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S. MINNECI

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TIME DELAY CONTROL CIRCUIT

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Fig 1.

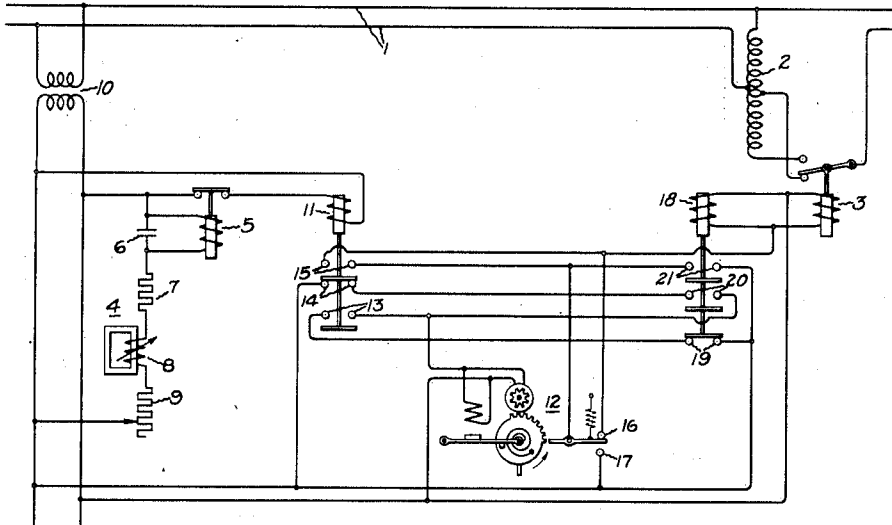
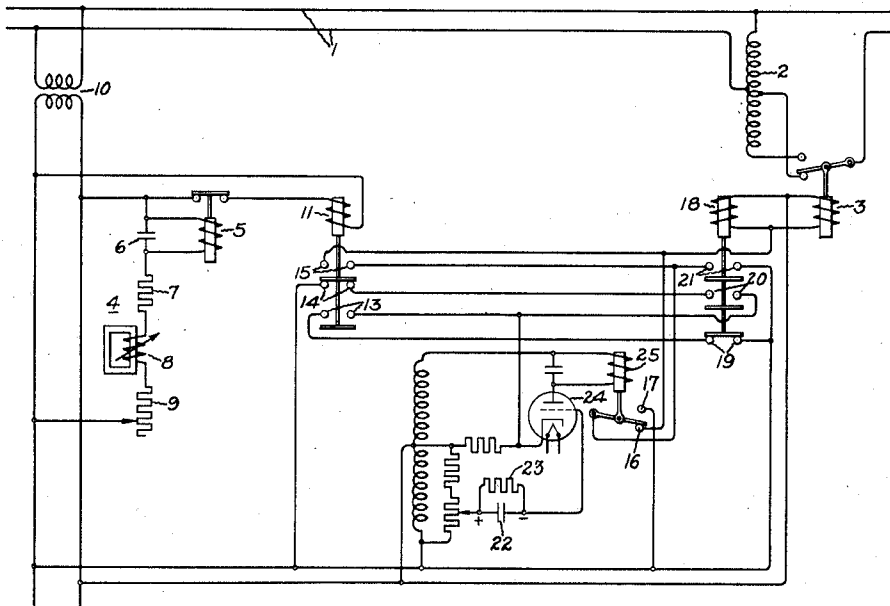


Fig 2.



Inventor:
Salvatore Minneci
by *Harry E. Dunham*
His Attorney.

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TIME DELAY CONTROL CIRCUIT

Salvatore Minnecl, Pittsfield, Mass., assignor to
General Electric Company, a corporation of
New York

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13 Claims. (Cl. 171—119)

This invention relates to time delay control circuits and more particularly to improvements in time delay control circuits for one-step type automatic feeder voltage regulators.

It is desirable to introduce a time delay in the control of most automatic feeder voltage regulators, so as to save the wear and tear on the mechanism which would otherwise occur as a result of the continual, momentary and small fluctuations in feeder circuit voltage which it is unnecessary to regulate.

