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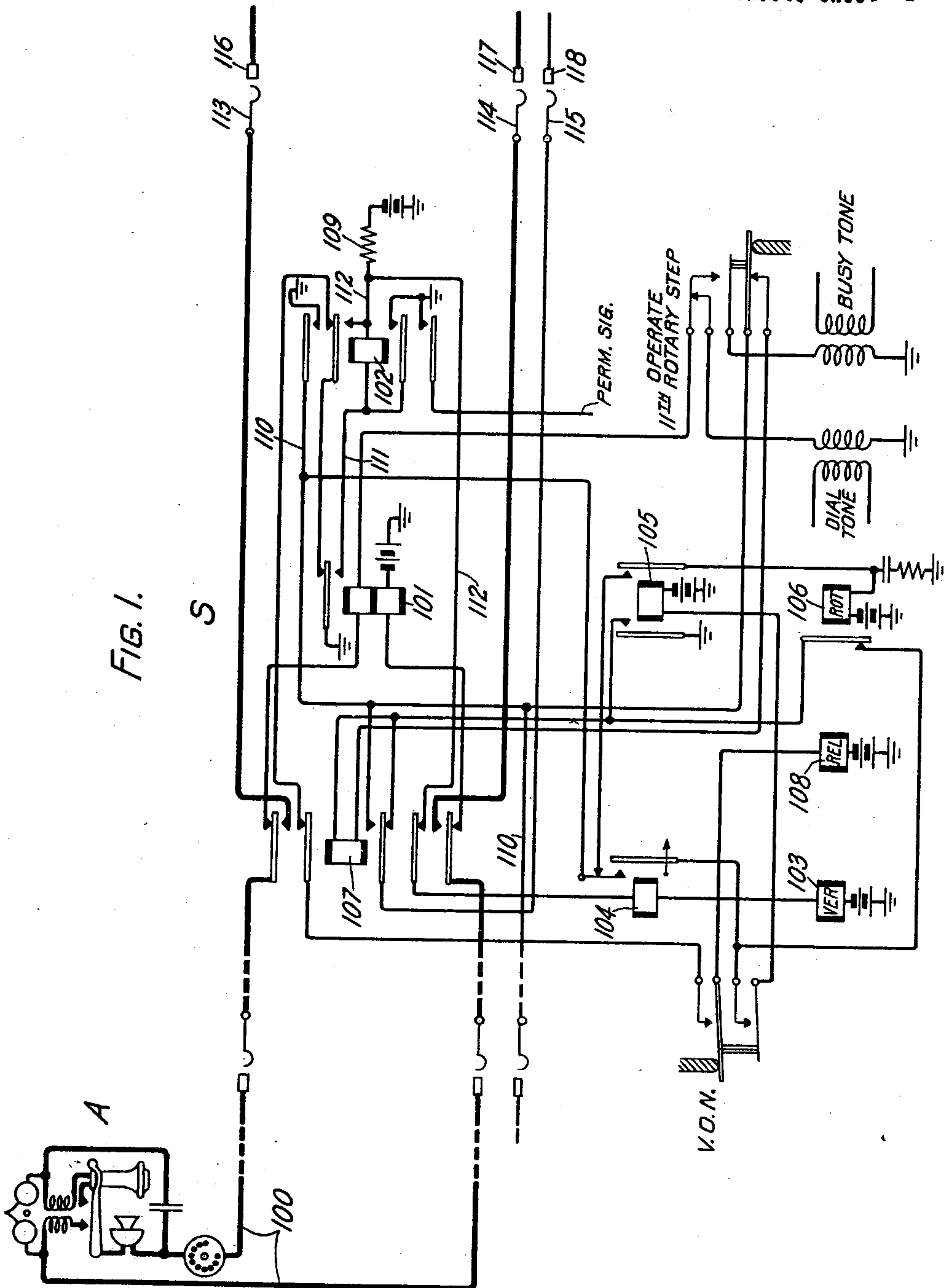
W. H. MATTHIES

