Jan. 5, 1932. E. E. HINRICHSEN 1,840,097

IMPULSE CIRCUIT

Filed July 31, 1930

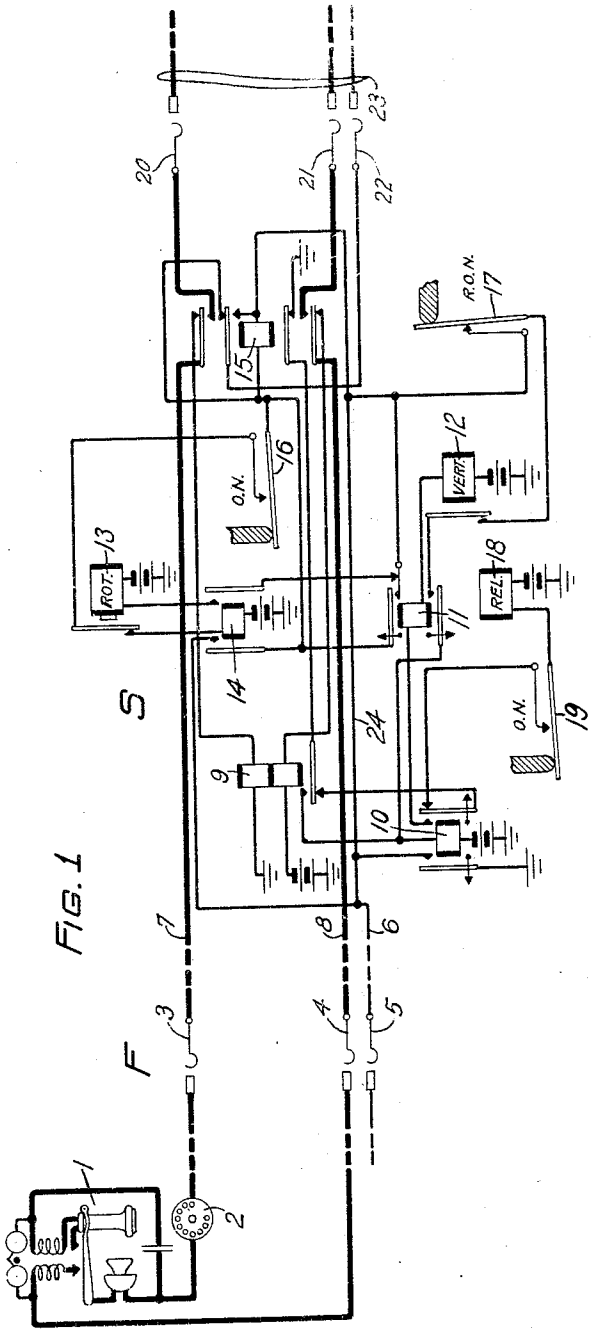

FIG. 1

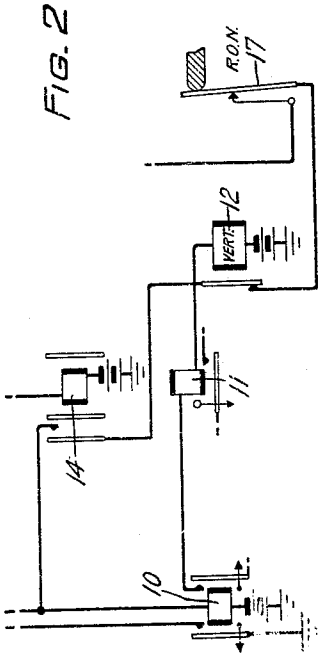

FIG. 2

INVENTOR
E. E. HINRICHSEN
BY M. B. McKenney
ATTORNEY

Patented Jan. 5, 1932 1,840,097

UNITED STATES PATENT OFFICE

EDWARD E. HINRICHSEN, OF NEW YORK, N. Y., ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

IMPULSE CIRCUIT

Application filed July 31, 1930. Serial No. 471,916.

This invention relates to impulse circuits and particularly to those employed in the operation of switches for telephone systems.

The objects are to improve the operating conditions of holding relays, to reduce the difficulties that have been experienced in giving these relays a satisfactory adjustment, and to otherwise improve the effectiveness and reliability of impulse circuits.

Heretofore it has been customary to arrange the impulse circuits of step-by-step switches such that the holding relay receives its operating energy over a circuit closed through the front contact of the impulse relay. Since the impulse relay releases and operates successively in response to a series of impulses, the circuit of the holding relay is opened on each successive impulse from the time the impulse relay opens its front contact until this contact is again closed. To prevent it from retracting its armature during those openings, the holding relay is constructed so as to release slowly. However, it has been found that unless the relay is properly adjusted it will lose enough energy on a long series of impulses to release, thus causing an improper operation of the apparatus.

