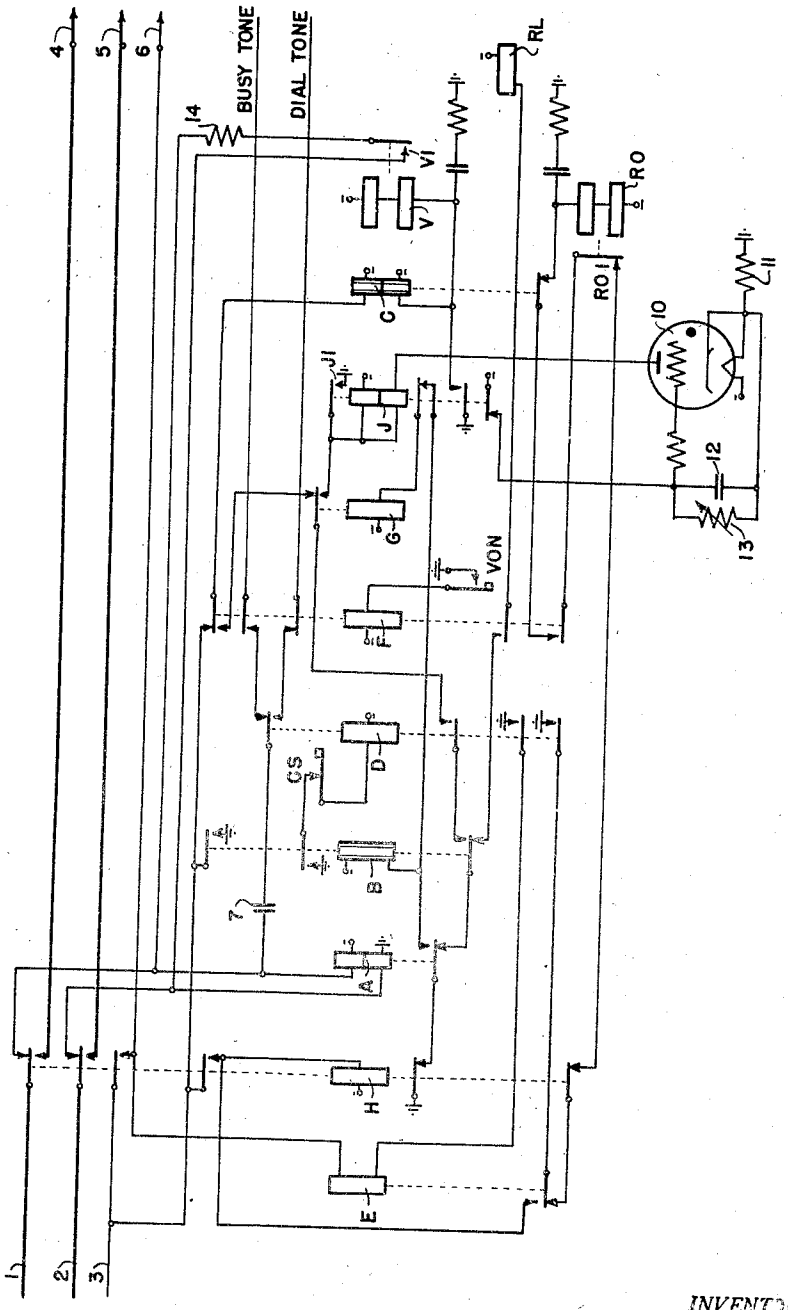
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IMPULSING CIRCUIT

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## IMPULSING CIRCUIT

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The present invention relates to impulsing circuits such as are used to control the operation of stepping switches in automatic telephone systems, and is more particularly concerned with arrangements for improving the reliability of operations of such switches when the control impulses are transmitted over lines of poor characteristics.

The usual impulsing devices which are located at the subscriber's stations of an automatic telephone system are constructed and adjusted to provide a fixed ratio between the break period and the make period of the impulses which they produce. The ratio commonly used in telephone systems of the Strowger type provides a break period equal to 61½% of the impulse period. This ratio is the optimum value for average operating conditions and allows considerable tolerance in the impulse speed, line resistance, line leakage, exchange voltage, and adjustment of the switching mechanism in the exchange. Variations of any of these quantities from their nominal values produce variations in the length of the impulse delivered to the switch magnets by the line relay in the exchange switching equipment. However, cases often arise where it is desirable to increase the permissible tolerance limits in order to provide increased reliability of operation of the switching mechanism under unusually poor impulsing conditions.

The principal object of the present invention is to provide a new and improved impulsing circuit which will deliver impulses having a fixed closure time in response to received impulses of variable speed and impulse ratio.

