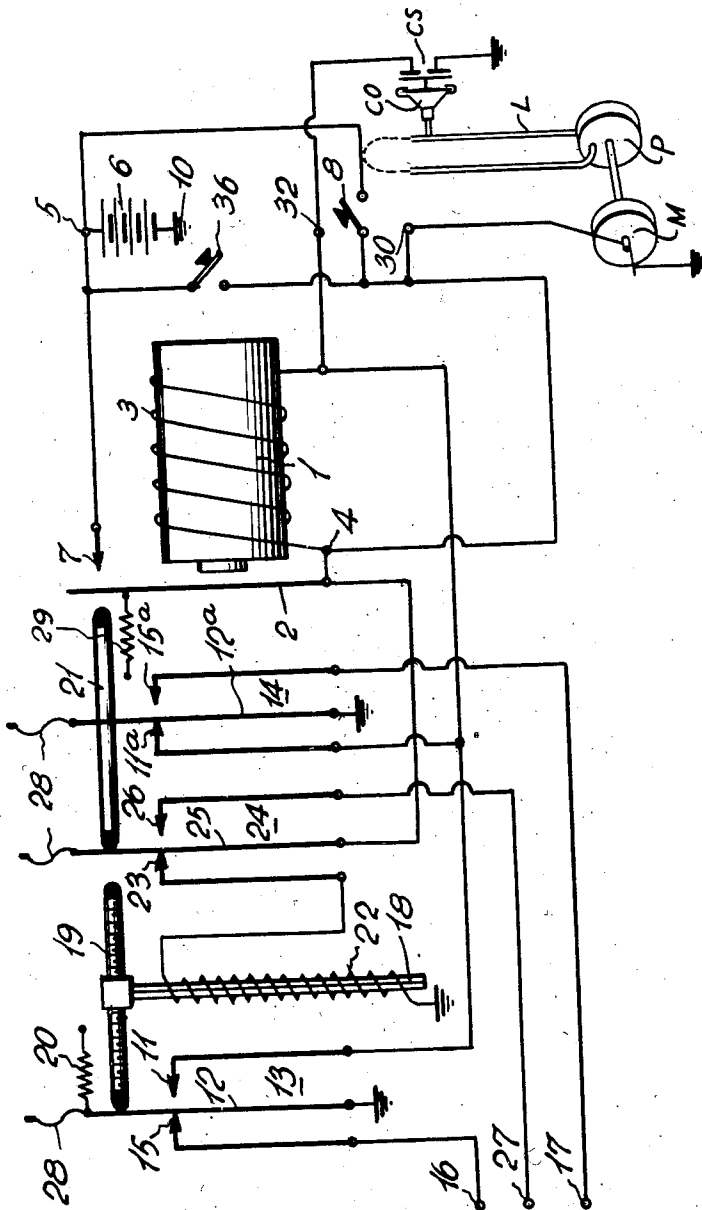


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TIME DELAY SWITCHING MEANS
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TIME DELAY SWITCHING MEANS

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The present invention relates to automatic time-delay electrical controlling devices by means of which a sequence of operations may be accomplished for controlling power-consuming circuits in various ways.

One object of the invention is the provision of a novel time-delay device wherein plural switches are operated automatically in predetermined sequence and at predetermined times after operation of the device is initiated.

A second object is the provision of a novel operating assembly of mechanical and electrical devices for accomplishing time-delayed operation of a circuit.

Another object is the provision of a novel time-delay controlling device cooperating with a conditionally operated circuit for provisionally energizing a controlling circuit, maintaining such energization for a predetermined period of time, and thereafter continuing or discontinuing such energization in accordance with the functioning or nonfunctioning of the conditionally operated circuit.

Still another object is the provision of a time-delay and time-controlled device arranged to provide various types of energization for plural circuits having different purposes.

The accompanying drawing is a schematic circuit diagram of a device arranged in accordance with the invention.

