April 8, 1958 E. J. LEONARD 2,830,235

INTERMITTENT-FLOW CONDENSER-STORAGE TIMER

Filed March 18, 1954

FIG. 1

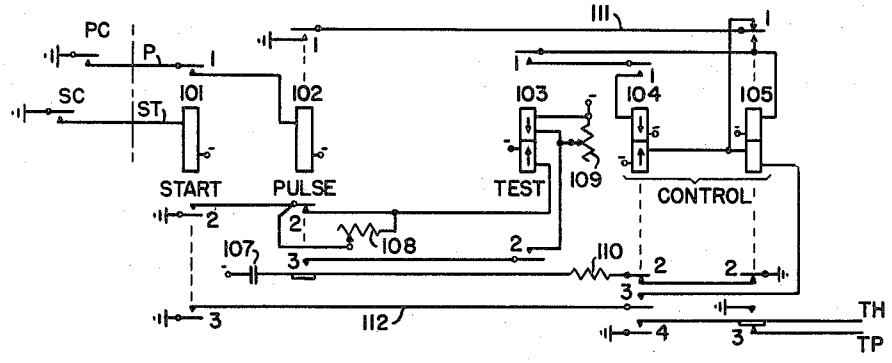


FIG. 2

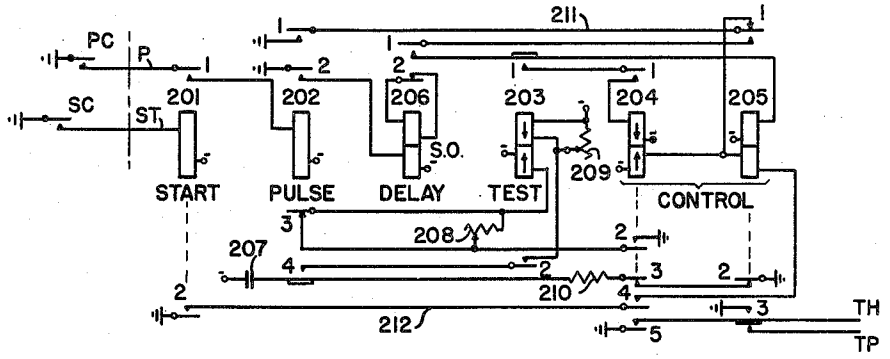
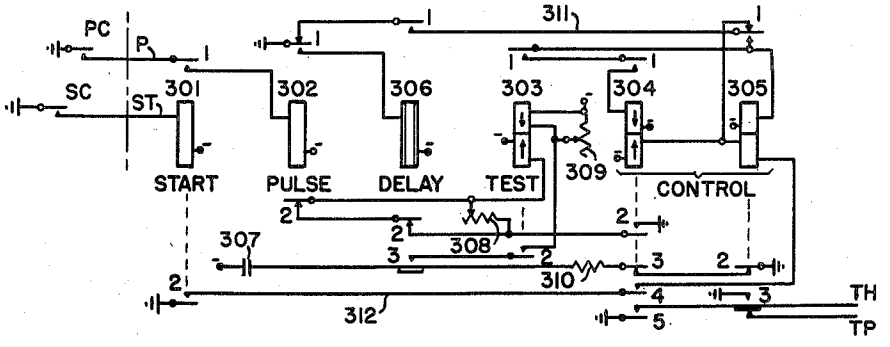


FIG. 3



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INTERMITTENT-FLOW CONDENSER-STORAGE TIMER

Edward J. Leonard, Chicago, Ill., assignor to International Telephone and Telegraph Corporation, a corporation of Maryland

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This invention relates to an intermittent-flow condenser-storage timer. Its principal object is to provide a new and improved condenser-storage type of timer wherein the flow of timing current is intermittent, whereby the time required for the condenser to pass the prearranged timing quantity of electricity is correspondingly increased.

A further object is to provide a condenser-storage timer of the foregoing character in which the timing interval may be readily adjusted within fairly wide limits.

GENERAL DESCRIPTION

It has been chosen to illustrate this invention as applied to relay apparatus suitable for use as a permanent timer common to a number of trunk equipments on an automatic telephone switchboard. There, a permanent-timing interval of approximately two minutes, for example, is commonly desired. Such an interval is considerably longer than the time during which charging or discharging current of relay-operating or relay-holding value can be passed continuously through a condenser of an economical capacity. According to the invention, this handicap is overcome by providing an associated pulsing arrangement wherein the timing condenser is required to pass relay-control current only at relatively momentary test intervals which correspond respectively to the control pulses.

