Dec. 5, 1939. R. E. MARBURY 2,182,637

RELAY TIMING CIRCUITS AND SYSTEMS

Filed Nov. 24, 1937 2 Sheets-Sheet 1

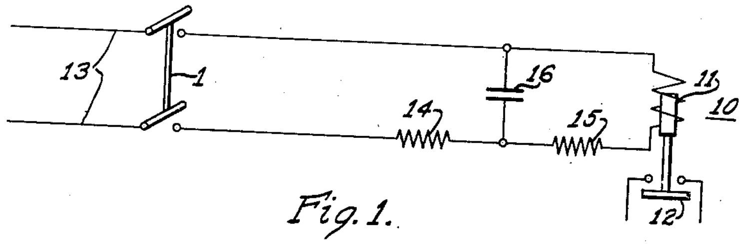

Fig. 1.

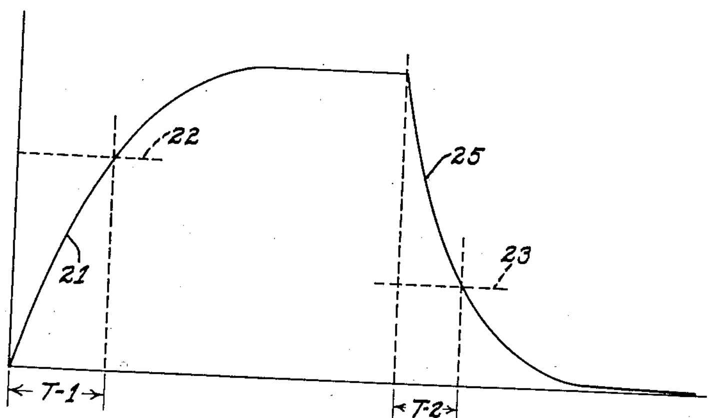

Fig. 2.

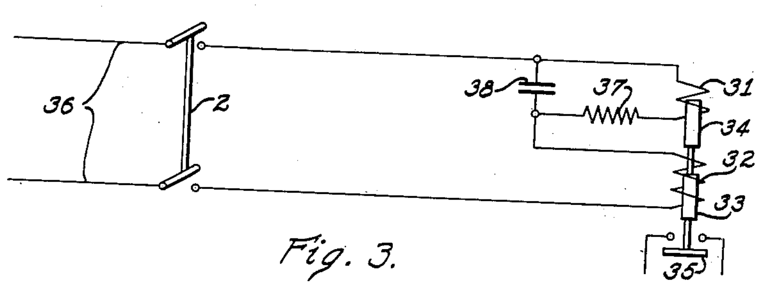

Fig. 3.

WITNESSES:
Leon M. Gorman
J. E. Foster

INVENTOR
Ralph E. Marbury.
BY
Paul E. Friedemann
ATTORNEY

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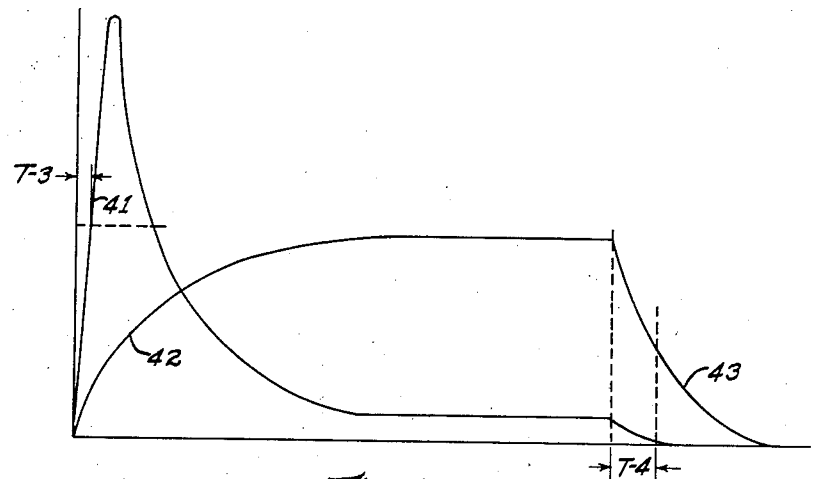

Fig. 4.

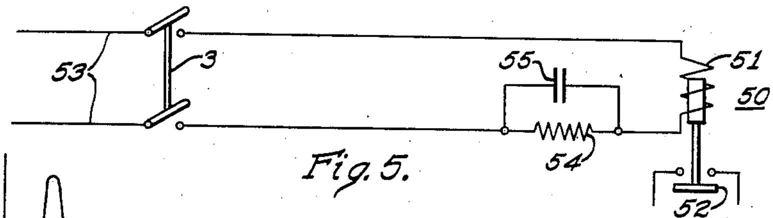

Fig. 5.