It has also been proposed heretofore to provide the holding relay with a second winding which serves to maintain the relay energized while the circuit through its primary winding is opened on each impulse.

The present invention is an improvement over these prior arrangements in that the holding relay need have only one winding and is provided with an auxiliary holding circuit which extends through a normally closed contact on the stepping magnet of the switch. The stepping magnet, which operates on an impulse delivered to it over a circuit closed by the back contact of the impulse relay, does not open the said auxiliary holding circuit until it has nearly completed its forward stroke. This means that the auxiliary holding circuit of the holding relay is closed for a considerable time after the primary holding circuit of the relay is opened at the front contact of the impulse relay. Thus the holding relay loses only a small part of its energy on the back stroke of the impulse relay and will regain what it has lost on each forward stroke. This guards against accidental operation of the switch and greatly simplifies the adjustment necessary for the holding relay.

According to another feature of the invention, the auxiliary holding circuit for the holding relay extends through a front contact of the change-over relay, which remains energized during the series of pulses and releases at the end of the series. This insures that the holding relay will not lock over its auxiliary circuit after the series of pulses ceases for the reason that the change-over relay, which releases at the end of the series, opens the auxiliary circuit at its contact, restoring the control of the holding relay solely to the impulse relay.

According to a further feature, the auxiliary holding circuit of the holding relay is extended through a contact opened by the first operation of the switch in its secondary movement to permit the release of the switch in case of abandonment during the secondary operation.

In the drawings, Fig. 1 represents a portion of an automatic telephone system in which the circuits for one of the selector switches are shown in detail, the remaining equipment being illustrated diagrammatically. Fig. 2 illustrates a modification of the circuit arrangement shown in Fig. 1.

Considering Fig. 1 first, a subscriber's line 1 appears at the central office in a suitable switching device such as a line finder F. When the line calls, the finder F is operated in the usual manner to set its brushes 3, 4 and 5 on the terminals of the line 1 and thereby extend the calling line to a selector switch

such as the selector S having the brushes 20, 21 and 22. As soon as the subscriber's line is extended to the selector S, a circuit is closed for the impulse relay 9 and may be traced from battery through the lower winding of said relay, lowermost contact of relay 15, over the ring conductor 8, brush 4, thence over the loop of the calling line and returning through brush 3 and tip conductor 7, uppermost back contact of relay 15, upper winding of relay 9 to ground. The impulse relay 9 attracts its armature and closes an initial energizing circuit for the holding relay 10. This circuit may be traced from battery through the winding of relay 10, front contact of relay 9 to ground through the inner lower contact of relay 15. The holding relay 10, which controls the release of the switch, is designed with a slow-release characteristic in order that it will maintain its armatures in their attracted position during the intervals that it is deprived of energizing current while the impulses are being received.

The calling subscriber now manipulates his impulse transmitter 2 to send a series of impulses representing a digital place in the wanted designation. On the first opening of the subscriber's line by the impulse transmitter 2, the impulse relay 9 releases its armature, first opening its front contact and immediately thereafter closing its back contact. The opening of the front contact of the relay 9 opens the energizing circuit of the holding relay and this relay commences to lose energy. However, due to its slow-release characteristic, it will retain its armatures. Relay 9 at its back contact closes a circuit for delivering the first impulse to the vertical stepping magnet 12. This circuit may be traced from ground through the inner lower contact of relay 15, back contact of relay 9, right-hand armature and front contact of relay 10, winding of the change-over relay 11, winding of the vertical magnet 12 to battery. The relay 11, which immediately operates in this circuit, is also constructed with a slow-release characteristic in order that it will retain its armatures attracted during brief interruptions of its energizing circuit. The vertical magnet 12 responds to current flowing in this circuit and steps the brushes 20, 21 and 22 one vertical step to position them opposite the first level of contacts in the switch.

The vertical off-normal contact 16 is closed on the first vertical step of the switch and completes a circuit for the relay 14. This circuit extends from battery through the winding of the relay, contact of the rotary stepping magnet 13, off-normal contact 16, upper front contact of the relay 11, conductor 24 to ground at the left contact of relay 10. Relay 14 operates and locks in a circuit from battery through its winding, contact of the stepping magnet 13, contact 16, left front contact of relay 14, to the grounded conductor 24.