In accordance with this invention, a single time delay relay having a cycle of operation consisting of two parts is used. The first part of the cycle consists in the relay going from a normal or reset condition to a timed out condition in a definite time period during which the relay is energized. The second part consists in an instantaneous resetting of the relay from its timed out condition to its resetting condition when the relay is de-energized. Two complete cycles of operation of this relay are used for each complete regulating step. Thus, one cycle of the time delay relay is used between the time when the primary relay closes in response to an abnormal voltage condition and the time when the regulator proper is operated, and another cycle of the time delay relay is used to introduce a time delay between the time when the primary relay opens in response to the return of normal voltage and the time when the regulator ceases to produce the regulating change.

An object of the invention is to provide a new and improved time delay control circuit.

Another object of the invention is to provide a new and improved time delay control circuit for one-step feeder voltage regulators.

The invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing, in which similar reference characters denote similar elements in the several figures, Fig. 1 is a diagrammatic illustration of an embodiment of the invention using a motor-operated time delay relay, while Fig. 2 is a modification using a vacuum tube time delay relay which, with the exception of its movable contacts, has no moving parts.

Referring now to the drawing and more particularly to Fig. 1, an alternating current feeder circuit 1 is provided with a one-step automatically controlled booster regulator. The regulator proper consists of an auto-transformer 2 and controlled electroresponsive device in the form

of a contactor 3. In its de-actuated condition, as shown in the drawing, the contactor by-passes the series winding of the auto-transformer. When the contactor 3 is actuated, the series winding is connected in the feeder circuit and a single step of voltage boost is produced.

The primary controller for the regulator may be of any well known type and is shown, for example, as a resonant relay consisting of a series ferro-resonant circuit 4 and an electromagnetic relay 5. As shown, the ferro-resonant circuit comprises a capacitor 6, a fixed resistor 7, an adjustable self-saturating iron-core reactor 8 and an adjustable resistor 9 serially connected to respond to the voltage on the unregulated side of the feeder circuit 1 by means of a potential transformer 10. The relay 5 may be connected across any one of the circuit elements of the resonant circuit and is shown as connected across the capacitor 6. The adjustments of the reactor 8 and the resistor 9 are provided for adjusting the sensitivity of the circuit.

This arrangement is well known to those skilled in the art and forms no part of the present invention. Briefly, the arrangement is such that when the voltage is normal or above, a condition of partial resonance exists causing a relatively large effective current to flow through the circuit 4, thereby producing a sufficiently high voltage drop across the capacitor 6 to maintain the contacts of the relay 5 open. If, however, the voltage falls slightly below normal, the circuit suddenly goes out of resonance, thereby causing the current to drop suddenly to a value low enough to cause the relay 5 to close its contacts. Interposed between the contacts of the relay 5 and the operating winding of the main contactor 3 is an auxiliary relay 11 and a motor-operated time delay relay 12. The auxiliary relay 11 is provided with a normally open set of contacts 13, a normally closed set of contacts 14 and a normally open set of contacts 15. The time delay relay 12 is provided with a normally closed set of contacts 16 and a normally open set of contacts 17, the contacts 16 opening after the relay has timed out and simultaneously therewith, the contacts 17 closing. In effect, the contacts 16 and 17 amount to a single-pole, double-throw switch which is in one position when the relay is reset and is in another position when the relay is timed out.

Three other sets of contacts are required. These contacts should be operated when the main contactor operates and are conveniently operated by a supplementary relay 18 having its operating winding connected in parallel with the op-

erating winding of the main contactor. This permits the use of standard relays as the supplementary relay 18 need only handle relatively small control currents, while the main contactor has to carry the main line of current. However, it will be obvious to those skilled in the art that, if desired, the contacts of the supplementary relay might just as well be operated mechanically by the main contactor. The contacts of the supplementary relay 18 are a set of normally closed contacts 19 and two sets of normally open contacts 20 and 21.