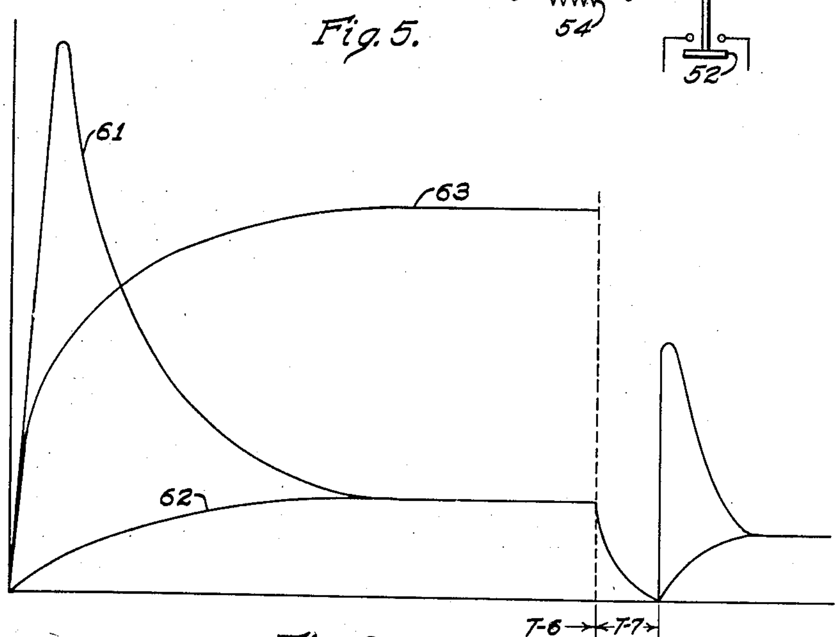

Fig. 6.

WITNESSES:
Leon M. Garman
J. E. Foster

INVENTOR
Ralph E. Marbury.
BY
Paul E. Friedemann
ATTORNEY

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UNITED STATES PATENT OFFICE

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RELAY TIMING CIRCUITS AND SYSTEMS

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

Application November 24, 1937, Serial No. 176,251

4 Claims. (Cl. 175—320)

This invention relates to relays and particularly to relay systems including fundamental electrical elements having time constants so related to the time constants of the relay winding or windings as to establish a desired time interval of operation for the relay, either in its forward or actuating operation, or in its backward or resetting operation.

An object of my invention is to provide a relay system embodying a combination of elements having time constants cooperatively related to those of the relay to establish a predetermined type of desired time operation and a predetermined type of desired time of resetting of the relay.

In electrical systems it is frequently desirable to control the time element in the actuating operation of a relay, to operate a switch, or in the resetting operation of the relay to perform the reverse operation of the switch, for the purpose of controlling an external circuit or an operation in a sequence of control. There are several types of timing operations frequently desired in a relay. One type of operation that may be desired is a delayed actuating or closing operation of the relay, and a delayed resetting or opening operation of the relay.

Another type of operation frequently desired is a quick actuating or closing operation of the relay, and a delayed resetting or opening operation of the relay.

A third type of operation frequently desired is that in which a fixed minimum time interval shall elapse between successive operations of a relay.

I have illustrated several relay circuits, respectively including a combination of fundamental electrical elements arranged to have electrical circuit constants cooperatively related to the electrical constants of the relay winding in such manner as to establish, purely electrically, the timing interval desired for the actuating or closing operation of the relay, or the timing interval desired for the resetting or opening interval of the relay.

Various circuits by means of which the several types of timing intervals are obtained in controlling the operation of a relay are illustrated in the accompanying drawings, in which:

Figure 1 is a diagram of an electrical circuit in which a relay is controlled to have both a delayed closing operation and a delayed opening operation;

Fig. 2 is a graph showing the operating and resetting time curves for the circuit of Fig. 1;

Fig. 3 is a diagram of an electrical circuit in which a relay is controlled to provide a quick closing or actuating operation, and a slow or delayed opening or resetting operation;

Fig. 4 is a graph showing the operating and resetting time curves for the circuit of Fig. 3;

Fig. 5 is a diagram of an electrical circuit in which a relay is to provide a minimum fixed interval between predetermined successive actuating operations; and

Fig. 6 is a graph showing the relay operating and resetting curves in relation to such time interval and other circuit conditions.