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TELEPHONE SYSTEM

Filed Nov. 19, 1928

2 Sheets-Sheet 1



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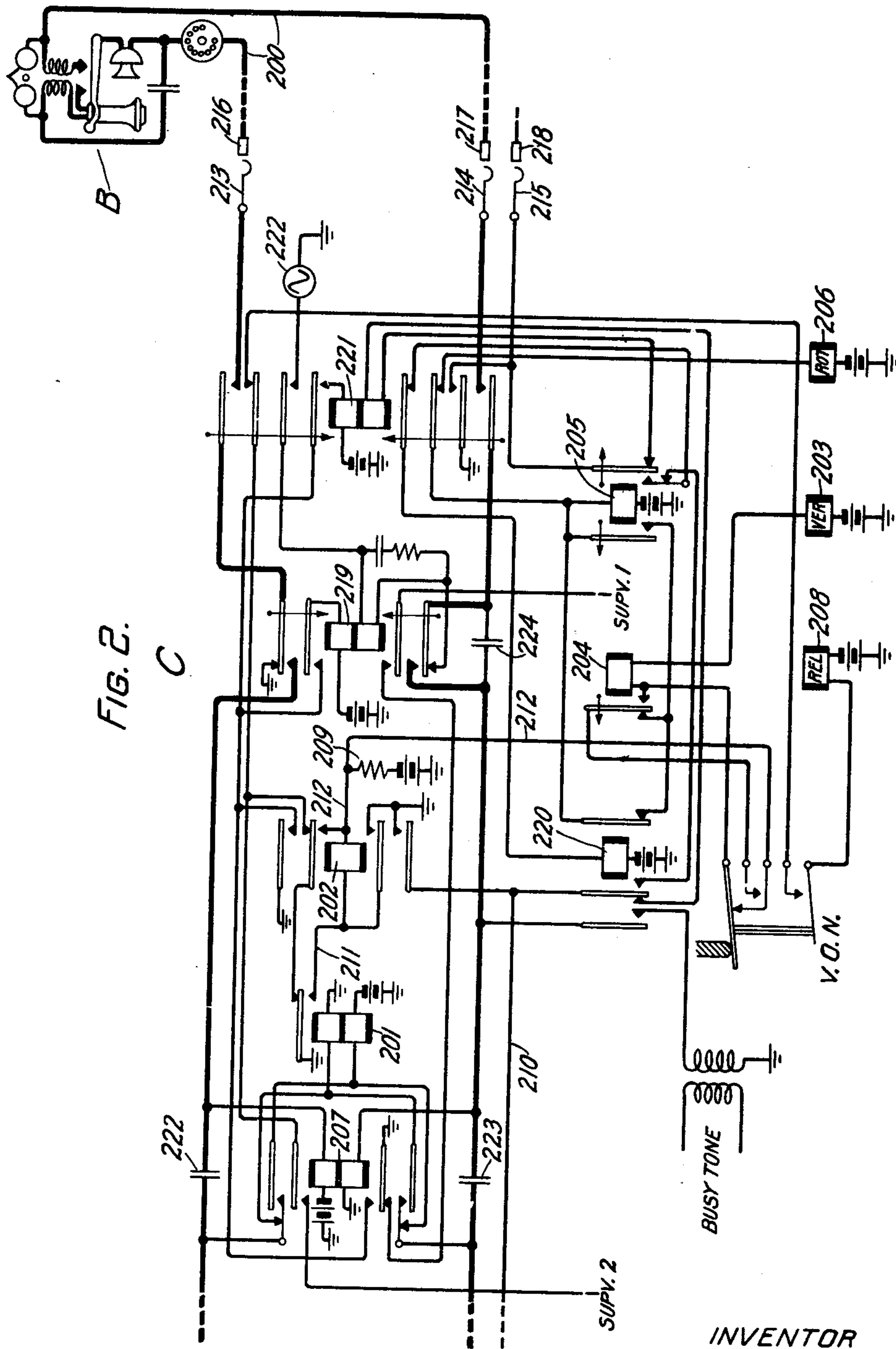
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2 Sheets-Sheet 2



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TELEPHONE SYSTEM

Application filed November 19, 1928. Serial No. 320,302.

This invention relates to operating and control circuits and particularly to impulse circuits for selective switches.

The objects of the invention are to increase the effective range over which impulses may be sent, to simplify the equipment used in impulse receiving circuits and to render these circuits more reliable during change-over operations.

Heretofore, plans have been devised for making a relay slow to release its armatures during interruptions caused by the sending of impulses for setting selective switches and similar devices. In some cases the relay is made slow by means of a special design of its magnetic circuit, while in other instances mechanical expedients are involved.

According to the present invention, these expedients are obviated and an ordinary relay is employed. This relay is prevented from releasing during the transmission of impulses by so arranging the circuits that during the intervals its original operating circuit is open the relay is sustained by a direct shunt path about its winding and by parallel paths through its winding and locking contacts. Furthermore, for each impulse delivered to the switch operating magnet, an induced current, caused by breaking the magnet circuit, is directed through the relay, tending to sustain its energization.