Contactors 3 and relays 11, 12 and 18 all receive their energizing current from transformer 15 10.

The operation is as follows. Assume that circuit 1 is energized by any suitable source of current and that the voltage of this circuit is normal or above normal. Under these assumed conditions, the parts will be in their illustrated positions with the exception of relay 5, which will have its contacts open. Assume now that the voltage falls sufficiently to cause the relay 5 to close its contacts. This immediately causes the auxiliary relay 11 to pick up and close its contacts 13 and 15 and open its contacts 14. The closure of the contacts 13 completes a circuit through the normally closed contacts 19 of the supplementary relay which energizes the time delay relay 12, thereby electromagnetically causing engagement of its driving gears and starting its operating motor. After a predetermined time, determined by the setting of the time delay relay 12, this relay will time out, whereupon its contacts 17 will close and its contacts 16 will open. The closure of the contacts 17 completes a circuit through the closed contacts 15 of the auxiliary relay 11 for energizing the main contactor coil which thereby connects the series winding of the auto-transformer 2 in the main feeder circuit and thus produces a predetermined voltage boost in this circuit.

At the same instant that the main contactor is energized, the supplementary relay 18 is also energized and this relay thereupon immediately opens its contacts 19 and closes its contacts 20 and 21. The closing of the contacts 21 completes a seal-in circuit for the main contactor and the supplementary relay 18, for as will be seen the contacts 21 are in parallel with the time delay closing contacts 17. The opening of the contacts 19 breaks the energizing circuit for the time delay relay. The closing of the contacts 20 has no immediate effect because the contacts 14 of the auxiliary relay are already open. Thus, the time delay relay 12 is de-energized by the actuation of the supplementary relay 18 and it is immediately spring reset as a result of the disengagement of its gears, thereby closing its contacts 16 and opening its contacts 17.

If now the voltage of the main circuit should for any reason rise to such a value as to cause the resonant relay 5 to open its contacts, the auxiliary relay 11 will immediately be de-energized, thereby opening its contacts 13 and 15 and closing its contacts 14. The opening of the contacts 13 has no effect as the contacts 19 of the supplementary relay are already open. Likewise, the opening of the contacts 15 has no immediate effect because the contacts 16 of the time delay relay which are in parallel with the contacts 15, are closed. Thus, the main contactor coil and the supplementary relay coil now receive their energization through the contacts 21 and 13 in series instead of through the contacts 21

and 15 in series. The closing of the contacts 14, however, completes a circuit through the previously closed contacts 20 of the supplementary relay for energizing the time delay relay whose motor then starts and causes the time delay relay to time out. As soon as the time delay relay times out, its contacts 16 open and its contacts 17 close. The opening of the contacts 16 breaks the holding circuit for the contactor coil and the supplementary relay coil and these devices immediately drop out and return to the positions illustrated in the drawing. The opening of the contacts 20 of the supplementary relay breaks the energizing circuit for the time delay relay which then immediately resets, thereby again closing its contacts 16 and opening its contacts 17. This returns all of the parts, except relay 5, to their illustrated positions and the regulator is ready for another operation whenever the voltage again falls below normal.

Fig. 2 differs from Fig. 1 in that a vacuum tube type time delay relay is substituted for the motor-operated time delay relay of Fig. 1. This vacuum type time delay relay is disclosed and claimed in an application of Elbert D. Schneider for a Time delay relay, Serial No. 155,518, filed July 24, 1937, and assigned to the assignee of the present application. The timing element of this relay is a capacitor 22, the time delay being the time required for a charge to leak off this capacitor. This time is determined by the value of a resistor 23. The potential of the capacitor is applied to the control electrode of a vacuum tube 24 in whose anode circuit is a relay winding 25 for operating in any well known manner the time delay contacts 16 and 17.