At the end of the first impulse, the transmitter 2 recloses the line, and the relay 9 attracts its armature, opening the stepping circuit and permitting the vertical magnet 12 to release. Relay 9 at its front contact recloses the initial energizing circuit of the holding relay 10, and this relay commences to regain its lost energy. On each of the following impulses, relay 9 retracts its armature and recloses the energizing circuit of the vertical magnet 12, and this magnet advances the switch to the next succeeding level.

In addition to its initial energizing circuit, the relay 10 is also provided with an auxiliary holding circuit which may be traced from battery to the winding of the relay, lower front contact of relay 11, normally closed contact of the vertical magnet 12, rotary off-normal contact 17, which does not open until the switch begins its rotary movement, conductor 24 to ground at the left contact of relay 10. Inasmuch as the relay 11 remains energized continuously throughout the impulse series, the auxiliary circuit is not opened at the lower contact of this relay. The auxiliary circuit is, however, opened once for each impulse at the normally closed contacts of the magnet 12. Since the energizing circuit of the magnet is not closed until the armature of relay 9 has closed its back contact and since the contacts on the magnet 12 may be adjusted to open only after the magnet has substantially completed its vertical stroke, it follows that the auxiliary circuit of the relay 10 is maintained closed for a considerable time after the initial energizing circuit of said relay is opened at the front contact of relay 9. Consequently, the relay 10 retains most of its energy, and, its circuit closes during each impulse for a sufficient time to enable it to regain all the energy that it has lost during the brief open period.

At the end of the impulse series, the line is reclosed for a longer interval, and relay 9 attracts and holds its armature against its front contact. After an interval, relay 11 releases its armatures and in so doing prepares an energizing circuit for the rotary magnet 13 to advance the brushes 20, 21 and 22 over the contacts of the selected group. The circuit for magnet 13 may be traced from battery through the winding of the magnet, right contact of relay 14, normal contacts of relay 11 to the grounded conductor 24. The magnet 13 energizes and steps the brushes onto the first set of contacts in the group. Magnet 13 also attracts its armature and opens the holding circuit of relay 14. Relay 14 immediately releases and opens the energizing circuit of the magnet 13, whereupon the magnet releases preparatory to taking the next step. If the circuit 23 appearing in the first set of contacts is busy,

the test brush 22 encounters a ground potential on the test terminal, and the relay 14 is reenergized in the following circuit: battery, through the winding of said relay, contact of the magnet 13, contact 16, inner upper back contact of relay 15, brush 22 to the grounded terminal. A parallel circuit may be traced from battery through the winding of relay 14, contact of the magnet 13, contact 16, winding of switching relay 15 to the grounded conductor 24. Since there is a direct ground potential on the brush 20, relay 15 is shunted and does not operate. Relay 14 in operating recloses the circuit of the magnet 13, which advances the brushes another step and opens the circuit of relay 14. Relay 14 releases and releases the magnet 13. This action continues until the test brush 22 encounters an idle terminal, which is represented by the absence of ground potential. At this time the shunt is removed from the winding of relay 15 and the relay immediately energizes. Relay 14, however, does not energize in this circuit due to the resistance of the relay 15. Accordingly, the circuit of the stepping magnet 13 is maintained open and the switch ceases to advance, coming to rest on the terminals of the idle circuit.

The relay 15 in operating switches the tip and ring conductors of the circuit through the brushes 20 and 21 and thence to the next succeeding switch. Relay 15 by attracting its armatures opens the circuit of relay 9 which releases its armature. After an interval the relay 10 releases since both its initial circuit and auxiliary holding circuit are now open. Before relay 10 can release to remove ground from conductor 24, ground potential will have been substituted on this conductor from the succeeding switch over a circuit extending through the brush 20 and the upper inner armature and front contact of relay 15. This substitute holding ground may serve to maintain the line finder F and also to hold the relay 15 energized.

When it is desired to release the selector S, ground potential is removed from the conductor 24, thereby permitting the release of relay 15. Relay 15 closes an energizing circuit for the release magnet 18, traceable from battery through the winding of said magnet, vertical off-normal contact 19, right back contact of relay 10, back contact of relay 9, to ground through the inner lower contact of relay 15. The release magnet 18 energizes and releases the switch S. When switch S fully restores, the vertical off-normal contact 19 is opened and the magnet 18 deenergizes.

The relay 10 is permitted to release after the switch has completed its functions since, as above noted, its initial energizing circuit is opened by the relay 9 and its auxiliary circuit has already been opened at the contact of relay 11.

