the alternating voltage derived from conductor 2 and the adjustable contact 15' of resistance 15. This component of voltage is derived from the source through resistance 14, the upper portion of resistance 15, capacitance 17, the grid-cathode circuit of electric discharge device 3 and switch 12. The other component is the unidirectional component of voltage appearing across the capacitance 17. Immediately after the closure of switch 12 and for a predetermined interval of time thereafter, depending upon the setting of the system, the negative unidirectional component provided by the pre-charge of capacitance 17 predominates and therefore maintains the electric discharge device 3 nonconducting. The negative unidirectional component of voltage produced by capacitance 17 immediately begins to decrease in magnitude upon closure of switch 12 because capacitance 17 discharges through resistance 18. After a predetermined interval of time, the grid 6 becomes sufficiently positive with respect to the critical control characteristic of the discharge device 3 and the device conducts current due to the establishment of the arc discharge between the cathode 3 and the anode 4. As soon as the electric discharge device 3 begins to conduct current, the load device or relay 8 will be energized effecting operation thereof and controlling the circuit 11 a predetermined interval of time after the closure of switch 12.

The relay is reset by opening switch 12. The capacitance 17 is charged to the polarity indicated during the half cycles of voltage of the source when conductor 2 is positive in potential relative to conductor 1. The circuit through which the capacitance 17 is charged during the reset period includes resistance 16, the lower portion of resistance 15, capacitance 17, the grid-cathode circuit of electric discharge device 3, and resistance 19. An additional charging circuit including the electric path 20 and electric valve 21 also operates in parallel with the grid-cathode circuit of electric discharge device 3 to increase the rate at which the capacitance 17 is charged. By employing the additional circuit 20 to expedite the establishment of a negative charge on the right-hand portion of capacitance 17, it will be appreciated that I provide a highly satisfactory arrangement for decreasing the reset time of the relay. This increased speed is of considerable importance in those applications where it is required to initiate the timing operations in rapid succession. Accordingly, it is of appreciable value to employ a time delay relay which requires a relatively short reset time.

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. A time delay relay comprising a voltage divider arranged to be connected across a source of alternating voltage, a grid controlled electric discharge device having its anode and cathode connected to be supplied from said source, a switch in the cathode connection, a capacitance connected between the grid and an intermediate point of said voltage divider, a resistance connected between said cathode and said voltage divider at a point thereof on the opposite side of said capacitance connection relative to said first mentioned cathode connection, and a charging circuit for said capacitance connected between said cathode and the common juncture of said capacitance and said grid.

2. A time delay relay for controlling the energization of a load circuit from a source of alternating voltage and including an electric discharge device having an anode, a cathode and a grid, a voltage divider connected across said source, a capacitance connected between an intermediate point of said voltage divider and said grid, a switch connected between said cathode and one terminal of said source, an impedance element connected between said cathode and a point of said voltage divider between said intermediate point and the other terminal of said source, and a unidirectional conducting device connected between said cathode and the common juncture of said capacitance and said grid.

3. A time delay relay for controlling the energization of a load circuit from a source of alternating voltage and including an electric discharge device having an anode, a cathode and a grid, a voltage divider connected across said source, a capacitance connected between said intermediate point of said voltage divider and said grid, a discharge circuit for said capacitance, a switch connected between said cathode and one terminal of said source, a resistance connected between said cathode and a point of said voltage divider opposite the cathode connection, and a unidirectional conducting device connected between said capacitance and said cathode for establishing a negative charge on said capacitance.

4. A time delay relay arranged to be connected across a source of alternating voltage including an electric discharge device having an anode, a cathode and a grid, the anode-cathode circuit being connected to be energized from said source, a voltage divider connected across said source, a switch in the cathode connection of said discharge device to said source, a timing capacitance connected between an intermediate point of said voltage divider and said grid, a conductive path from said cathode to one terminal of said source to establish a circuit for charging said capacitance through the grid-cathode circuit of said electric discharge device, and a unidirectional conducting device connected between said cathode and the common juncture of said capacitance and said grid to provide an additional path for increasing the rate at which said capacitance is charged.