In the diagram shown in Fig. 1, a relay 10 is provided with a winding 11 and an element 12 controlled thereby that is illustrated, for the purpose of this invention, as a switch, or contact member. The relay is not limited to the control of an electrical circuit switch 12 but may be utilized to operate any mechanical member to perform a mechanical operation. The energization of the relay 10 is derived from a direct-current supply circuit 13, connected to a direct current source of supply, or through a rectifying device to an alternating current source of supply. For the purpose of this application, however, the energizing circuit 13 is a direct current circuit.

The operation and energization of the relay 10 by the direct current energy from the energizing circuit 13 is controlled by two resistors 14 and 15, and a condenser 16. The two resistors are connected in series with the winding 11 of the relay and the condenser 16 is connected to bridge or shunt the relay winding 11 and the resistor 15.

In the circuit shown in Fig. 1, the time constants of the resistors 14 and 15, and of the condenser 16, are so co-operatively related to the time constants of the winding 11 of the relay 10, that when the circuit 13 is first closed by switch 1 to energize the relay, the first current charge will be absorbed in charging the condenser 16, so that the energization of the winding of the relay to operate the relay will be delayed. The manner in which the energization of the relay winding is delayed is illustrated in Fig. 2, by the curve 21, representing the voltage across the relay coil. The relay pick-up value is shown by the horizontal dashed line 22. As the voltage across the relay reaches the value corresponding to the line 22, the relay winding 11 becomes energized to perform its operation to close the switch 12. As will be observed from the graph in Fig. 2, the curve 21 crosses the line 22 at a time T—1 after the energization of the circuit from the supply 13. That time is a function of the product of the resistance of resistor 14 and the capacitance of the condenser 16.

If, now, the relay is to be de-energized to permit the switch 12 to be opened, the circuit 13 is opened by switch 1 and energization of the relay 10 discontinued. The energy magnetically stored in the field of the winding 10 and in the condenser 16 must be dissipated, however, before the winding of the relay will be sufficiently de-energized to permit the relay to return to its initial de-energized position. The respective time constants of the relay winding 11 and of the resistor 15 and of the condenser 16 are so selected that they will cooperate to provide the time interval that is desired for the de-energization of the winding 11 of the relay to provide the time delay that is wanted.

Such time delay is illustrated by the curve 25 in Fig. 2, which illustrates the manner in which the current in the circuit of the winding 11 is slowly dissipated to the drop out value indicated by the horizontal line 23. The time T—2 between circuit opening and relay opening is a function of the product of the resistance and capacity constants of resistor 15 and condenser 16.

The circuit shown in Fig. 3 is arranged to provide a quick closing operation and a delayed opening operation of the relay 30. As shown in the drawings, the relay 30 comprises a main holding winding, or coil 31, and an auxiliary actuating or pick-up coil 32. The construction of the relay is schematically illustrated to show an actuating core 33 that is responsive to the actuating winding 32 and movable thereby to a position at which a holding core 34 will be moved into the holding magnetic zone of the holding winding 31 of the relay. Winding 31 is not sufficiently strong to actuate the relay, but will hold it in operated closed position once it has been moved thereto by the actuating winding 32. The relay 30, when closed, operates a switch or other similar member 35. The energization of the relay is derived from a direct current circuit 36, through the closure of switch 2 and the timing operations of the relay are controlled by a resistor 37 and a condenser 38. The resistor 37 is connected in series circuit relation between the two windings 31 and 32, and the condenser 38 is connected to bridge or shunt the resistor 37 and the relay holding winding 31.

When the circuit 36 is first energized, assuming switch 2 is closed, the immediate charging current impulse to the condenser 38 energizes the actuating winding 32 to actuate the relay to its operated or closed position, at which the holding core 34 is within the range of influence of the holding winding 31. While as the condenser is charged, the holding winding 31 becomes energized in series with the actuating winding 32 to an extent that is sufficient to hold the relay closed, although it is not sufficient to close the relay initially from its normally open position. With this circuit, the relay is provided with a quick closing operation.

When the relay is to be de-energized, the supply circuit 36 is de-energized or switch 2 is opened, and the actuating winding 32 becomes quickly de-energized according to its time constant which must be small. The time constant of the holding winding 31, however, is comparatively large, and its energy, together with the energy stored in the condenser 38, must be dissipated before the holding winding 31 will be sufficiently de-energized to release the holding core 34 to permit the relay to resume its initial open position.

The closing operation of the relay 30 is quickly effected, as indicated by the charging current curve 41 of Fig. 4, within the time interval T—3. In the meantime, the holding coil is energized, as shown in curve 42, to a value sufficient to hold the relay closed. When the relay circuit is opened to de-energize the relay, the time curve is illustrated by the curve 43 which represents the decaying current in the circuit of the holding winding. As illustrated, that current does not diminish to the drop-out value until the expiration of an interval T—4 after the energizing circuit 36 has been opened. That time interval is a function of the product of the constants of resistor 37 and condenser 38.