In the drawing, a relay, designated 1, comprises an armature 2 and a winding 3, one end terminal 4 of which is arranged for connection to one side 5 of a power source 6 through a pair of main contacts 7. The contacts 7 are so operated by the armature 2 as to be closed when the winding 3 is energized and opened when it is deenergized. Initial energization of the relay winding to close contacts 7 may be accomplished by momentarily closing the impulse switch 8. The effect of the closing of the switch 8 is to momentarily bridge the main contacts 7, connecting the end 4 of the relay winding to the side of the power source. When the end 4 of the relay winding has been connected to the power source, either through contacts 7 or switch 8, control of the energization of the relay is accomplished by a relay circuit that includes the winding 3 and parallel connections with the other side 10 or ground of the power source 6. These parallel connections are made through the stationary contacts 11 and 11a and the single movable contacts 12 and 12a of two single pole double throw switches 13 and 14, the movable contacts 12 and 12a being connected through ground to the side 10 of the power source

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so that upon closing of the contacts of either switch 13 or 14 the relay circuit is complete. The second stationary contacts 15 and 15a of the switches 13 and 14 respectively are connected to terminals 16 and 17, so that application of the voltage of the side 10 of the power source to such terminals depends on the positions of the movable contacts 12 and 12a of the respective switches.

A thermally actuated time-delay operator comprises a bimetallic element 18 and a transversely and adjustably mounted member 19 that is moved axially in opposite directions as the element is heated or cooled. When the member 19 is moved by the cooling of the bimetallic element 18 (to the left as seen in the drawing), it moves the contact 12 of the switch 13 into closed relation to the stationary contact 15, which is connected to the terminal 16, the same movement of the member 19 accomplishing opening of the contacts 11 and 12 of the switch 13. When the member 19 is moved in the opposite direction by heating of the bimetallic element 18, it permits contact 12 of the switch 13, under the influence of a biasing spring 20, to close with the contact 11 and break with the contact 15, so that the relay circuit is closed through the switch 13.

In its movement by the heating of the bimetallic element 18, the member 19 also contacts and moves a switch-operating element 21. This element 21 is unbiased and is movable in the one direction only by the member 19 upon heating of the bimetallic element 18, being left in the position to which it has been so moved when the member 19 is moved in the return direction. The operating element 21 is so positioned relative to the armature 2 as to be moved in the return direction only by the armature upon deenergization of the relay 1. The movable contact 12a of the relay circuit switch 14 is mechanically connected to the switch-operating element 21, so that upon movement of the element by the member 19 upon heating of the bimetallic element 18 the movable contact 12a of the switch is closed with the stationary contact 15a while upon return movement of the element 21 by the armature the contact 12a is closed with the contact 11a, completing the relay circuit through the switch 14.

For control of the thermally actuated operator, a heater circuit is arranged in parallel with the relay circuit. This circuit includes a heating coil 22 associated with the bimetallic element 18 one end of which is connected through ground to the side 10 of the power source, the other end being connected to one stationary contact 23 of a

single pole double throw switch 24, the movable contact 25 of which is connected to that main contact 7 which is moved by the armature 2 of the relay. The other stationary contact 26 of the switch 24 is connected to a terminal 27, so that application of the voltage of the movable main contact 7 to the terminal 27 depends on the position of the movable contact 25 of the switch 24, and application of that voltage to the terminal alternates with its application to the heater coil. The movable contact 25 of the switch 24 is mechanically connected to the switch-operating element 21, so that upon movement of the element by the thermally actuated operator upon heating of the coil 22, the contact 25 is moved away from the contact 23, breaking the heater circuit and applying voltage to the terminal 27, while upon return movement of the member 21 contacts 26 and 25 are broken and the heater circuit closed through contacts 25 and 23.

Each of the switches 13, 14 and 24 is provided with a snap acting device 28, switches 14 and 24 being unbiased so that their operation depends entirely upon movement of the operating element 21 by the thermally actuated operator upon heating or by the armature upon deenergization of the relay.

It will be seen from the above that the complete circuit in effect comprises two parallel branches, one of which is the relay circuit and the other the heater circuit, in series with the main contacts 7 and the power source 6.