A feature of the invention is a circuit in which one of the parallel paths for supplying current to the relay also acts to shunt a portion of the inductive surge coming from the magnet, thus protecting the contacts on the impulse relay without the use of a condenser.

According to another feature the relay is guarded against accidental release by one of said parallel current supply paths while the other path is momentarily opened to effect a change-over operation.

The drawing discloses a selector circuit and a connector circuit, both of which embody the features of this invention. In Figure 1 a calling subscriber's station A is diagrammatically shown connected by the line 100 and by a line finder or some other equivalent means to the line leads of selector S. In Figure 2 a connector circuit C is shown di-

agrammatically connected over line 200 to a called subscriber's station B. Figures 1 and 2 together may be used to illustrate the establishment of a call from station A to station B, the operation of the selector S being controlled by the dialing of the first digit of the called station's number and the operation of the connector C being controlled by the dialing of the last two digits of the called station's number.

With the station A and selector S connected as illustrated, relay 101 of selector S is operated by an obvious circuit which includes the line 100, back contacts of relay 107, both windings of relay 101, normally closed contacts of the 11th rotary step springs, and the secondary winding of the dial tone induction coil. In operating, relay 101 closes a circuit from battery through resistance 109, in parallel with the windings of vertical stepping magnet 103 and relay 104 connected in series, through lead 112, winding of relay 102, lead 111, and through the front contact and armature of relay 101, to ground. Relay 102 is operated by this circuit but vertical magnet 103 and relay 104 are not operated on account of the resistance of relay 102 and on account of their windings being shunted by resistance 109. In operating, relay 102 connects ground to lead 110 so as to hold the connection between the station A and selector S. In operating, relay 102 also connects ground through its lower inner front contact and armature to lead 111 so that the circuit through the windings of relay 102, resistance 109, magnet 103 and relay 104 will not be opened by the release of relay 101 as hereinafter described.

When the calling subscriber dials the first digit of the called station's number, relay 101 releases and reoperates each time the line circuit is opened and closed at the contacts of the dial. Each release of relay 101 connects ground through its back contact, and through the inner upper armature and front contact of relay 102, to lead 112 thereby short-circuiting the winding of relay 102 and causing the operation of vertical stepping magnet 103 and relay 104. The reoperation of relay 101 after each release removes the

short-circuit around the winding of relay 102, causing the release of the vertical magnet. Relay 104 is a slow-to-release relay and remains in its operated position until all of the dial pulses corresponding to the first digit of the called number have been received. Each operation of the vertical stepping magnet steps the brushes of the selector up one level. Relay 102 has no slow-to-release characteristic but the circuit arrangement is such that during the time that the armature of relay 101 is traveling between its front and back contacts, either on release or reoperation, the energization of relay 102 is maintained by the ground connected through its inner lower front contact and armature to lead 111; when the armature of relay 101 is touching its back contact, during dialing, the de-energization of relay 102 is retarded by a self-induced current through its short-circuited winding; and when this short circuit is removed by the reoperation of relay 101, the energization of relay 102 is quickly restored by the circuit which includes the lower inner armature and front contact of relay 102 and includes the windings of magnet 103 and relay 104 in parallel with resistance 109, the restoration being aided by an inductive surge from the winding of the vertical stepping magnet. This circuit arrangement, whereby the surge from the vertical magnet is absorbed by the winding of relay 102 and by the resistance 109, makes it unnecessary to furnish other protection for the contacts of relay 101.

As soon as the shaft and multiple brushes of the selector are stepped up to the first level the vertical off normal springs V. O. N. are actuated and a circuit for operating relay 105 is closed. This circuit may be traced from battery through the winding of relay 105, lower contacts of the V. O. N. springs, armature and front contact of relay 104, lead 110, and through the outer upper armature and front contact of relay 102, to ground. Since relay 104 is slow to release, this circuit is closed in all cases including that in which only one dial pulse is created by the dialing of the first digit of the called number. In operating, relay 105 closes a locking circuit from battery through its winding, lower contacts of the V. O. N. springs, back contact and armature of the rotary stepping magnet 106, and through the left-hand front contact and armature of relay 105, to ground. When relay 101 reoperates, after the last pulse of the series which are created by the dialing of the first digit, both vertical magnet 103 and relay 104 release. The multiple brushes 113, 114 and 115 are now in position opposite the level of terminals which corresponds to the first digit dialed.