THE DRAWINGS

Referring to the accompanying drawings, Figs. 1, 2, and 3 are respective schematic circuit diagrams of three embodiments of the invention for supplying ground energization to output wires TH and TP, which may be the source of time-hold and time-pulse wires TH and TP shown in Fig. 5, part 1 of the drawings in the pending application of Bellamy et al., Serial No. 85,292, filed April 4, 1949, for a Primary-Secondary-Spread Crossbar Telephone System.

In each embodiment the timer is controlled over the external pulse and start leads P and ST, which are connected to their respective contacts PC and SC. The pulse contacts PC may be contacts of any well-known interrupter, and may deliver relatively short pulses at a fifteen-second interval, for example. The start contacts SC may be contacts on a common start relay, which is arranged to be operated from any trunk equipment in use.

DETAILED DESCRIPTION

This invention having been described generally, a detailed description will now be given.

First embodiment (Fig. 1)

The timer of Fig. 1 includes five electromagnetic relays of the type commonly used on telephone switchboards. They comprise start, pulse, and test relays **101** to **103**, and control relays **104** and **105**. These relays are controlled by current from the usual D. C. source, which has a grounded positive pole and a free negative pole. Condenser **107** is the timing storage condenser. It is normally maintained in a charged condition by being connected across the current source through limiting resistor **110**, and break contacts **2** of control relays **104** and **105**, whereby it may be of the type (electrolytic for example) which has a longer life when maintained charged at maximum potential difference when the circuit is quiescent. Otherwise, the grounded pole of the current source could be substituted at the left-hand terminal of **107**.

When timing is needed, start contacts SC close and remain closed until timing is no longer needed. Start relay **101** is operated by contacts SC, over start wire ST. At its contacts **1**, relay **101** prepares an operate path for the pulse relay **102**; its contacts **3** prepare a hold circuit for control relay **104** and an operate circuit for relay **105**; and its contacts **2** operates test relay **103** by energizing its lower winding through closed contacts **2** of pulse relay **102**. The timing operation now awaits pulses over wire P.

Upon the receipt of the first ground pulse over wire P after the operation of relay **101**, relay **102** is operated through contacts **1** of start relay **101** for the duration of the pulse, perhaps fifty milliseconds. At its contacts **1**, relay **102** operates control relay **104** by energizing its lower winding over wire **111** through break contacts of break-make contact set **1** of relay **105**. Ground applied to wire **111** shunts the lower winding of relay **105** (ground from wire **111** on one side of the winding and ground from wire **112** through closed contacts **3** of relay **104** on the other side) thereby preventing it from operating until ground is removed from wire **111**. At its contacts **2**, relay **104** opens the charging path for condenser **107**. At its contacts **2**, relay **102** removes operating ground from the lower winding of test relay **103** and places a holding ground thereon through potentiometer **108**. By varying the setting, of potentiometer **108**, the holding current for relay **103** may be varied. At its contacts **3**, relay **102** restores test relay **103** by energizing its upper differential winding through its closed contacts **2**.

The current flow through the upper winding of test relay **103** causes a reversal of magnetic flux through its magnetic structure (not shown). This reversal of flux causes relay **103** to release in about ten milliseconds, for example, opening its own restoring circuit at its contacts **2**. By varying the setting of potentiometer **109**, the relay-control current drawn from timing-storage condenser **107** may be varied.

At its contacts **1**, relay **104** prepares its releasing circuit dependent upon when the relay-control current of condenser **107** diminishes thereby allowing relay **103** to remain operated during the receipt of a pulse over wire P; its contacts **2** opens the charging path of condenser **107**; its contacts **3** closes its holding circuit and prepares an operate circuit for relay **105**; and its contacts **4** applies ground to output wires TH and TP.

Upon the end of the first ground pulse over wire P, pulse relay **102** restores. At its contacts **3**, relay **102** opens the restoring circuit for test relay **103**; its contacts **1** removes ground potential from wire **111** thereby removing the shunt from the lower winding of control relay **105** at which time it operates in series with relay **104**; its contacts **2** reoperates test relay **103**.

At its contacts **1**, relay **105** prepares its hold circuit and also a release circuit for relay **104**; its contacts **2** further opens the charging path for condenser **107**; and at its contacts **3** ground is removed from output wire TP and ground is applied to wire TH independent of relay **104**.

