March 24, 1925. 1,530,968

S. B. WILLIAMS, JR

RECORDING DEVICE

Filed April 22, 1922 2 Sheets-Sheet 1

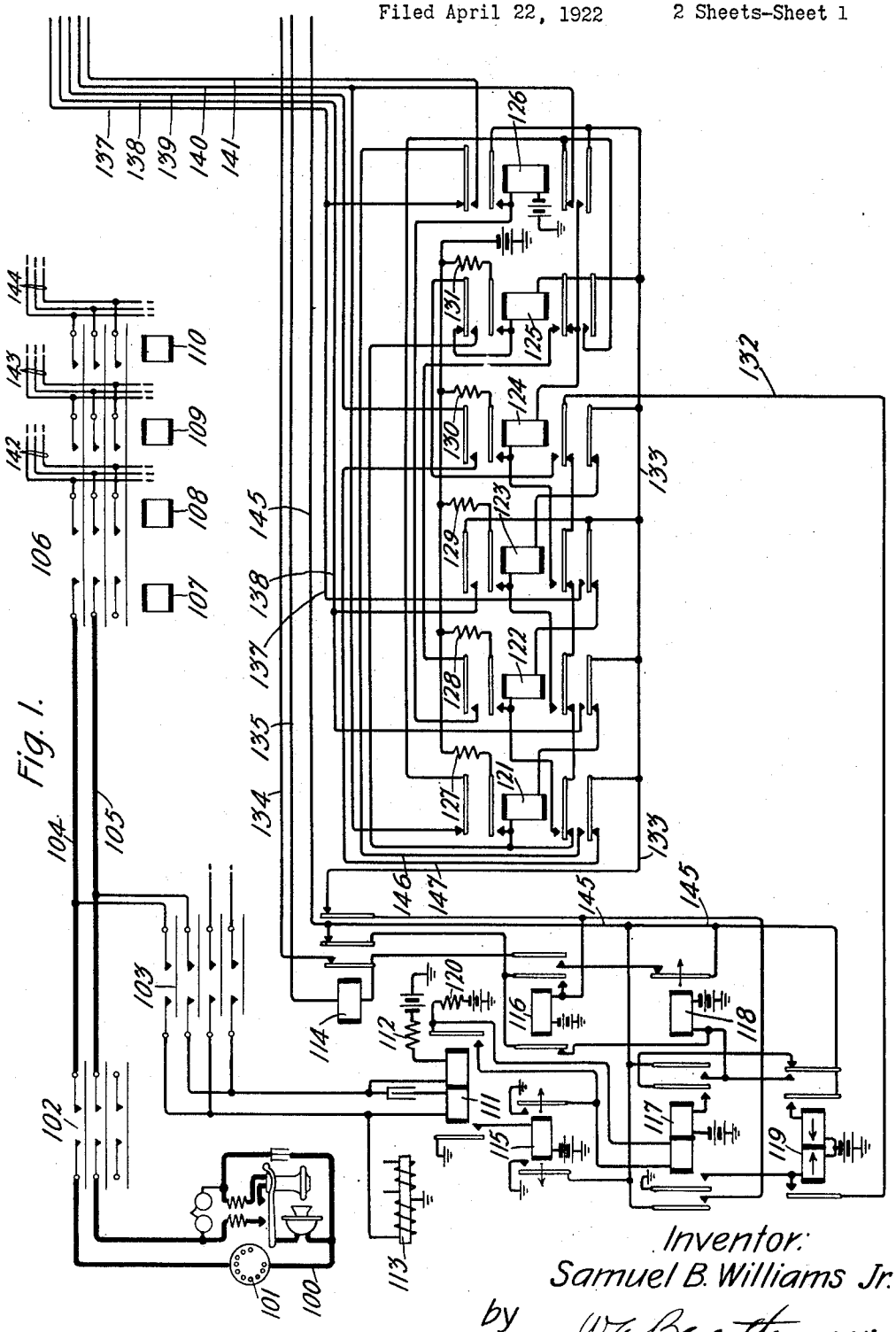

Fig. 1.