When relay 104 releases, a circuit is closed from battery through the winding of the rotary stepping magnet 106, through the right-hand armature and front contact of relay 105, normally closed contacts of relay 104, lead 110, and through the outer upper armature and front contact of relay 102, to ground. The rotary magnet 106 operates in this circuit advancing the multiple brushes into contact with the first set of terminals in the selected level. In operating, the rotary magnet 106 opens the circuit through the winding of relay 105, thus causing the release of relay 105. In releasing, relay 105 opens the circuit through the winding of the rotary magnet 106, thereby releasing the rotary magnet. A circuit may now be traced from battery through the winding of relay 105, lower contacts of the V. O. N. springs, back contact of the rotary magnet 106, winding of relay 107, and through lower contacts of the 11th rotary step springs, to the ground on lead 110. If the first set of terminals in the selected level is idle relay 107 is operated in this circuit, but relay 105 is marginal and does not operate in series with the winding of relay 107. If the first set of terminals is busy relay 105 reoperates, but relay 107 does not operate since its winding is short-circuited by a busy ground on the test terminal 118. The circuit for reoperating relay 105 may be traced from battery through its winding, through the lower contacts on the V. O. N. springs, back contact of the rotary magnet 106, back contact and inner lower armature of relay 107, and through the test brush 115, to ground on the test terminal 118 of the busy trunk. The reoperation of relay 105 closes the circuit through the winding of the rotary stepping magnet 106, thereby advancing brushes 113, 114, and 115 to the second set of terminals in the selected level. The alternate operation and release of relay 105 and magnet 106 continues until the test brush 115 makes contact with the test terminal of an idle set, at which time the winding of relay 107 is no longer short-circuited and relay 107 operates. The operation of relay 107 opens the circuit through the windings of relay 101, connects the calling line 100 through brushes 113 and 114 to terminals 116 and 117 of the selected idle trunk, opens the circuit from battery through the windings of vertical magnet 103 and relay 104, and connects a temporary make-busy ground to test terminal 118 of the selected trunk. This make-busy circuit may be traced from ground through the front contact and outer upper armature of relay 102, lead 110, front contact and inner lower armature of relay 107, and through test brush 115 to test terminal 118. Relay 102 is held operated, temporarily, by the circuit from battery through resistance 109 to ground through its inner lower armature and front contact; and as soon as relay 101 releases, the winding of relay 102 is short-circuited by the ground on the armature and through the back contact

of relay 101. The consequent release of relay 102 is slow so that a permanent make-busy ground is connected to test terminal 118, by the selected trunk circuit, before relay 102 disconnects the temporary make-busy ground from this terminal. It should be noted that relay 102 is held operated at the time of the release of relay 101 without the use of continuity contacts on relay 101, this desirable result being due to the use of resistance 109 and the temporary holding circuit thereby provided. After relay 102 has released, relay 107 is held operated by the ground on terminal 118; this circuit may be traced from battery through the winding of relay 105, lower contacts of the V. O. N. springs, back contact of rotary magnet 106, winding of relay 107, lower contacts of the 11th rotary step springs, front contact and inner lower armature of relay 107, and through brush 115, to the make-busy and holding ground on terminal 118.

The selected trunk may terminate in a connector such as C shown in Fig. 2 or may terminate in another selector. If additional selectors are used in completing the connection between the calling line 100 and the connector C their operation is controlled by the dialing of additional digits of the called number. In all cases the dialing of the last two digits of the called number controls the operation of the connector C.

In the following description it is assumed that the selected trunk connects directly to the connector C shown in Fig. 2. Relay 201 is operated by a circuit which includes both windings of relay 201, outer back contacts of relay 207, terminals 116 and 117 and brushes 113 and 114 of selector S, outer front contacts of relay 107, and the line 100. In operating, relay 201 closes a circuit from battery through resistance 209, in parallel with battery through the windings of vertical stepping magnet 203 and relay 204 in series, through lead 212, winding of relay 202, lead 211, and through the front contact and armature of relay 201, to ground. Relay 202 is operated by this circuit but vertical magnet 203 and relay 204 are not operated on account of the resistance of relay 202 and on account of their windings being shunted by resistance 209. In operating, relay 202 connects ground through its outer lower armature and front contact to lead 210 so as to hold the connection between the preceding selector and the connector C, and connects a locking ground through its inner lower armature and front contact to lead 211.