Upon the receipt of the second ground pulse over wire P, relay **102** is again reoperated placing the potentiometer **108** in the holding circuit for relay **103** and completes the release path for the upper winding of relay **103** to restore it. Relays **104** and **105** remain operated being connected in series from ground at contacts **3** of relay **101**, contacts

3 of relay 104, through their windings to battery. Relay 104 does not restore when wire 111 is again grounded as it requires about thirty milliseconds, for example, to restore. Before the period of time necessary to release relay 104 has elapsed its release circuit is opened at contacts 1 of test relay 103 which restores in a shorter period of time, perhaps ten milliseconds.

At the end of the second pulse over wire P, relay 102 restores again reoperating test relay 103.

Upon the receipt of succeeding ground pulses over wire P, pulse relay 102 is repeatedly reoperated and each cycle (operation and release) thereof, releases and reoperates test relay 103 in the manner as described. The release operation of test relay 103 intermittently draws relay-control current from condenser 107, until such time (after the receipt of a total of eight ground pulses over wire P, for example) that the condenser is discharged sufficiently that the current is insufficient to restore test relay 103. At its contacts 1, relay 103 releases control relay 104 by energizing its upper differential winding from ground on wire 111, through contacts 1 of relays 105, 103 and 104.

Relay 104 upon releasing, at its contacts 2 prepares a charging circuit for condenser 107, and at its contacts 4 places the ground on wire TH under control of relay 105. To prevent relay 104 from reoperation, its holding and releasing circuits are opened at its contacts 3 and 1 respectively.

At its contacts 1, relay 105 is held operated from ground on wire 111.

Upon the end of the ground pulse over wire P, pulse relay 102 restores. At its contacts 3, relay 102 removes condenser 107 from the restoring circuit for test relay 103; at its contacts 2 relay 103 is reoperated; and at its contacts 1 ground is removed from wire 111 allowing relay 105 to restore.

At its contacts 2, relay 105 reconnects condenser 107 across its current source to recharge it; and at its contacts 3 removes ground from wire TH.

If timing is no longer needed, the timer is returned to its normal condition by opening start contacts SC, thereby allowing start relay 101 and test relay 103 to restore.

If there is any further need for timing, start contacts SC remain closed and the receipt of further ground pulses over wire P causes the timer to continually repeat its operational cycle until the start contacts SC are opened.

The timing interval may be readily adjusted by varying the settings of potentiometers 108 and 109. Potentiometer 108 controls the amount of holding current necessary to hold relay 103 operated, while potentiometer 109 controls the amount of current drawn from condenser 107 to restore it.

Second embodiment (Fig. 2)

The timer of Fig. 2 includes six electromagnetic relays, relays 201 to 205 being similar to relays 101 to 105 of Fig. 1, and a slow-operating delay relay 206. Condenser 207 is normally maintained in a charged condition by being connected across the current source through limiting resistor 210, and break contacts 3 and 2 of control relays 204 and 205 respectively.

When timing is needed, start relay 201 is operated in a manner as described for start relay 101, of Fig. 1. At its contacts 1, relay 201 prepares an operate path for the pulse relay 202; and its contacts 2 prepares a holding circuit for control relay 204 and an operate circuit for control relay 205. The timing operation now awaits pulses over wire P.

Upon the receipt of the first ground pulse over wire P after the operation of relay 201, relay 202 is operated through contacts 1 of start relay 201 for the duration of the pulse. At its contacts 1, relay 202 operates control relay 204 by energizing its lower winding over wire 211 through break contacts of break-make contact set 1 of relay 205.

At its contacts 1, relay 204 prepares its release circuit; its contacts 2 prepares an operate circuit for test relay 203; its contacts 3 opens the charging path for condenser 207; its contacts 4 closes its holding circuit and prepares an operate circuit for relay 205 from ground on wire 212; and its contacts 5 applies ground to output wires TH and TP.

Upon the end of the first pulse over wire P, pulse relay 202 restores. At its contacts 1, relay 202 removes ground from wire 211 allowing relay 205 to operate in series with relay 204; and its contacts 3 operates test relay 203 by energizing its lower winding through closed contacts 2 of relay 204.

At its contacts 1, relay 205 prepares a release circuit for relay 204 and its holding circuit; and its contacts 3 removes ground from output wire TP.