In Fig. 5 is illustrated a modified relay circuit in which a relay 50 is provided with a winding 51 to control a switch or similar mechanical element 52. The relay is energized from a direct current circuit 53 through a resistor 54 bridged by a condenser 55. When switch 3 is first closed, the relay 50 is energized to close its switch 52 quickly by reason of the charging current of the condenser 55. The relay then remains closed because of the holding current that then traverses the resistor 54 shunting the condenser 55. The relay 50 will now remain closed as long as circuit 53 is energized or connected to its source. If switch from the energized circuit 53 should now be opened, relay 50 would be de-energized and it would open immediately. The energy stored in the condenser 55, however, must be first dissipated in the closed circuit including the condenser 55 and the resistor 54 before a reclosure of the circuit 53 will be able to energize the winding 51 sufficiently to operate the relay. So long as the condenser 55 remains partially charged, the amount of charging current which it will immediately be able to receive will not be sufficient to re-energize and re-operate the relay 50. The relay will therefore remain insufficiently energized until the circuit 53 has remained open for a sufficient time to permit the condenser 55 to discharge or dissipate substantially its entire quantity of stored energy.

The manner in which the circuit in Fig. 5 operates is schematically illustrated by the graph in Fig. 6, in which curve 61 represents the charging current curve when the relay is first connected to the supply circuit 53 after the condenser 55 has become entirely discharged. That current is sufficient to operate the relay. The current through the resistor 54 is shown by curve 62, and the resistance value of resistor 54 in relation to the impedance of coil 51 is so selected that the current through the resistor will be sufficient in magnitude to hold the relay closed. Curve 63 represents the voltage across relay winding 51.

If now, as at time T—6 in Fig. 6, the relay is to be de-energized and the circuit 53 is opened, the energy of the condenser and resistor combination will require a time interval illustrated by T—7 of Fig. 6 before the condenser will be sufficiently discharged, to permit the condenser to receive a subsequent charging current sufficient to again energize the relay winding 51.

In each case, the condenser and resistor time constants are selected to be co-operatively related to the time constants of the relay in such manner as to provide the operation of the nature described. The selection of such constants will, of course, depend upon the design and size of the respective relays and their windings, and upon the operating currents necessary to operate the relay and also upon the value of the drop-out current at which point the relay will be permitted to open. All of such co-operative relations will follow the well established formulae, applying to inductive and reactive circuits.

By means of such simple fundamental electrical elements, the time element in the operation of a relay, to its closed position, or to its open position, may be predetermined and controlled in a simple and reliable manner.

My invention is not limited to any specific construction of relays nor to any specific time constants in the elements that are to co-operate with the relays, since the various circuits may be modified without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim as my invention:

1. A relay system arranged for quick actuation and delayed resetting, comprising a main winding on the relay and an auxiliary winding on the relay, an energizing circuit for the relay, a condenser in series with the auxiliary winding and shunting the main winding, and a resistor in circuit with the main winding and the condenser, the time constants of the resistor, of the condenser, and of the two relay windings being such that the auxiliary winding will serve to operate the relay, and the main winding will serve to hold the relay in operated position thereafter, but not to actuate the relay to operated position, and such that the main winding will co-operate with the resistor and the condenser to delay the resetting operation of the relay when the relay circuit is de-energized.

2. In combination, a relay comprising an actuating winding and a holding winding connected in series relationship, an energizing circuit therefor, and means connected in parallel to the holding winding and operative when the energizing circuit is energized to effect instantaneous energization of the actuating winding and delayed energization of the holding winding, and operative when the energizing circuit is deenergized or opened, to effect instantaneous de-energization of the actuating winding and to effect delayed de-energization of holding winding.

3. A relay system comprising a relay having an actuating winding and a holding winding, an external resistor connected between the two windings, and a condenser bridging the resistor and the holding winding.

4. In an electric time limit control scheme, in combination, an electromagnetic device having two coils, a condenser, a source of direct current energy, one of said coils and the condenser being connected in series and the other coil being connected in parallel to the condenser, means for connecting the coils and condenser to said source of direct current energy whereby the coil connected in series with the condenser becomes rapidly energized to thus effect the operation of the electromagnetic device immediately after connection of said coils and condenser to the said source of direct current and the coil connected across the terminals of the condenser remains energized by the discharge current of the condenser for a definite time to maintain said electromagnetic device in operated condition for a definite time after the coils and condenser are disconnected from the source of direct current.

RALPH E. MARBURY.