A further object of the invention is to provide an impulsing circuit in accordance with the preceding object in which the fixed closure time is measured by means of a resistor-condenser combination and a thermionic tube.

Another object is to provide a telephone selector switch employing means for delivering pulses of a fixed duration to the switch magnets and including circuit arrangements for delivering pulses of greater length to the changeover relay which must remain operated during a series of received impulses.

A feature of the invention is the provision, in a selector switch having means for providing a fixed length of pulse to the magnets, of means for pre-energizing the line relay to increase the length of the impulses delivered to the holding relay.

Other objects and features of the invention will appear upon a further perusal of the specification taken in connection with the accompanying drawing which illustrates in the form of a schematic diagram the application of the invention to a two-motion telephone selector switch of the Strowger type.

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Briefly described, the invention consists in providing a timing circuit comprising a thermionic tube having a delay network consisting of a condenser and a resistor in its grid circuit, and a pair of relays arranged to be controlled by contacts of the usual line relay and by the thermionic tube so as to initiate the operation of the timing means in response to each restoration of the line relay and to repeat pulses of a fixed duration, determined by the time constant of the delay network in the grid circuit of the thermionic tube, to the switch magnets. Circuit arrangements including contacts of the preceding pair of relays are provided to insure that a circuit is closed to the changeover relay while the line relay is restored or while a circuit is closed to the switch magnets.

Referring now to the drawing, relay A is the usual line relay, relay B is the usual holding relay, relay C is the usual changeover relay, relay D is normally a slave relay to relay B, relay E is the usual rotary stopping relay, relay F is a slave relay to the usual vertical off-normal springs, relay H is the usual switching through relay, magnets V, RO, and RL are the usual vertical, rotary, and release magnets, relays G and J are additional relays associated with the improved impulsing circuit, and thermionic tube 10 together with the delay network connected in its grid circuit constitutes the timing means which determines the duration of the pulses delivered to the vertical magnet V.

In order that the invention may best be understood, a detailed description of the operation of the selector switch incorporating the invention will be given. For this purpose it will be assumed that the selector switch is seized in the usual manner over leads 1, 2 and 3, by a preceding line finder or rotary lineswitch. When the selector is seized a loop circuit is closed to line relay A over leads 1 and 2, and a circuit is closed to the upper winding of changeover relay C over lead 3. Relay A operates and closes a multiple circuit to relays B and G. Relay G operates and prepares a circuit to relay J. Relay C operates. Relay B operates, grounds lead 3 to hold the preceding switch and relay C, closes a circuit to relay D through the cam springs CS, and further prepares the circuit to relay J. Relay D operates, connects the dial tone lead to lead 1 through condenser 7 to inform the calling subscriber that the equipment is prepared to receive impulses,

further prepares the circuit to relay J, and prepares circuits for the rotary magnet RO and the rotary stopping relay E.

When the calling subscriber dials the first digit of a desired number relay A is momentarily restored a number of times corresponding to the digit dialled. Each time that relay A restores it completes a circuit to the upper winding of relay J and opens the circuit to relays B and G. Relay B is made slow to release by a copper sleeve on its core so that it will remain operated during impulsing. Relay J operates, closes its locking circuit through its preliminary make contacts J1, disconnects relay G from relay B to prevent the shunting effect of relay B from retarding the release of relay G, completes a multiple circuit to the vertical magnets V and the lower winding of relay C, and disconnects negative battery from the grid of thermionic tube 10. Relay G restores, opens the operating circuit to relay J, and prepares a second circuit for the upper winding of relay C. The vertical magnets V operate to raise the switch shaft to the first level of bank contacts, and operate the vertical magnet springs V1 to close a circuit through resistor 14 to relay A. Resistor 14 has a value sufficiently high so that relay A will not operate in series with it, but the operate time of relay A is appreciably reduced due to this pre-energizing circuit thus permitting it to operate more quickly when the loop circuit over leads 1 and 2 is reclosed. The effect of the pre-energization of relay A is to increase the duration of the impulses delivered to relay B during dialling insuring its continued operation.