Upon the receipt of the second pulse over wire P, relay 202 is reoperated to release test relay 203 in the manner as described for test relay 103, of Fig. 1. Potentiometers 208 and 209 perform the same functions as potentiometers 108 and 109 of Fig. 1. The release circuit for relay 204 is not completed at this time because test relay 203 is released before delay relay 206 is operated. Relay 206 is provided with an upper short circuited winding to render it slow operating.

At the end of the second pulse over wire P, relay 202 restores to reoperate test relay 203.

Upon the receipt of succeeding pulses over wire P, relays 202, 203 and 206 operate as described until the relay-control current of condenser 207 is insufficient to release relay 203. The operation of slow-operate delay relay 206 (when relay 203 remains operated during a pulse) completes the release circuit of relay 204 from ground on wire 211, contacts 1 of relays 206, 203, and 204.

At its contacts 3, relay 204 prepares a recharging circuit for condenser 207; its contacts 1 opens its release circuit; its contacts 4 opens its holding circuit and the operate circuit for relay 205; its contacts 5 places the ground on wire TH under control of relay 205; and its contacts 2 releases test relay 203.

At its contacts 1, relay 205 is held operated for the duration of the pulse from ground on wire 211, through contacts 1 of delay relay 206.

At the end of the pulse, relay 202 restores removing holding ground from wire 211 and releasing relay 206. Relay 205 releases completing the noted charging circuit for condenser 207 and removes ground from wire TH.

As described for the timer of Fig. 1, if timing is no longer needed start contacts ST are opened to release start relay 201; or if timing is further needed start contacts ST remain closed and the timer repeats its operational cycle until such time start contacts ST are opened.

Third embodiment (Fig. 3)

The timer of Fig. 3 includes six electromagnetic relays, relays 301 to 305 being similar to relays 101 to 105 of Fig. 1, and relays 201 to 205 of Fig. 2, and a slow-release delay relay 306. Condenser 307 is normally maintained in a charged condition by being connected across the current source through limiting resistor 310, break contacts 3 and 2 of relays 304 and 305 respectively.

As described for Fig. 2, when timing is needed, start relay 301 is operated to prepare operating circuits for relays 302 and 305 and a holding circuit for relay 304.

Upon the receipt of the first pulse over wire P after the operation of start relay 301, relay 302 is operated for the duration of the pulse. At its contacts 1, relay 302 operates delay relay 306.

Relay 306 at its contacts 1 prepares an operate circuit for control relay 304.

At the end of the first pulse, relay 302 releases to operate relay 304 by energizing its lower winding through closed contacts 1 of slow-release relay 306 and contacts 1 of relay 105.

Relay 306 has been provided with a copper sleeve over its magnetic core to render it slow-releasing. Relay 306 will remain operated for fifteen milliseconds, for example, after its operate circuit has been opened by relay 302 thereby allowing relay 304 to operate and receive holding ground from wire 312 through its closed contacts 4 and the lower winding of relay 305.

At its contacts 1, relay 304 prepares its release circuit; its contacts 3 opens the charging path for condenser 307; its contacts 2 operates test relay 303 by energizing its lower winding through contacts 2 of relays 306 and 302; and its contacts 5 applies ground to output wires TH and TP.

Relay 306 upon releasing allows relay 305 to operate in series with relay 304 as described for relay 105 of Fig. 1. Relay 305 at its contacts 3 removes ground from output wire TP.

Upon the receipt of the second pulse over wire P, relay 302 reoperates to close the operating circuit for delay relay 306. At its contacts 2, relay 302 opens the operate circuit for relay 303 but is held operated through potentiometer 308.

At its contacts 1, relay 306 prepares a release circuit for relay 304; its contacts 2 further opens the operate path for relay 303; and its contacts 3 releases relay 303 by energizing its upper-differential winding.

At the end of the second pulse over wire P, relay 302 releases and after a slight delay relay 306 releases to reoperate test relay 303.

Upon the receipt of succeeding pulses over wire P, relays 302, 303, and 306 operates, as hereinbefore described until the relay-control current of condenser 207 is insufficient to release relay 303.

At the end of the pulse (when relay 303 remains operated during a pulse) relay 302 releases to restore control relay 304 by energizing its upper-differential winding through closed contacts 1 of relay 306, wire 311, contacts 1 of relays 305, 303 and 304.

At its contacts 3, relay 304 prepares a recharging circuit for condenser 207; its contacts 1 opens its release circuit, its contacts 4 opens its holding circuit and the operate circuit for relay 305; its contacts 5 places the ground on wire TH under control of relay 205; and its contacts 2 opens the operate circuit for test relay 303.