With the parts in their illustrated positions capacitor 22 is charged with the indicated polarity by the grid current which flows only when the left hand side of the secondary of potential transformer 10 is positive with respect to the other side. When contacts 13 close the cathode of tube 24 is connected directly to the left side of transformer 10, thus preventing further charging of the capacitor, whose charge then leaks off through resistor 23. In a predetermined time, enough negative charge has leaked off to permit tube 24 to conduct current and energize relay 25.

This vacuum tube time delay relay is relatively inexpensive, it has no moving parts with the exception of one movable contact and is substantially independent of changes in ambient temperature.

The general operation of Fig. 2 is exactly the same as that of Fig. 1.

While there have been shown and described particular embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications can be made therein without departing from the invention and, therefore, it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In an electrical control circuit, a controlled electroresponsive device having an actuated and a deactuated condition, means including a time delay relay having a timed out condition and a reset condition for causing a change in the condition of said controlled device when said relay is in its timed out condition, means operative in accordance with said change in the condition of

said device for resetting said relay, and means controlled by said relay for preventing any change in the condition of said device when said relay is in its reset condition.

2. In an electrical control circuit, a primary circuit controller for selectively producing a pair of different circuit controlling conditions, a time delay electroresponsive circuit controller having a timed out condition and a reset condition, an energizing circuit for said time delay controller controlled by said primary controller for causing said time delay controller to go from its reset to its timed out condition whenever said primary controller makes a circuit controlling change, and means actuated whenever said time delay controller times out for resetting it independently of said primary controller.

3. In a time delay control circuit, an electro-responsive device whose actuation is to be controlled, a primary circuit controller for selectively producing a first and a second circuit controlling condition, a time delay element for causing delayed actuation of said device after said controller changes from said first to said second condition, means responsive to the actuation of said device when said controller is in said second condition for resetting said element while maintaining said device actuated, said element being arranged to cause delayed deactuation of said device when said controller is changed from said second to said first condition, and means responsive to the deactuation of said device when said controller is in said first condition for resetting said element while maintaining said device deactuated.

4. In an electrical control circuit, a controlled electroresponsive device having an actuated and a deactuated condition, means including a time delay relay having a timed out condition and a reset condition for causing a change in the condition of said controlled device when said relay is in its timed out condition, means operative in accordance with said change in the condition of said device for relatively quickly resetting said relay, and means controlled by said relay for preventing any change in the condition of said device when said relay is in its reset condition.

5. In an electrical control circuit, a primary circuit controller for selectively producing a pair of different circuit controlling conditions, a time delay electroresponsive circuit controller having a timed out condition and a reset condition, an energizing circuit for said time delay controller controlled by said primary controller for causing said time delay controller to go from its reset to its timed out condition whenever said primary controller makes a circuit controlling change, and means actuated whenever said time delay controller times out for relatively quickly resetting it independently of said primary controller.

6. In a time delay control circuit, an electro-responsive device whose actuation is to be controlled, a primary circuit controller for selectively producing a first and a second circuit controlling condition, a time delay element for causing delayed actuation of said device after said controller changes from said first to said second condition, means responsive to the actuation of said device when said controller is in said second condition for relatively quickly resetting said element while maintaining said device actuated, said element being arranged to cause delayed deactuation of said device when said controller is changed from said second to said first condition,

and means responsive to the deactuation of said device when said controller is in said first condition for relatively quickly resetting said element while maintaining said device deactuated.

7. In a regulator system, in combination, a primary device responsive to a quantity to be regulated and having first and second circuit controlling conditions, a regulator of said quantity, a time delay relay responsive to said primary device going from its first to its second position for causing delayed operation of said regulator, means operated in accordance with the delayed operation of said regulator for substantially instantaneously resetting said time delay relay, means responsive to said primary device going from its second to its first condition for causing said time delay relay to cause delayed cessation of operation of said regulator, and means operative in accordance with the cessation of operation of said regulator for substantially instantaneously resetting said time delay relay.