The filament of tube 10 is energized from the exchange battery in series with resistor 11. The cathode of the tube is connected to the junction between resistor 11 and the filament so that it is maintained at a negative potential with respect to ground by an amount equal to the voltage drop across the resistor 11. The anode of tube 10 is normally connected to the negative terminal of the exchange battery through the two windings of relay J in series thus maintaining the anode negative with respect to the cathode. However, when ground is connected to the upper winding of relay J by relay A the anode of tube 10 is made positive with respect to the cathode. Tube 10 does not conduct current at this time due to the negative bias placed on its control grid by condenser 12, which is normally charged to a potential equal to the voltage drop across the filament of tube 10. The operation of relay J opens this charging circuit and thus permits condenser 12 to discharge through resistor 13. The values of condenser 12 and resistor 13 are chosen so that the grid bias on tube 10 will reach a point where the tube is rendered conducting in a time equal to the desired length of pulse to the vertical magnets V. Resistor 13 is preferably made adjustable to permit variation in the duration of the repeated impulses as desired. To provide the most accurate timing tube 10 is preferably of the gas discharge type so that the anode current of the tube will increase abruptly from zero to a finite value when its grid reaches a critical potential rather than increasing gradually as it would do if tube 10 were of the high vacuum type. In the following description it will be assumed that the gas discharge type of tube is used. When tube 10 fires it causes the lower winding of relay J to be energized in opposition to the upper winding. Relay J consequently restores, opens the locking circuit to its upper winding and removes ground or plus battery from the anode of tube 10 at contacts J1 thus causing the tube to become deionized, opens the circuit to the vertical magnets V, reconnects relay G in multiple with relay B so that it will be reoperated after A reoperates, and recloses the charging circuit to condenser 12. When relay A reoperates it recloses the multiple circuit to relays B and G. Relay G again operates and prepares the circuit to operate relay J by its upper winding the next time that relay A restores. The switch is now in the same condition as when first seized except that the vertical magnets have raised the switch shaft one vertical step thus bringing about the operation of the vertical off normal springs VON. These springs complete a circuit to relay F which operates, transfers the upper winding of relay C from ground on lead 3 to contacts of relay G, disconnects dial tone from the calling line, and prepares circuits to the rotary magnets RO and the release magnet RL. During succeeding impulses of the first digit relay J is operated and relay G released in response to the restoration of relay A. When relay G restores it closes a circuit to the upper winding of relay C from back contacts of relay A. The object of this last circuit is to provide a longer length of impulse to relay C than it receives from its lower winding alone. The succeeding impulses are repeated to the vertical magnets V by relay J in the same manner as the first impulse.

At the conclusion of the series of impulses relays A, B, C, D, F, and G will be operated and the switch shaft will have been raised to the desired level. Relay C restores a short time after the last impulse and closes a circuit to the rotary magnets RO through the rotary interrupter springs RO1. The rotary magnets operate self-interrupted to advance the switch wipers 4 to 6 over the bank contacts of the selected level. When the wipers reach an idle second selector or connector negative battery is extended to relay E over wiper 6 from the succeeding switch. Relay E operates, opens the driving circuit to the rotary magnets RO to stop further rotary motion, and closes a circuit to relay H. Relay H operates, closes its locking circuit to lead 3, transfers the calling subscriber's loop from relay A to the succeeding switch over wipers 4 and 5, extends the holding lead 3 to the succeeding switch over wiper 6, opens the impulsing circuit thus opening the circuits to relays B and G, and opens a further point in the rotary magnet driving circuit. Relays A, G, and E restore. Relay B restores, opens the circuit to relay D, and removes ground from the holding lead 3. During the release time of relay B the succeeding switch places a multiple ground on the holding lead over wiper 6 which ground is under the control of the calling subscriber's loop circuit. Relay D restores, opens further points in the impulsing circuit and rotary magnet driving circuits, and removes the operating ground from relay E. Relays H and F remain operated throughout the connection. When the calling subscriber's loop circuit is opened at the conclusion of the conversation the succeeding switches remove the ground from the holding lead which is extended over wiper 6 thereby opening the circuit to relay H. Relay H restores and closes a circuit to the release magnet RL which operates to permit the switch shaft to return to normal. When the shaft is restored the vertical off normal springs open and release relay F which restores and opens the circuit to the release magnet RL.

In the event that there were no idle second selectors or connectors available on the selected level the rotary magnets would have driven the wipers beyond the last contacts in the level to the 11th rotary step where cam springs CS operate and open the circuit to relay D. Relay D restores, connects the busy tone lead in the calling line through condenser 7, opens incomplete circuits to relays E and J, and opens the rotary magnet driving circuit to stop further operation of the magnets RO. The calling subscriber hangs up upon hearing the busy tone thus opening the loop to relay A. Relay A restores and opens the circuit to relay B. Relay B restores, opens a further point in the circuit to relay D, closes a circuit to the release magnet RL, and removes ground from lead 3 to release the preceding switch. The release magnet RL operates to permit the switch shaft to restore to normal. Relay F is released when the vertical off normal springs open as previously described.