Operation is as follows. With the circuit in non-operating, completely deenergized condition, as shown in the drawing, an impulse is delivered from a suitable source by momentarily closing the switch 8 and consequently momentarily energizing the relay 1. At this time the relay circuit is complete, being closed through contacts 12a and 11a of the switch 14, contacts 11 and 12 of the switch 13 being open. This condition of the switches 13 and 14 is due to the heater circuit being deenergized, the bi-metallic element cold, and the member 19 and element 21 being in their left hand positions. The momentary closing of the switch 8 and the consequent energization of the relay closes the main contacts 7, establishing a holding circuit for the relay through the switch 14. At the same time, since contacts 23 and 25 of switch 24 are closed, the heater circuit becomes energized through the main contacts 7, heating the bimetallic element 18. As the element 18 is heated, the member 19 moves to the right, closing contacts 11 and 12 of switch 13 to complete the relay-holding circuit through that switch. Thereafter, the member 19 being suitably adjusted relative to the element 21 and the movable contact 12 of switch 13, the element 21 is shifted to the right, opening contacts 23 and 25 of the switch 24 to open the heater circuit, and opening contacts 11a and 12a of the relay circuit switch 14. The element 18 then cools, opening contacts 11 and 12 of switch 13, but leaving the switch-operating element 21 in its right hand position, so that the relay circuit contacts 11a and 12a of switch 14 remain broken, as do the heater circuit contacts 23 and 25 of switch 24. Upon opening of the relay circuit contacts 11 and 12 of switch 13 by the leftward movement of the member 19, both relay circuit paths are broken and the relay circuit, and the winding 3 of the relay become deenergized, releasing the armature 2. Upon such release, the armature, under the

influence of a spring 29, moves to the left, moving the switch-operating element 21 and the movable contacts of switches 24 and 14 to their original positions. This movement of the armature 2 also opens the main contacts 7, so that the circuit remains in its non-operating condition until another cycle is initiated.

The device may be used to operate one power-consuming device conditionally upon operation of another device. To this end a terminal 30 is connected to the movable main contact 7, so that a power-consuming device, illustratively shown to be a motor M may be energized therefrom, upon closing of the main contacts 7. A circuit, may be attached to the contact 32 to bridge out the switches 13 and 14 of the relay circuit and connect the relay winding 3 with the source of supply, and this circuit attached to the contact 32 may be conditionally controlled by the operation of some device that it may be desirable or necessary to have in operation during consumption of power by the device fed from the contact 30, but for commencement of operation may require a certain period of time. To illustrate the aforesaid arrangement, the motor M energized from terminal 30 drives a pump P, the pump supplying fluid pressure to a line L. Connected in said line is a conditionally operated device CD responding to the pressure in the line L reaching a predetermined value, consequent to the proper functioning of motor M and its circuit, pump P and line L. The conditionally operated device actuates a controlling switch CS in the circuit connected to the contact 32. It will be understood that the circuit connected to 32 may be controlled by numerous other devices responding to the functioning or non-functioning of the power consuming device or other devices put into operation thereby, for example, by an electromagnetic device, a cam, or a thermal or float operator, all as well known in the art.

In this type of control the time-delay circuit operates exactly as described above, power being delivered through the contact 30 upon closing of the main contacts 7, and such delivery being continued during a cycle of operation of the device. If during this period the conditionally operated circuit on contact 32 is closed, the breaking of the relay circuit by the switch 13 will not deenergize the relay 1, due to the holding effect of the circuit on contact 32, but if that circuit fails to close during the controlling cycle the relay 1 will be deenergized as described, interrupting power supply to the device on contact 30 by opening of the main contacts 7. In either case the control circuit will complete its cycle and return to ready condition in which it is illustrated in the drawing.

Other types of circuit control can be effected through terminal pairs 16, 27 and 17, 27. Between terminals 16 and 27 a circuit is closed through contacts 12 and 15 as long as 7 and 25 and 26 remain closed. An interruption of energization is obtained during repeated cycles of operation of the thermal controlling device 19 opening and closing at 15.

A time-controlled delayed action circuit may be connected between contacts 17 and 27. After sufficient time to actuate the thermal element 18 the contacts 15a and 26 will be closed allowing current to flow through switches 7 and 26 to 27 and returning from 17 through 15a to ground.

An emergency switch 36 may be provided to connect the contact 30 directly to the source of energy and overrule the control by the time

limit relay whenever such action may become necessary or desirable.

It will be seen from the foregoing that the control device herein disclosed presents great convenience in providing a wide variety of controlling operations by means of which various types of circuit can be operated according to the purpose of the circuit.

I claim:

1. A time-delay electrical controlling device comprising a relay having a winding and an armature, a thermally actuated operator, a switch-operating element movable in one direction only by the thermally actuated operator upon being heated and in the opposite direction only by the armature upon deenergization of the relay, a heater circuit including a heating element for the thermally actuated operator and a switch mechanically connected to the switch-operating element for closing and opening respectively upon movement of said element by the armature and operator, a relay circuit including the winding of the relay and two switches arranged in parallel and in series with the winding for completing the circuit upon closing of either, one of the said parallel switches being mechanically connected with the thermally actuated operator for closing and opening respectively as the operator is heated and cooled, the other parallel switch being mechanically connected with the switch-operating element for opening when said element is moved by the thermally actuated operator and closing when it is moved by the armature, and contacts closed and opened by the armature when the relay is energized and deenergized for connecting the heater and relay circuits with a source of power.