When the calling subscriber dials the next to the last digit of the called station's number relay 201 releases and reoperates each time the line is opened and closed at the contacts of the dial. Each release of relay 201 connects ground through its back contact, and through the inner upper armature and front

contact of relay 202, to lead 212, thereby short-circuiting the winding of relay 202 and causing the operation of vertical stepping magnet 203 and relay 204. The reoperation of relay 201, after each release, removes the short-circuit around the winding of relay 202, thus causing the release of the vertical magnet. Relay 204 is a slow-to-release relay and remains in its operated position until all of the dial pulses corresponding to the next to the last digit of the called number have been received. Each operation of the vertical stepping magnet steps the brushes of the selector up one level. Relay 202 has no slow-to-release characteristic but the circuit arrangement is such that during the time that the armature of relay 201 is traveling between its front and back contacts, either on release or reoperation, the energization of relay 202 is maintained by the ground connected through its inner lower front contact and armature to lead 211; when the armature of relay 201 is touching its back contact, during dialing, the de-energization of relay 202 is retarded by a self-induced current through its short-circuited winding; and when this short-circuit is removed by the reoperation of relay 201, the energization of relay 202 is quickly restored by the circuit which includes the windings of magnet 203 and relay 204, in parallel with resistance 209, the restoration being aided by an inductive surge from the winding of the vertical stepping magnet. This circuit arrangement, whereby the surge from the vertical magnet is absorbed by the winding of relay 202 and by resistance 209 makes it unnecessary to furnish other protection for the contacts of relay 202.

As soon as the shaft and multiple brushes are stepped up to the first level the vertical off-normal springs V. O. N. are actuated and the circuit for reoperating vertical magnet 203, and for preventing the release of relay 204 (until all of the pulses corresponding to the digit dialed have been received), is now traced through the front contact and armature of relay 204 and upper normally open contacts of the V. O. N. springs, instead of through the normally closed contacts of the V. O. N. springs. When relay 201 reoperates at the end of the series of dial pulses which are created by the dialing of the next to the last digit of the called station's number, both vertical magnet 203 and relay 204 release. The release of relay 204 closes a circuit from battery through the winding of rotary stepping magnet 206 and back contact of relay 221, in parallel with battery through the winding of relay 205, through the right-hand armature and back contact of relay 220, back contact of relay 204, upper normally open contacts of the V. O. N. springs, lead 212, winding of relay 202, and through the front contact and armature of relay 201, to ground. Relay 202 is held operated by this circuit but

rotary magnet 206 and relay 205 do not operate on account of the resistance of relay 202 and on account of their windings being shunted by resistance 209. The multiple brushes 213, 214 and 215 are now in position
 5 opposite the level of terminals which corresponds to the digit dialed.

It should be noted that relay 204 is equipped with a set of transfer springs rather than with
 10 a set of continuity springs and that the use of the transfer springs is desirable since they are more easily maintained in adjustment. In the past it has been necessary to use continuity springs in order to prevent the release
 15 of the relay corresponding to relay 202 during the change-over from the delivery of impulses to the vertical magnet to the delivery of impulses to the rotary magnet. Although transfer springs are used in this circuit, the
 20 release of relay 202, during this change-over, is prevented by the holding circuit which is traced from battery through resistance 209, lead 212, winding of relay 202, and through the inner lower armature and front contact
 25 of relay 202, to ground.

When the calling subscriber dials the last digit of the called station's number, which we will assume to be 3, relay 201 releases and reoperates as many times as there are units in
 30 that digit. The first release of relay 201 connects ground through its armature and back contact and through the inner upper armature and front contact of relay 202, to lead 212, thereby short-circuiting the winding of
 35 relay 202 and causing the operation of relay 205 and rotary magnet 206. The operation of the rotary stepping magnet 206 advances the brushes 213, 214, and 215 into contact with the first set of terminals in the selected level.
 40 The right-hand contacts of relay 220 are shunted by the left-hand contacts of relay 205 when relay 205 operates, so that the circuit for energizing the windings of relay 205 and rotary magnet 206 is no longer under the
 45 control of relay 220.