At its contacts 1, relay 305 is held operated from ground on wire 311 until delay relay 306 releases opening its holding circuit.

When relay 305 releases, it completes the recharging path for condenser 307 and removes ground from wire TH.

As described for the timer of Fig. 1, if timing is no longer needed, start contacts ST are opened to release start relay 301; or if timing is further needed start contacts ST remain closed and the timer repeats its operational cycle until such time start contacts ST are opened.

Although the timers herein disclosed are shown as they may be applied in conjunction with permanent timing, it will be readily apparent to those skilled in the art that the provisions of the work contacts of the control relays will readily lend themselves to numerous applications in circuit design.

I claim:

1. In an electric timer, a storage condenser, circuit means comprising first and second circuit paths for passing current through the condenser respectively in first and second directions, preparing means for maintaining the second path open and the first path closed to cause current flow in the first direction to bring the potential difference between the terminals of the condenser to a preassigned starting value, starting means and means for operating it to start a timing period, means controlled by the starting means for disabling the preparing means during the started timing period, pulse means for closing the second circuit intermittently during the started timing period to cause current to flow in the second direction to bring the potential difference between the condenser terminals to a preassigned termination value, whereby the current flow in the second circuit comprises intermittent pulses of a strength which diminishes progressively to a termination value determined by the said termination value of potential difference, test means included in the second circuit, and means controlled by the test means for terminating the started timing period responsive to a pulse in the second circuit of a strength no greater than the said termination value of pulse strength.

2. In an electric timer according to claim 1, said test means including a relay having a test winding included in the second circuit, and contacts on the test relay controlled by the flow of current through the test winding for preventing termination of the started timing cycle so long as the pulses in the second circuit are of a greater strength than their said termination value.

3. In an electric timer according to claim 2, said test relay having a second winding for controlling the relay contacts jointly with the first winding, and separate means for passing operatively effective current through the second winding between closures of the second circuit.

4. In an electric timer according to claim 3, said relay windings being opposed, with the second winding serving to operate the relay contacts and the first winding serving to restore them, said relay contacts including a pair which open the second circuit upon restoration by the first winding, whereby the second circuit is promptly opened to terminate any test pulse therein of greater than termination strength.

5. In an electric timer according to claim 1, means included therein for holding the starting means operated and for maintaining the preparing means disabled throughout a timing period, the said means for terminating a timing period including means for restoring the starting means and for rendering the preparing means again effective.

6. In an electric timer according to claim 5, the pulse means for closing the second circuit intermittently including means for delivering a continuous succession of control pulses of which those delivered during a timing period are in timed relationship with respective closures of the second circuits, the starting means, when restored, being responsive to any said control pulse, and means for delaying the operation of the terminating means responsive to the termination closure of the second circuit until the associated control pulse is ended, whereby the resulting restoration of the starting means does not result in the reoperation of the starting means until the next succeeding control pulse is delivered.

7. In an electric timer according to claim 1, means for varying the impedance of the second circuit to vary the cumulated closure time required to reach an assigned termination value of potential difference at the condenser terminals.

8. In an electric timer according to claim 1, means for varying the termination value of current strength to vary the termination value of potential difference at the condenser terminals.

9. An electric timer comprising a storage condenser and means for charging and discharging it in cycles each of which comprises a timing period and a recovery period, said charging and discharging means including a pulse relay, a test relay, and control-relay mechanism having a recovery position and a timing position, pulse

means for operating the pulse relay intermittently at regular intervals which determine the recovery period allowed, means responsive to an operation of the pulse relay for causing the control-relay apparatus to move from recovery position to timing position to start a timing period which includes a plurality of the said intervals, means controlled by the pulse relay for closing a timing circuit for the test relay through the condenser, the test relay responding to each such closure during the timing period until the condenser is no longer able to furnish sufficient current, and means controlled by the test relay for causing the control-relay apparatus to resume its recovery period until the pulse relay is next operated.

10. In an electric timer according to claim 9, a delay relay controlled by the pulse relay, and means controlled by the delay relay included in the means for causing the control-relay apparatus to resume its recovery position.

11. In an electric timer according to claim 10, said delay relay being a slow-operating relay operated by the impulse relay.

12. In an electric timer according to claim 10, said delay relay being a slow-releasing relay operated by the impulse relay.

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