2. A time-delay electrical control device comprising a relay having an armature and a winding, a relay circuit including the winding of the relay and parallel switches connected in series with the winding for completing the circuit upon closing of either, a heater circuit connected in parallel to the relay circuit and including a heating element and a switch, a pair of contacts arranged for operation by the armature upon energization of the relay for connecting the heater and relay circuits with a source of power, a thermally actuated time-delay operator arranged for heating by the heating element and mechanically connected to one of the parallel switches of the relay circuit for closing said switch when heated and opening it when cooled, and a shiftable switch-operating element movable in one direction only by the thermally actuated operator and means for moving it in the opposite direction only by the armature, said element being mechanically connected with the second parallel switch of the relay circuit and the switch of the heater circuit for opening said switches when moved by the thermally actuated operator and closing them when moved by the armature.

3. An electrical control device for energizing a circuit for a predetermined period of time to permit operation of a conditionally actuated switch to maintain the circuit energized; said device comprising two parallel circuits, one of said circuits including in series the winding of a relay having the armature and two parallel branches one of which includes the conditionally actuated switch and the second including two parallel switches arranged to close that branch upon closing of either, the second parallel circuit including a heating element and a switch, said device also comprising a thermally actuated time-delay operator heated by the heating element

and mechanically connected with one of the parallel switches of the second branch of the first circuit for opening it when cooled and closing it when heated, a switch-operating element mechanically connected with the second parallel switch of said branch and with the switch of the second circuit and movable in opposite directions for respectively opening and closing said switches, said element being operatively associated with the thermally actuated operator for movement thereby only in the direction to open the switches when the operator is heated, and also being operatively associated with the armature of the relay for movement thereby only in the direction to close the switches when the relay is deenergized, a pair of main contacts in series with the two parallel circuits and arranged to be closed and opened by the armature upon energization and deenergization of the relay to connect said circuits with a source of power and maintain the relay winding energized so long as either branch of the first parallel circuit is closed, and an initiating switch parallel to the main contacts for initiating operation of the device by energizing the relay to close the main contacts.

4. An electrical device for timed control of plural circuits connected to a power supply comprising a relay having an armature and a winding, a time-delay thermally actuated operator, a switch-operating element movable in one direction only by the thermally actuated operator when heated and means for moving it in the opposite direction only by the armature when the relay is deenergized, a relay circuit including the relay winding and parallel controlling means each comprising one stationary contact of a single pole double throw switch having its movable contact connected to one side of the power supply, a heater circuit including a heating element thermally associated with the thermally actuated operator and controlling means comprising one stationary contact of a single pole double throw switch having its movable contact connected to the opposite side of said power supply, terminals respectively connected to the second stationary contacts of the three said double throw switches, the movable contacts of the heater circuit switch and one of the relay circuit switches being mechanically connected to the switch-operating element for opening the circuit contacts and closing the terminal-contacts when the element is moved by the thermally actuated operator and opening the terminal-connected contacts and closing the circuit contacts when said element is moved by the armature, a pair of main contacts in series with the said circuits for connecting them in parallel with the power supply and operable by the armature for closing when the relay is energized and opening when it is deenergized, switching means for bridging the main contacts and thereby initiating operation of the device, and a terminal connected between the main contacts and the relay winding for deenergization and energization simultaneously with the winding.

5. An electrical circuit controlling device including a normally open main switch, a relay for closing said switch having an armature and a winding, a time-delay operating device for opening said main switch a predetermined time period following initiation of its operation, a relay circuit including the relay winding and parallel switches in series with the winding, the first switch being normally closed and arranged to be opened by said device only after the elapse of

said time period and the second switch being normally open and arranged to be closed by said device only after the elapse of said time period and the second switch being normally open and arranged to be closed by said device substantially with opening of said first switch, means for energizing said relay circuit, a circuit for effecting actuation of the time-delay operating device including a normally closed control switch arranged to be opened substantially with opening of the first switch, and means controlled by the relay on deenergization of the relay circuit for closing the actuating circuit control switch and the first switch of the relay circuit.