With the multiple brushes in contact with the first set of terminals in the selected level, a circuit is closed from battery through the
 50 winding of relay 220, inner lower armature and back contact of relay 221, front contact and right-hand armature of relay 205, and through brush 215 to the test terminal 218 of the first set. If this set of terminals is busy, test terminal 218 is grounded and relay
 55 220 may operate, but, since the units digit of the called number is 3, the operation or non-operation of relay 220 prior to the multiple brushes being in contact with the third set of terminals is immaterial. When relay
 60 201 reoperates, after its first release, rotary magnet 206 releases but since relay 205 is a slow-to-release relay it remains operated until all of the pulses corresponding to the last digit have been received. Relay 202 remains
 65 in its operated position, during the dialing

of the last digit, for the same reasons as when the next to the last digit of the called number was being dialed; the only difference is that the winding of the rotary magnet 206,
 70 in parallel with the winding of relay 205, is included in the circuit in place of the winding of the vertical magnet 203, in series with the winding of relay 204, so that the winding of relay 202 and the resistance 209 absorb the surge from the rotary stepping magnet
 75 206 each time relay 201 reoperates.

When the last pulse has been received and test brush 215 is in contact with the test terminal of the called line and before relay 205 releases, relay 220 operates if the called line
 80 is busy. This circuit may be traced from battery through the winding of relay 220 inner lower armature and back contact of relay 221, right-hand armature and front contact of relay 205, and through test brush 215,
 85 to ground on the test terminal 218. The operation of relay 220 connects busy tone to the ring lead of the incoming trunk. The release of relay 205 then closes a locking circuit for relay 220 under control of relay 202. If
 90 the called line is idle relay 220 does not operate and when relay 205 releases a circuit is closed from battery through the winding of the cut off relay (not shown) of the called line, through test terminal 218, test brush 215,
 95 right-hand armature and back contact of relay 205, lower winding of relay 221, inner left-hand armature and back contact of relay 220, and through the outer lower armature and front contact of relay 202, to ground
 100 Relay 221 operates in this circuit and closes a locking circuit through its upper winding to ground at the upper outer armature and front contact of relay 202. In operating relay 221 also closes the ringing circuit from
 105 the ringing current source 222, through the second upper armature and front contact of relay 221, lower winding of relay 219, outer lower armature and back contact of relay 219, outer lower armature and front contact
 110 of relay 221, multiple brush 214 and line terminal 217, loop of the called line 200, line terminal 216 and multiple brush 213, outer upper armature and front contact of relay 221, and through the outer upper armature
 115 and back contact of relay 219, to ground. Audible ringing tone is transmitted through condenser 224 over the ring side of the incoming trunk to the calling subscriber.

When the called subscriber answers, relay
 120 219 operates and it locks through its upper winding to ground at relay 202. In operating relay 219 opens the ringing circuit and connects battery through the upper winding of relay 207 and ground through the lower
 125 winding of relay 207, through front contacts on relays 219 and 221, and through multiple brushes 213 and 214, to the called line. Relay 207 operates in this circuit thereby reversing the battery and ground through the
 130

windings of relay 201, with respect to the tip and ring leads of the incoming trunk, to indicate that the called subscriber has answered. The operation of relay 207 also supplies a holding ground at its inner lower armature and front contact for relays 219 and 221 which is independent of relay 202. The incoming trunk is connected through condensers 222 and 223 and through the front contacts of relays 219 and 221 to the called line for talking.

When the connection is released by the calling subscriber the circuit for relay 201 is opened. The consequent release of relay 201 causes the release of relay 202. In releasing, relay 202 removes the holding ground from lead 210 so that relay 107 of selector S releases. A busy potential is maintained on lead 210 by the ground on the next to the lowest armature of relay 221, through the right-hand armature and back contact of relay 205, lower winding of relay 221, and inner left-hand armature and back contact of relay 220, to prevent the seizure of this connector on another call until the subscriber has replaced the receiver at the called station. When the called subscriber hangs up the receiver, relay 207 releases thereby causing the release of relays 219 and 221. The release of relay 221 closes a circuit from battery through the winding of the release magnet 208, lower contacts of the V. O. N. springs, back contact of relay 221 and back contacts of relays 202 and 201, to ground. The operation of the magnet 208 in this circuit returns the connector shaft and multiple brushes to normal. With the shaft in its normal position the circuit through the release magnet 208 is opened by the restoration of the V. O. N. contacts to normal.

When the make-busy and holding ground is disconnected from terminal 118 in the bank of selector S (by the release of relay 202 in the connector C), relay 107 of selector S closes a circuit from battery through the winding of release magnet 108, upper contacts of the V. O. N. springs, back contact of relay 107, back contact of relay 102, and through the back contact of relay 101, to ground. The release magnet 108 operates in this circuit to cause the return of the multiple brushes to normal. When the brushes reach their normal position, the V. O. N. springs are shifted to normal thus opening the circuit through the winding of the release magnet 108.