Inventor:
Samuel B. Williams Jr.
by W. A. Beatty. Att'y.

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S. B. WILLIAMS, JR

RECORDING DEVICE

Filed April 22, 1922 2 Sheets-Sheet 2

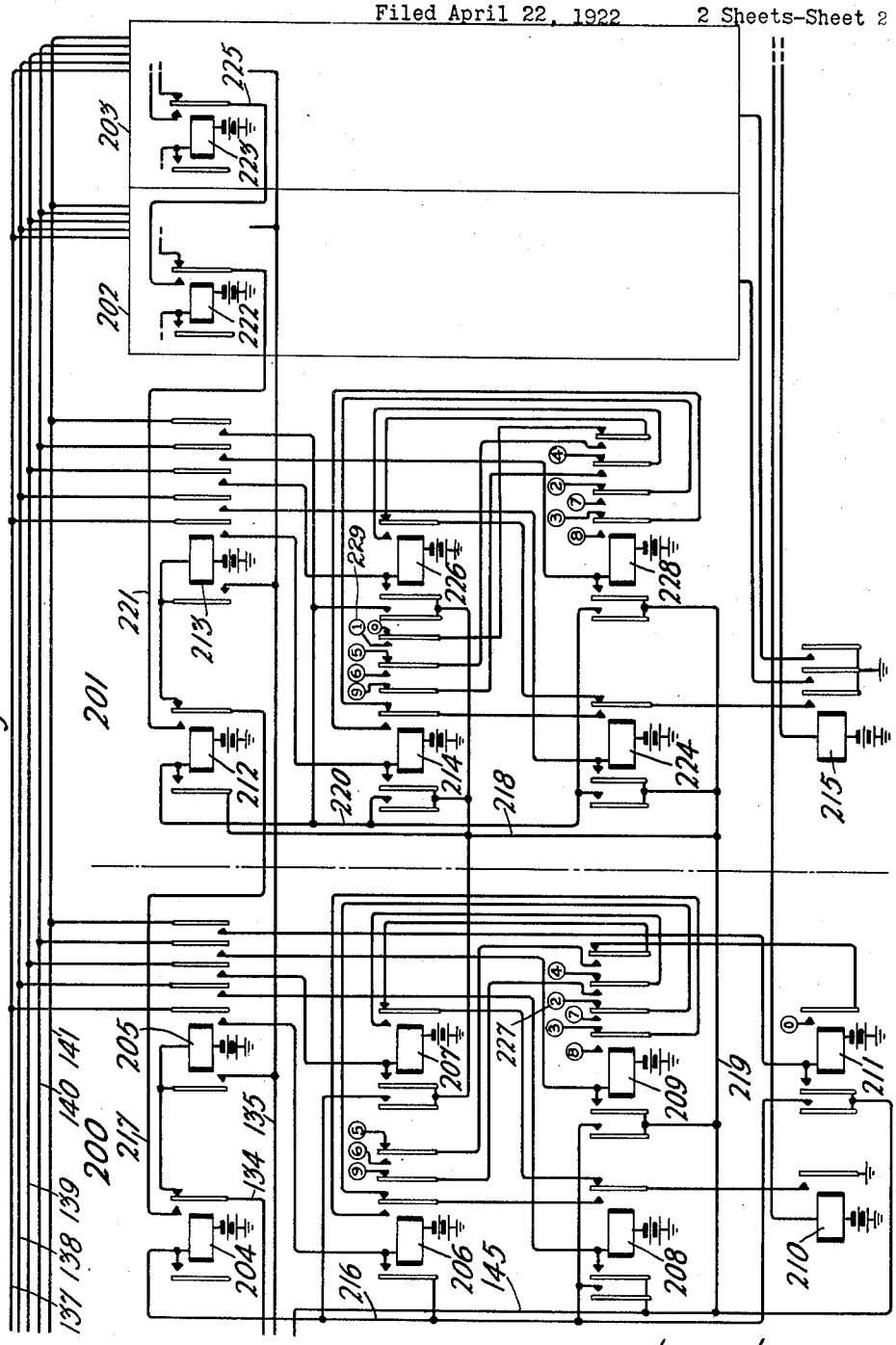

Fig. 2.