8. In combination, an alternating current power circuit, a voltage booster connected in said circuit, a voltage sensitive primary relay having a normally open set of contacts which close when the voltage of said circuit falls to an abnormally low value, an auxiliary relay arranged to be actuated by the closure of the contacts of said primary relay, a time delay relay arranged to be energized by the actuation of said auxiliary relay, said time delay relay being arranged to cause delayed actuation of said voltage booster, means operative in accordance with the actuation of said booster for completing a seal-in circuit for said booster and substantially instantaneously resetting said time delay relay, said time delay relay being arranged to be re-energized by the deactuation of said auxiliary relay for causing delayed time delay interruption of the seal-in means for said booster, and means operative in accordance with the deactuation of said booster for substantially instantaneously resetting said time delay relay.

9. In a time delay control system, a supply circuit, an electroresponsive device having an operating winding, a time delay relay having a normally open set of time delay closing contacts and a normally closed set of time delay opening contacts, a set of normally open control contacts, and a set of normally open supplementary contacts arranged to be closed in accordance with the energization of said operating winding, said operating winding being connected in series circuit relation with said control contacts and said supplementary contacts across said supply circuit, said normally closed time delay opening contacts being connected in parallel with said control contacts, and said normally open time delay closing contacts being connected in parallel with said supplementary contacts.

10. In a time delay control system, a supply circuit, a time delay relay, two sets of control contacts so interconnected that when either set is closed the other is open, two sets of similarly interconnected supplementary contacts arranged to be operated after said time delay relay times out, a pair of parallel branch circuits each containing a set of control contacts and a set of supplementary contacts in series, said parallel branch circuits being connected in series circuit relation with said time delay relay across said supply circuit.

11. In a time delay control system, a supply circuit, a time delay relay having electrical operating means, a set of normally open control con-

tacts interlocked with a set of normally closed control contacts so that when the normally open contacts are closed the normally closed contacts are open, two similarly related sets of supplementary contacts arranged to be actuated at the end of the time delay period of said time delay relay, said operating means being connected in series circuit relation with the normally closed supplementary contacts and the normally open control contacts across said supply circuit, said normally closed control contacts and said normally open supplementary contacts being connected in series with each other and in parallel with the other two sets of contacts.

12. In a time delay control system, a supply circuit, a time delay relay having electrical operating means and a set of time delay closing contacts interlocked with a set of time delay opening contacts, an electroresponsive device having an operating winding, three sets of supplementary contacts two of which are arranged to be closed and the other of which is arranged to be open in accordance with the energization of said operating winding, and three sets of control contacts so interlocked that two of said sets close simultaneously with the opening of the third set, a pair of parallel connected branch circuits serially connected with the operating means of said time delay relay across said supply circuit, one of said branch circuits containing serially therein a set of open control contacts and a set of closed supplementary contacts, the other branch circuit containing serially therein a set of closed control contacts and a set of open supplementary contacts, the remaining control contact and the remaining supplementary contact being connected in series circuit relation with the operating wind-

ing of said electroresponsive device across said supply circuit, said time delay contacts being connected respectively in parallel with said remaining two sets of contacts.

13. In a time delay control system, a supply circuit, a time delay relay having electrical operating means, a set of normally open time delay closing contacts interlocked with a set of normally closed time delay opening contacts, a main controlled contactor having an operating coil, a control relay having two sets of normally open contacts and a set of normally closed contacts, a supplementary relay having its operating winding connected in parallel with the operating winding of the main contactor and having two sets of normally open contacts and a set of normally closed contacts, a pair of parallel connected branch circuits connected in series circuit relation with the operating means of said time delay relay across said supply circuit, one of said parallel branches containing serially therein the normally closed control contacts and a set of normally open supplementary contacts, the other parallel branch containing serially therein a set of normally open control contacts and the set of normally closed supplementary contacts, the remaining sets of normally open control and supplementary contacts being connected in series circuit relation with said main contactor operating winding, said normally open time delay closing contacts being connected in parallel with said remaining set of supplementary contacts, and said normally closed time delay opening contacts being connected in parallel with said remaining set of control contacts.

SALVATORE MINNECI.