Should the subscriber abandon the call before transmitting impulses to the switch, relay 9 in releasing would close the previously-traced energizing circuit for the magnet 12, and the magnet on energizing would open the auxiliary circuit of relay 10 permitting this relay to release after an interval. Should the subscriber abandon the call during the rotary movement of the switch, the release of relay 10 is insured by the rotary off-normal contact 17. The release of relay 9 under such a condition closes an energizing circuit for the vertical magnet 12, but, since the switch has commenced its rotary movement, magnet 12 is unable to advance its stepping dog a full step, and, according to the adjustment of the armature on the magnet, its contact might not open. However, the auxiliary holding circuit of the relay 10 has already been opened at the contact 17, and, therefore, the relay is permitted to release. If it were desired to dispense with the contact 17, the vertical magnet might be so adjusted that it would open its left contact on a short stroke of its stepping dog.

Fig. 2 illustrates a modification of the invention. In this figure the auxiliary holding circuit of the relay 10 instead of leading through a contact of relay 11 extends through a contact of the relay 14. It will be recalled that relay 14 energizes on the first vertical step of the switch and remains energized during the vertical movement. Therefore, the auxiliary circuit of relay 10 remains closed at the contact of relay 14 during the vertical movement of the switch and is opened successively at the contact of the vertical magnet 12 as above described. During the secondary or rotary movement of the switch the relay 14 operates and releases successively to control the rotary magnet 13. These brief interruptions of the auxiliary circuit of relay 14 do not interfere with the relay 10 since this relay is now held over its initial energizing circuit through the front contact of relay 9. At the end of the rotary movement, relay 9 deenergizes and relay 14 remains deenergized to permit the release of relay 10.

The finder F and the selector switch S disclosed in this application may be of any suitable construction. The selector S is preferably of the two-movement step-by-step type having a first stepping movement to select groups of trunks or lines and a second stepping movement to select individual trunks or lines. A switch of this character is described in the patent to Keith et al. No. 815,176, granted March 13, 1906.

While the invention has been illustrated in connection with a specific circuit arrangement, it is to be understood that it is not limited to these particular circuits. It should also be noted that this invention is applicable to repeaters used for repeating impulses from an incoming circuit to an outgoing circuit

and that it is also applicable to connector switches in which both the primary and secondary movements are directively controlled by impulses.

What is claimed is:

1. The combination in an impulse circuit of an impulse relay, a stepping magnet, means controlled by said relay for delivering impulses to said stepping magnet, a holding relay, a circuit for the winding of said holding relay closed at the front contact of said impulse relay, and a second circuit for said winding controlled by said stepping magnet.

2. The combination in an impulse circuit of an impulse relay, means for sending impulses to cause the successive operation and release of said relay, an operating device having contacts which open when the device is energized, a second relay having a winding and a circuit for said winding closed at the front contact of said impulse relay, a circuit controlled by said impulse relay for delivering operating impulses to said operating device, and a second circuit for said winding extending through the contacts of said operating device.

3. The combination in an impulse circuit of an impulse relay, a magnet, a circuit controlled by said relay for delivering operating impulses to said magnet, a second relay having a single winding therefor, a circuit for said winding closed by said impulse relay, an auxiliary circuit for said winding controlled by said magnet, and a releasing device controlled by said second relay.

4. In combination, an impulse relay, a stepping magnet, a circuit controlled by said impulse relay for delivering impulses to operate said magnet, a relay having its winding in said circuit, a holding relay having a circuit closed by said impulse relay, and a second circuit for said holding relay controlled by said magnet and by said second-mentioned relay.

5. The combination in a selective switch having primary and secondary movements of an impulse relay, a magnet for operating said switch in its primary movement, a circuit controlled by said relay for sending impulses to operate said magnet, a second relay having a circuit closed by said impulse relay, an auxiliary circuit for said second relay controlled by contacts on said magnet, and a contact operated by said switch in its secondary movement for controlling said auxiliary circuit.

6. The combination in an impulse circuit of an impulse relay, a stepping magnet, a circuit controlled by a back contact of said impulse relay for delivering operating impulses to said magnet, a holding relay, a circuit for the winding of said holding relay controlled at a front contact of said impulse relay, and another circuit for said winding controlled at a back contact of said stepping magnet.

7. The combination in an impulse circuit of an impulse relay, a magnet, a circuit controlled by said relay for delivering operating impulses to said magnet, a second relay having a single winding and having slow-to-release characteristics, a circuit for said winding closed by said impulse relay, an auxiliary circuit for said winding controlled by said magnet and a release device controlled by said second relay.

In witness whereof, I hereunto subscribe my name this 25th day of July, 1930.

EDWARD E. HINRICHSEN.