Inventor:
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by W. L. Beatty Att'y.

Patented Mar. 24, 1925. 1,530,968

UNITED STATES PATENT OFFICE.

SAMUEL B. WILLIAMS, JR., OF BROOKLYN, NEW YORK, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

RECORDING DEVICE.

Application filed April 22, 1922. Serial No. 555,940.

To all whom it may concern:

Be it known that I, SAMUEL B. WILLIAMS, Jr., a citizen of the United States, residing at Brooklyn, in the county of Kings, State of New York, have invented certain new and useful Improvements in Recording Devices, of which the following is a full, clear, concise, and exact description.

This invention relates to recording and selecting mechanisms and more particularly to the adaptation of such mechanisms for use in telephone exchange systems.

The object of the invention is a mechanism of this character comprising a plurality of operating devices arranged to coact with each other in an improved manner for securing the required recording and selecting operations.

A feature of the invention relates to the provision of a recording apparatus including a series of successively operable relays, said series arranged for repeated operation responsive to a set of impulses, the number of relays responsive in the series varying with progressive operations of the series, whereby a comparatively large number of records or registrations may be taken.

Another feature relates to an arrangement in which the series of relays comprises a number less than the possible number of impulses to be received, each relay deenergizing upon the energization of the succeeding relay, and wherein the number of relays available for reoperation is diminished at each progressive operation of the series.

A still further feature of the invention relates to the provision of means, in a system where series of designation impulses are recorded on relay registers, whereby certain preliminary or accidental impulses if delivered to a given register may be erased in order to permit the regular series to be received and properly recorded without any detrimental effects.

Another feature relates to an arrangement in which designations are recorded in succession on a series of counting relays and then transferred to relay registers, and wherein sequence relays are adapted to transfer the association of the counting relays from one register to another.

Other features and advantages of this invention will be described fully hereinafter and covered in the appended claims.

Referring to the drawing, Figs. 1 and 2 taken in conjunction with each other illustrate so much of a telephone exchange system, incorporating a recording and selecting mechanism of the type embodying the present invention, as is necessary for a complete understanding thereof. Fig. 1 discloses a subscriber's line terminating in a switch at the central office, other switches for extending the line, together with the details of an impulse receiving mechanism responsive to designation impulses for establishing the record of a call at the office. Fig. 2 shows in full two separate relay register devices, each for receiving and recording a different portion of a designation. At the right of this figure there are also illustrated in schematic form two additional registers for recording other parts of the designation.

In telephone systems of the automatic and semi-automatic types, it is found desirable to register on apparatus located at the central exchange the designation of the wanted line or circuit. This registration having been recorded may later be used for governing the selective operations of switches to extend the required connection or for controlling well-known call indicating mechanism. It is in a system of this general character that the recording mechanism embodying the features of applicant's invention is particularly useful.

In the system disclosed the subscriber's line 10 extends to the central office and there terminates in a line switch 102 diagrammatically shown. The line switch 102 is adapted to extend the subscriber's line 100 to any of a number of trunks, one of which trunk 104, 105, is illustrated leading to a first selective switch 106. Switch 106 may be of the same character as the line switch 102 and serves to extend the incoming trunk 104, 105 to other trunks 142, 143 and 144. Obviously, trunks 142, 143 and 144 may lead to succeeding selective switching devices where they are again selectively connected to other trunks and so on until the connection is completed.

Also located at the central office is an impulse receiving and recording mechanism

comprising an organization of relays and circuits, the function of which is to receive series of impulses transmitted over the calling subscriber's line and to record the designations represented by such impulses. There may be any desired number of these recording mechanisms arranged to serve a group of subscribers' lines, the particular one to be taken for use at any given time depending upon its busy or idle condition. A selecting switch 103 is provided for associating an idle one of the recording mechanisms, comprising the remainder of Figs. 1 and 2, with the particular trunk 104, 105 to which the calling subscriber's line has been extended by the switch 102.