While the features of this invention have been shown embodied in a particular selector and a particular connector it is understood that the invention is not limited to selector and connector switches or to switches of the step-by-step type, but is applicable to all systems in which numerically directive impulses are received by means provided for this purpose.

What is claimed is:

1. In combination, an impulse receiving relay, a magnet for operation in response to impulses received by said impulse relay, a control relay cooperating with said impulse relay to deliver impulses to said magnet, a non-inductive resistance, and circuits including contacts of said impulse relay for operating said control relay, one of said operating circuits including the winding of said magnet, the other of said operating circuits including said non-inductive resistance.
2. In combination, an impulse receiving relay, a magnet for operation in response to impulses received by said impulse relay, a control relay cooperating with said impulse relay to deliver impulses to said magnet, a non-inductive resistance, circuits including contacts of said impulse relay for operating said control relay, one of said operating circuits including the winding of said magnet, another of said operating circuits including said non-inductive resistance, and a circuit for holding said control relay while impulses are being received.
3. In combination, an impulse receiving relay, a magnet for operation in response to impulses received by said impulse relay, a control relay cooperating with said impulse relay to deliver impulses to said magnet, a non-inductive resistance, a circuit including contacts of said impulse relay for operating said control relay, and circuits for holding said control relay while impulses are being received, one of said holding circuits including the winding of said magnet, another of said holding circuits including said non-inductive resistance.
4. In combination, an impulse receiving relay, a magnet for operation in response to impulses received by said impulse relay, a control relay cooperating with said impulse relay to deliver impulses to said magnet, a non-inductive resistance, a circuit including contacts of said impulse relay for operating said control relay, and circuits for holding said control relay while impulses are being received, one of said holding circuits including the winding of said magnet, another of said holding circuits including said non-inductive resistance, and a third one of said holding circuits including contacts of said impulse relay.
5. In combination, an impulse receiving relay, a magnet for operation in response to impulses received by said impulse relay, a control relay cooperating with said impulse relay to deliver impulses to said magnet, a non-inductive resistance, circuits including contacts of said impulse relay for operating said control relay, one of said operating circuits including the winding of said magnet, the other of said operating circuits including said non-inductive resistance, and circuits for holding said control relay operated while

impulses are being received, one of said holding circuits including the winding of said magnet, the other of said holding circuits including said non-inductive resistance.

5 6. In combination, an impulse receiving relay, a magnet for operation in response to impulses received by said impulse relay, a control relay cooperating with said impulse relay to deliver impulses to said magnet, a
10 non-inductive resistance, circuits including contacts of said impulse relay for operating said control relay, one of said operating circuits including the winding of said magnet, the other of said operating circuits including
15 said non-inductive resistance, and circuits for holding said control relay operated while impulses are being received, one of said holding circuits including the winding of said magnet, another of said holding circuits in-
20 cluding said non-inductive resistance, and a third one of said holding circuits including contacts of said impulse relay.

7. In combination, an impulse receiving relay, a magnet for operation in response
25 to impulses received by said impulse relay, a control relay cooperating with said impulse relay to deliver impulses to said magnet, a non-inductive resistance, a circuit including contacts of said impulse relay for
30 operating said control relay, a circuit for holding said control relay while impulses are being received, and a circuit including said resistance for absorbing the inductive surge from said magnet each time said impulse
35 relay reoperates.

8. In combination, an impulse receiving relay, a magnet for operation in response to impulses received by said impulse relay, a control relay cooperating with said im-
40 pulse relay to deliver impulses to said magnet, a circuit including an armature and a front contact of said impulse relay for operating said control relay, and a circuit including said armature and a back contact
45 of said impulse relay and including a contact of said control relay for holding said control relay while impulses are being received.

9. In combination, an impulse receiving
50 relay, a magnet for operation in response to impulses received by said impulse relay, a control relay cooperating with said impulse relay to deliver impulses to said magnet, a circuit including an armature and
55 a front contact of said impulse relay for operating said control relay, and circuits for holding said control relay while impulses are being received, one of said holding circuits including said armature and a back
60 contact of said impulse relay and including a contact of said control relay, the other of said holding circuits being independent of said impulse relay.

10. In combination, an impulse receiving
65 relay, a magnet for operation in response

to impulses received by said impulse relay, a control relay cooperating with said impulse relay to deliver impulses to said magnet, an auxiliary relay, a circuit including the wind-
ing of said auxiliary relay for operating
70 said magnet, a circuit for operating said control relay, and circuits for holding said control relay while pulses are being received, one of said holding circuits including the
75 windings of said magnet and said auxiliary relay, another of said holding circuits excluding said magnet and excluding the contacts of said impulse relay.