5. A time delay relay for controlling the energization of a load circuit from a source of alternating voltage including an electric discharge device having an anode, a cathode and a grid, the anode-cathode circuit of the electric discharge device being connected to be energized from said source, a voltage divider connected across said source, a capacitance connected be-

tween an intermediate point of said voltage divider and said grid, a switch connected between the cathode and said source, an impedance element connected between said cathode and said source to establish a path for the charging of said capacitance to impress negative voltage on said grid when said switch is in the open circuit position, and a unidirectional conducting device connected between said cathode and the common juncture of said capacitance and said grid.

6. A time delay relay comprising a voltage divider arranged to be connected across a source of alternating voltage, an electric discharge device having its anode and cathode connected to be supplied from said source, a switch in the cathode connection of said discharge device to said source, a capacitance connected between the grid and an intermediate point of said voltage divider, a reactance connected between said cathode and a point of said voltage divider on the opposite side of the capacitance connection relative to the cathode connection for providing a path for charging said capacitance through the cathode-grid circuit of said electric discharge device to impress a negative voltage on said grid, and an additional charging circuit for said capacitance comprising a unidirectional conducting device connected between said cathode and the common juncture of said capacitance and said grid.

7. In combination, a source of alternating voltage, a load device, a time delay relay for effecting energization of said load device a predetermined interval of time after a controlling operation comprising an electric discharge device having an anode, a cathode and a grid, the anode-cathode circuit being connected to said load device and to said source, a voltage divider connected across said source, a capacitance connected between an intermediate connection of said voltage divider and said grid, a switch connected between said cathode and said source, a resistance connected between said cathode and one terminal of said source to provide a conducting path for the charging of said capacitance through the cathode-grid circuit of said electric discharge device when said switch is in the open circuit position, and an additional electric path for charging said capacitance comprising a unidirectional conducting device connected between said cathode and the common juncture of said capacitance and said grid.

8. A time delay relay comprising a voltage divider arranged to be connected across a source of alternating voltage, a grid controlled electric discharge device having its anode and cathode connected to be supplied from said source, a switch in the cathode connection, a capacitance connected between the grid and an intermediate point of said voltage divider, a resistance connected between said cathode and said voltage divider at a point thereof on the opposite side of said capacitance relative to the cathode connection, and a unidirectional conducting device connected in circuit with said capacitance for providing an additional path for accelerating the charging of said capacitance when said switch is in the open circuit position.

9. A time delay relay connected to be operated from a source of alternating voltage including an electric discharge device having an anode, a cathode and a grid, a capacitance, means for charging said capacitance to impress a negative unidirectional biasing potential on said grid to maintain said discharge device nonconducting for a pre-

determined interval of time and comprising a circuit including the grid-cathode circuit of said electric discharge device and a unidirectional conducting device connected to operate in parallel with the grid-cathode circuit of said electric discharge device for establishing a charge on said capacitance of the same polarity as that produced by the grid rectification current of said electric discharge device.

10. A time delay relay connected to be energized from a source of alternating voltage including an electric discharge device having an anode, a cathode and a grid, means including a capacitance for impressing on said grid a negative unidirectional biasing potential sufficient to maintain said discharge device nonconducting for a predetermined interval of time, means including the grid-cathode circuit of said electric discharge device for charging said capacitance by utilizing the grid rectification current of said discharge device, and means connected between said grid and said cathode for establishing a charge on said capacitance of the same polarity as that produced by the grid rectification current.

11. A time delay relay connected to be energized from a source of alternating voltage including an electric discharge device having an anode, a cathode and a grid, means including a capacitance for impressing on said grid a biasing potential sufficient to maintain said electric discharge device in a predetermined condition of conduc-

tivity for a predetermined interval of time, means including the grid-cathode circuit of said electric discharge device for charging said capacitance by utilizing the grid rectification current of said discharge device, and means including a unidirectional conducting device for establishing a charge on said capacitance of the same polarity as that produced by the grid rectification current to decrease the reset time required to restore said biasing potential on said capacitance.

12. A time delay relay connected to be energized from a source of current including an electric discharge device having an anode, a cathode and a grid, means including a capacitance for impressing on said grid a biasing potential sufficient to maintain said electric discharge device in a predetermined condition of conductivity for a predetermined interval of time, means including the grid-cathode circuit of said electric discharge device for charging said capacitance by utilizing the grid-rectification current of said discharge device, and means including a unidirectional conducting device having an impedance substantially smaller than that of the grid-cathode circuit of said electric discharge device for establishing a charge on said capacitance of the same polarity as that produced by the grid-rectification current to decrease the reset time required to restore said biasing potential on said capacitance.

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