The switches 102, 103 and 106 may be of the general type shown and described in detail in the application of C. L. Goodrum, Serial No. 524,083, filed December 22, 1921, and also in the British Patent No. 183,438, issued to the Western Electric Company, Limited. On the other hand, these switches may be of any well-known type such as power driven selectors or switches in which multicontact relays are employed for building up the connections with means for selecting and operating the necessary relays. While the recording mechanism embodying this invention is well adapted for use in systems employing switches of the character illustrated, it is to be understood that any other suitable form of switching device may be used instead.

A detailed description will now be given of the operation of the system. It will be assumed that the designation which the subscriber wishes to record comprises four digits representing the number 2134. Each of these digits is represented by a separate series of impulses transmitted over the line which are received by the counting relay series shown in Fig. 1 and recorded successively on the four respective registers 200, 201, 202 and 203. When the calling subscriber initiates the call by removing his receiver from the switchhook, the line switch 102 operates to extend the calling line to an idle trunk 104, 105. Moreover the selecting switch 103 operates to associate the idle recording mechanism shown in detail with the selected trunk 104, 105. In response to these operations a circuit is closed from battery through the resistance 112, right-hand winding of the impulse relay 111, through the switch 103, conductor 105, through the switch 102, over the loop of the calling line 100 and returning to the switch 102, conductor 104, through the switch 103, left-hand winding of the balancing coil 113 to ground. Relay 111 operates and closes a circuit from ground through its left contact, winding of relay 115 to battery. Relay 115 operates and establishes a circuit from ground through its left contact, middle contact of relay 114, left contact of relay 116, winding of relay 118 to battery. Relay 118 operates in this circuit before the impulses are received. Relay 115 also closes a circuit from battery, through the resistance 120, left-hand winding of relay 117, right contact of relay 115 to ground. Relay 117, however, fails to operate since its left-hand winding is shunted by the following circuit: battery, through the resistance 120, right contact of relay 111, right contact of relay 115 to ground. Nothing further happens until the calling subscriber manipulates his dial.

When he operates his dial 101 to transmit two impulses, constituting the first series, the impulse relay 111 deenergizes and energizes twice in succession. On the first deenergization of relay 111 the shunt circuit around the left-hand winding of relay 117 is opened and this relay immediately operates. Relay 111 also opens the circuit of relay 115, but this latter relay being slow-to-release maintains its armatures attracted during brief interruptions of its circuit. Relay 117, on operating, closes a temporary holding circuit for itself traceable from battery, through the right-hand winding and inner right contact of said relay, outer right back contact of relay 119, left contact of relay 115 to ground. The reason for closing a locking circuit for relay 117 is to insure that this relay remains operated until relay 119 has had sufficient time to attract its armatures. Also a circuit is closed from battery through the winding of relay 116, outer left contact of relay 117, to ground at the left contact of relay 115. Relay 116 becomes operated and locks in a circuit from battery through its winding and inner right contact, middle contact of relay 114, conductor 145 to ground at the left contact of relay 115.

Relay 117, furthermore, closes a circuit from battery, through the left-hand winding of relay 119, left contact of relay 117 to ground. Relay 119 attracts its armatures and a circuit is closed from battery through the right-hand winding and inner right-hand contact of relay 119, conductor 145, left contact of relay 115 to ground. Another circuit is established from battery through the left-hand winding and left contact of relay 119, conductor 132, inner lower back contacts of relays 124, 123, 122 and 121 in series, winding of relay 121, lowermost back contact of relay 122, conductor 133, outer contact of relay 114, inner right contact of relay 116, middle contact of relay 114 to ground over conductor 145. The winding of relay 121 is included in this circuit, but does not receive sufficient current to energize due to the fact that it is shunted by the direct circuit to ground at the left contact of relay 117.

At the end of the first line interruption the relay 111 again attracts its armatures

and replaces the shunt around the left-hand winding of relay 117. Relay 117 releases and removes the shunt from around the winding of counting relay 121. Relay 121, therefore, becomes energized.