11. In combination, an impulse receiving relay, a magnet for operation in response to
80 a first train of impulses received by said impulse relay, a second magnet for operation in response to a second train of impulses received by said impulse relay, a control relay cooperating with said impulse relay to de-
85 liver said first and second trains of impulses to said first and second magnets respectively, an operating circuit for the control relay including a contact of the impulse relay, and
90 circuits independent of the contacts of the impulse relay and independent of said magnets for holding the control relay operated.

12. In combination, an impulse receiving relay, a magnet for operation in response
95 to a first train of impulses received by said impulse relay, a second magnet for operation in response to a second train of impulses received by said impulse relay, a control re-
100 lay cooperating with said impulse relay to deliver said first and second trains of im- pulses to said first and second magnets re-
105 spectively, an operating circuit for the control relay including a contact of the impulse relay, and circuits independent of the con-
110 tacts of the impulse relay and independent of said magnets for holding the control relay operated each time said impulse relay re-
115 leases during the reception of impulses and for holding the control relay operated dur-
ing the change-over from the delivering of
120 impulses of said first train to said first magnet to the delivering of impulses of said sec-
ond train to said second magnet.

13. In combination, an impulse receiving relay, a magnet for operation in response to
125 a first train of impulses received by said impulse relay, a second magnet for operation in response to a second train of impulses received by said impulse relay, a control relay cooperating with said impulse relay to de-
130 liver said first and second trains of impulses to said first and second magnets respectively, an operating circuit for the control relay in-
135 cluding a contact of the impulse relay, cir-
140 cuits independent of the contacts of the im- pulse relay and independent of said magnets
145 for holding the control relay operated each time said impulse relay releases during the
reception of impulses and for holding the
150 control relay operated during the change-

over from the delivering of impulses of said first train to said first magnet to the delivering of impulses of said second train to said second magnet, a circuit for quickly restoring the energization of the control relay to its former full value and for absorbing the inductive surge from the winding of said first magnet when said impulse relay reoperates after each impulse of said first train, said restoring circuit including said first magnet and said control relay, and a circuit for quickly restoring the energization of the control relay to its former full value and for absorbing the inductive surge from the winding of said second magnet when said impulse relay reoperates after each impulse of said second train, the second of said restoring circuits including said second magnet and said control relay.

14. In combination, an impulse receiving relay, a magnet for operation in response to impulses received by said impulse relay, a control relay cooperating with said impulse relay to deliver impulses to said magnet, a non-inductive resistance connected to the winding of said control relay, an operating circuit for the control relay including a contact of the impulse relay, a holding circuit for said control relay closed while the armature of said impulse relay is moving between its normal and its operated position, a circuit for preventing the release of the said control relay while the armature of said impulse relay is in its normal position during the reception of impulses, and a circuit including said non-inductive resistance for restoring the energization of said control relay when the armature of said impulse relay resumes its operated position during the reception of impulses.

15. In combination, an impulse receiving relay, a magnet for operation in response to impulses received by said impulse relay, a control relay cooperating with said impulse relay to deliver impulses to said magnet, a non-inductive resistance permanently connected to the winding of said control relay, an operating circuit for the control relay including a contact of the impulse relay, a holding circuit for said control relay closed while the armature of said impulse relay is moving between its normal and its operated position, said holding circuit including the windings of said magnet and said control relay, a circuit for preventing the release of said control relay while the armature of said impulse relay is in its normal position during the reception of impulses, said last mentioned circuit being independent of said magnet, and a circuit including said non-inductive resistance for quickly restoring the energization of said control relay when the armature of said impulse relay resumes its operated position during the reception of impulses.

16. In combination, an impulse receiving relay, a magnet for operation in response to impulses received by said impulse relay, a control relay cooperating with said impulse relay to deliver impulses to said magnet, a non-inductive resistance connected to the winding of said control relay, an operating circuit for the control relay including a contact of the impulse relay, a holding circuit for said control relay closed while the armature of said impulse relay is moving between its normal and its operated position, a circuit for preventing the release of the said control relay while the armature of said impulse relay is in its normal position during the reception of impulses, and a circuit including said non-inductive resistance for restoring the energization of said control relay and for absorbing the inductive surge from the winding of said magnet when the armature of said impulse relay resumes its operated position during the reception of impulses.

In witness whereof, I hereunto subscribe my name this 8th day of November, 1928.

WILLIAM H. MATTHIES.