What is claimed is:

1. In an automatic switch having a line relay, a holding relay controlled by contacts of said line relay, and stepping means for directing the operation of the switch; timing means controlled by contacts of said line relay operative to repeat impulses having a fixed desired duration to said stepping means in response to the receipt of impulses of an undesired duration by said line relay, and means controlled by said stepping means for pre-energizing said line relay to thereby increase the average current in said holding relay during impulsing.

2. In combination, a gas discharge tube having a cathode, an anode, and a control grid, a relay having two windings one of which is included in the anode circuit of said tube, an operating circuit for said relay including its other winding, contacts on said relay for causing an aperiodic voltage to appear between the control grid and cathode of said tube in response to the operation of the relay, and said tube firing when said aperiodic voltage reaches a predetermined value to energize said one winding in opposition to said other winding and thereby cause said relay to restore.

3. In a combination as claimed in claim 2, circuit arrangements causing said tube to be deionized in response to the restoration of said relay.

4. In combination, a thermionic tube having a cathode, an anode, and a control grid, a relay having two windings one of which is included in the anode circuit of said tube, an operating circuit for said relay including its other winding, contacts on said relay for causing an aperiodic voltage to appear between the control grid and cathode of said tube in response to the operation of the relay, and said tube becoming conductive when said aperiodic voltage reaches a predetermined value to energize said one winding in opposition to said other winding and thereby cause said relay to restore.

5. In a signaling system, a first circuit over which impulses are at times transmitted, a thermionic tube having a cathode, an anode, and a control grid, means associated with said first circuit for initiating an impulse over a further circuit and for initiating the flow of an aperiodic current in the grid circuit of said tube in response to the receipt of an impulse over said first circuit, said aperiodic current rendering the tube conductive a predetermined time interval thereafter, and said means being operated by the anode current of said tube to terminate the impulse over said further circuit.



6. In an automatic switch, a line relay, an auxiliary relay controlled by said line relay, timing means comprising a space discharge device, an aperiodic circuit, and a relay, a stepping magnet controlled by said timing means, circuit arrangements including contacts of said auxiliary relay for delivering a momentary impulse to said timing means in response to each restoration of said line relay, said timing means being operative to deliver an impulse of fixed duration to said stepping magnet in response to said momentary impulse.

7. In an automatic switch, a line relay, an auxiliary relay controlled by said line relay, timing means, a stepping magnet controlled by said timing means, circuit arrangements including contacts of said auxiliary relay for delivering a momentary impulse to said timing means in response to each restoration of said line relay, said timing means being operative to deliver an impulse of fixed duration to said stepping magnet in response to said momentary impulse, a changeover relay having two windings, and circuit arrangements for energizing one of said windings by said timing means for the duration of said impulse and for at times energizing the other of said windings through contacts of said line relay during its restored period.

8. In combination, a gas discharge tube having a cathode, an anode, and a control grid, a relay having two windings one of which is included in the anode circuit of said tube, an operating circuit for said relay including its other winding, means for momentarily completing said operating circuit, contacts on said relay for completing a locking circuit through said other winding in response to the operation of the relay and further contacts on said relay for causing an aperiodic voltage to appear between the control grid and cathode of said tube, and said tube firing when said aperiodic voltage reaches a predetermined value to energize said one winding in opposition to said other winding and thereby cause said relay to restore.

9. In combination, a thermionic tube having a cathode, an anode, and a control grid, a relay having two windings one of which is included in the anode circuit of said tube, an operating circuit for said relay including its other winding, means for momentarily completing said operating circuit, contacts on said relay for completing a locking circuit through said other winding in response to the operation of the relay and further contacts on said relay for causing an aperiodic voltage to appear between the control grid and cathode of said tube, and said tube becoming conductive when said aperiodic voltage reaches a predetermined value to energize said one winding in opposition to said other winding and thereby cause said relay to restore.

10. In combination, a gas discharge tube having a cathode, a control grid, and an anode, an aperiodic circuit between the cathode and the anode of said tube, a relay having two windings one of which is included in the anode circuit of said tube, an operating circuit for said relay including its other winding, means for momentarily completing said operating circuit, contacts on said relay for completing a locking circuit through said other winding in the response to the operation of said relay and other contacts on said relay for causing an aperiodic voltage between the grid and the cathode of said tube, said aperiodic voltage

reaching a value to fire said tube in a predetermined time, the anode current of said tube energizing said one winding in opposition to said other winding and thereby cause said relay to restore, and means to adjust said aperiodic circuit for at times changing said predetermined time.

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