It should be noted at this place that the armatures and contacts of the counting relays 121, 122, 123, 124 and 125 are so designed that the inner upper armature of each of these relays makes connection with its contact slightly in advance of the time when the remaining armatures disengage their back contacts. Hence, the inner upper armature of relay 121 closes its front contact before the operating circuit of said relay is opened at the inner lower armature and back contact. The relay 121 now locks in a circuit traceable from battery through the resistance 127, inner upper contact and winding of said relay, lowermost back contact of relay 122 to the grounded conductor 133.

When the relay 117 deenergizes to remove the shunt from around the winding of counting relay 121 the flow of current through the left-hand winding of relay 119 is suddenly reduced due to the inclusion of the resistance of relay 121 in circuit therewith. Following this, the inner upper armature of relay 121 makes engagement with its front contact and maintains this engagement for an interval before the operating circuit including the left-hand winding of relay 119 is open. During this interval the current flow in the left-hand winding of relay 119 is still further reduced by the shunting effect of current flow from battery through the resistance 127. At the end of this last-mentioned interval relay 121 breaks its back contacts and severs completely the circuit through the left-hand winding of relay 119.

The windings of relay 119 are wound differentially with respect to each other. The flux set up by the left-hand winding of this relay is sufficient to maintain the armatures attracted in opposition to the flux set up by the right-hand winding, even when the flow of current through said left-hand winding has been reduced as above described. However, the double reduction of current through the left-hand winding of relay 119 decreases the resultant flux so that when the circuit of the left-hand winding is opened completely the relay releases quickly.

When the second and last line interruption occurs relay 111 releases, relay 117 again operates and relay 119 in turn becomes energized. Relay 119 completes a circuit from battery through its left-hand winding and contact, conductor 132, thence through the inner lower back contacts of relay 124, 123 and 122 in series, inner lower front contact of relay 121, winding of relay 122, lowermost back contact of relay 123 to the grounded conductor 133. At the end of the interruption, relay 117 becomes deenergized and relay 122 operates. Relay 122 locks in a circuit from battery through the resistance 128, inner upper contact and winding of relay 122, lowermost back contact of relay 123 to the grounded conductor 133. Relay 122, on operating, opens the holding circuit of relay 121 and this latter relay retracts its armatures. Thus at the end of the first series of two impulses the counting relay 122 is operated and all remaining relays are deenergized.

During the transmission of the impulses the slow-to-release relay 118 maintains its armature attracted by means of a circuit closed intermittently at the outer right contact of relay 117. At the end of the series, however, an interval of time elapses during which the circuit of relay 118 is held open by the relay 117 sufficiently long to permit the deenergization of relay 118. Relay 118, on deenergizing, closes a circuit from ground through the left contact of relay 115, conductor 145, contact of relay 118, outer right contact of relay 116, inner contact of relay 114, conductor 134, right back contact of relay 204, winding of relay 205 to battery. Relay 205 operates and completes a circuit from battery through its winding and left contact, conductor 135, winding of relay 114, thence to ground at the left contact of relay 115 as described. Relay 114, however, does not operate in this circuit since it is shunted by the circuit first traced through the winding of relay 205. Relay 205 at its right-hand contacts extends the control conductors 137, 138, 139, 140 and 141 through to the relays of the first register 200.

Since the counting relay 122 is operated a circuit may be traced from the grounded conductor 133 through the lowermost front contact of relay 122, conductor 138, next to the inner right contact of relay 205, winding of relay 208 to battery. Inasmuch as none of the remaining counting relays are operated no condition is placed on any of the other control conductors and hence relay 208 is the only one to be energized in the register set 200. Relay 208 attracts its armatures and closes a circuit from battery through its winding and inner left contact, conductor 145 to ground. Relay 208 closes a circuit from battery through the winding of relay 204, conductor 216, outer left contact of relay 208 to ground over conductor 145. Relay 204 attracts its armatures and opens the shunt around the winding of relay 114. Relay 114 immediately operates in series with the winding of relay 205 by means of the circuit previously described. Relay 114 at its middle contact opens the holding circuit of relay 116 and this latter relay becomes deenergized. Relay 116, in turn, opens the energizing circuit of relays 205 and 114 and they also release their ar-