6. A controlling device according to claim 5, wherein the parallel switches of the relay circuit and the actuating-circuit control switch are each a single pole double throw switch, the actuating-circuit control switch having its movable contact connected to one side of a power source, its one stationary contact connected to the control circuit and its other stationary contact to a first terminal, the parallel switches having their movable contacts connected to the other side of the power source and each having one stationary contact connected to the relay circuit and the other to a second terminal.

7. A controlling device according to claim 5 wherein the main switch is closed and opened by the armature upon energization and deenergization of the relay, and is operative when closed to connect the relay and actuating circuits in parallel with a power source, with the actuating circuit thereupon serving as a holding circuit for the relay, and wherein the means for energizing the relay circuit includes a switch in bridging relation to the main switch for initially energizing the relay circuit.

8. A controlling device according to claim 5, wherein a branch circuit is connected in parallel with the first and second parallel switches and includes a conditionally operated switch operative when closed to maintain the relay energized through said branch circuit independently of the relay circuit.

9. A time-delay electrical controlling device comprising a relay having a winding and an armature, a relay circuit including said winding and a pair of parallel switches in series with the winding for completing the relay circuit upon closing of either, one of said parallel switches being normally closed and the other being normally open, a time-controlled circuit arranged to be energized by energization of the relay and including a normally closed switch and a time-delay operator arranged to effect the opening of the normally closed parallel switch and of the switch of the time-controlled circuit and the closing of the normally open parallel switch a predetermined time interval following energization of said time-controlled circuit and thereupon to effect deenergization of the relay circuit a predetermined time interval following the first-named time interval, and means controlled by the armature upon deenergization of the relay circuit for effecting re-closing of said normally closed parallel and time-controlled circuit switches.

10. A time-delay electrical controlling device comprising a relay having a winding and an armature, a time-delay thermally actuated operating device, a switch-operating element movable in one direction only upon heating of the thermally actuated operating device and arranged relative to the armature to be moved in

the opposite direction only by the armature upon deenergization of the relay, a circuit including the relay winding, means for energizing said circuit, an operating circuit for the thermally actuated device, and switching means operated upon energization of the relay-winding circuit and respectively by the switch-operating element and the thermally actuated device for sequentially energizing the operating circuit, then deenergizing the operating circuit, and finally deenergizing the relay-winding circuit.

11. In a switching device, a connection to one side of a power supply, a normally open main switch in said connection, a second parallel connection to the same side of the power supply, a relay circuit adapted to be connected to said power supply through either of said connections and including a relay having a winding and an armature operative to effect closing of said main switch upon the relay circuit being energized, means for momentarily completing a circuit through the relay winding and said second parallel connection thereby to energize the relay and initiate closing of the main switch, said relay circuit including normally closed switch means operative to complete a circuit through the relay winding and first connection, and a delayed-action thermal device responsive for its actuation for completion of the last-named circuit for opening said switch means.

12. In a switching device, a circuit, a relay operative when energized to close said circuit, a thermal delayed-action device operative upon energization of the relay to maintain the circuit closed throughout a cycle of heating and cooling and thereupon to deenergize the relay and thereby open said circuit, and means operative in response to deenergization of the relay to condition the device for another operation as aforesaid.

13. In a switching device, a first circuit, a relay operative when energized to close said circuit, a thermal delayed-action device operative upon energization of the relay to maintain the circuit closed throughout a cycle of heating and cooling and being thereupon normally operative to deenergize the relay and thereby open said circuit, and a second circuit connected in parallel to said first circuit and adapted when energized to maintain the first circuit closed independently of the action of said thermal delayed-action device.

14. In a switching device, a first circuit, a relay operative when energized to close said circuit, means for initially energizing said relay, a thermal delayed-action device operative upon energization of the relay to maintain the circuit closed throughout a heating and cooling cycle and being thereupon normally operative to deenergize said relay, and a second circuit connected in parallel with the first circuit and adapted when completed to maintain the first circuit closed independently of the action of said thermal delayed-action device.

15. In a switching device, a normally open supply circuit, a relay circuit including a relay operative when energized to close said supply circuit and a thermal delayed-action device adapted to open the relay circuit a predetermined time interval after energization of said relay circuit, means for initially energizing said relay circuit, a power output circuit connected to the supply circuit and being energized upon said supply circuit being closed, and a control circuit connected to the supply circuit in parallel with the output

circuit and adapted when energized to maintain the relay energized following opening of the relay circuit.

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