matures. Relay 114 at its outer contact also opens the holding circuit of counting relay 122 and this relay becomes deenergized. Thus, the counting relays and the receiving circuit in Fig. 1 have completely restored to the normal condition at the end of the series of impulses in readiness to receive the next series of impulses. Relay 205, on deenergizing, disconnects control leads 137, 138, 139, 140 and 141 from the first register 200 to prevent interference when the next digit is recorded.

The subscriber now manipulates the dial 101 to transmit a single impulse representing the second digit of the designation. As has already been explained, a single line interruption causes the first counting relay 121 to operate and lock through the back contact of relay 122. At the end of the series, the slow-to-release relay 118 becomes deenergized and a circuit is closed from ground through the left contact of relay 115, conductor 145, contact of relay 118, outer right contact of relay 116, inner contact of relay 114, conductor 134, thence through the right front contact of relay 204, conductor 217, right back contact of relay 212, winding of relay 213 to battery. Relay 213 operates and closes a circuit from battery through its winding and left contact, conductor 135, thence through the winding of relay 114 to ground as previously explained. Relay 114 does not operate since it is shunted by the energizing circuit of relay 213. Relay 213 at its right contact extends the control conductors through to the relay registers of the second set 201.

Since the first counting relay 121 alone is operated a circuit is traceable from ground over conductor 133, through the lowermost front contact of relay 121, conductor 146, uppermost back contact of relay 126, conductor 137, thence through the innermost right contact of relay 213, winding of relay 214 to battery. Relay 214 operates and locks in a circuit from battery through its winding and inner left contact and conductors 218 and 219 to ground over conductor 145. Relay 214 also completes a circuit from battery through the winding of relay 212, conductor 220, outer left contact of relay 214 to ground over conductor 218. Relay 212 operates and locks through its winding and left contact to ground over conductor 218. Relay 212 opens the shunt around the winding of relay 114 and this relay operates in series with relay 213. Relay 114 opens the circuit of relay 116 as explained, which in turn, opens the circuit of relays 114 and 213 and these relays become deenergized. Also the counting relay 121 and the other relays of the impulse receiving circuit are restored to normal ready for the next series of impulses.

The subscriber next operates his dial 101 to transmit a series of three impulses representing the third digit of the number. At the end of the second interruption relay 122 is operated and locked as above explained. On the third line interruption relay 119 operates and a circuit is closed from battery through its left-hand winding and contact, conductor 132, through the inner lower back contacts of relays 124 and 123, inner lower front contact of relay 122, winding of relay 123, lowermost contact of relay 124 to ground over conductor 133. Relay 123 operates and locks in a circuit from battery through the resistance 129, inner upper contact and winding of said relay, lowermost contact of relay 124 to the grounded conductor 133.

At the end of the series of impulses relay 118 releases and a circuit is completed from ground over conductor 145, through the contact of relay 118, thence as already traced over conductor 134, through the right front contact of relay 204, conductor 217, right front contact of relay 212, conductor 221, right back contact of relay 222, thence through the winding of a relay at the third register 202 corresponding to relays 205 and 213. In the manner already explained the control conductors 137, 138, 139, etc. are extended through to the register relays of the third set 202. Inasmuch as the third and fourth registers 202 and 203 correspond identically to the register 201, this latter register may be considered in connection with the records to be established on said registers 202 and 203. Since the counting relay 123 is operated a circuit may be traced from ground over conductor 133, lowermost front contact of relay 123, conductor 137, innermost contact of relay 213, winding of relay 214 to battery. Relay 214 operates and locks to the grounded conductor 218. Moreover, a second circuit is closed from the grounded conductor 133, uppermost contact of relay 123, conductor 138, through the next to the inner contact of relay 213, winding of relay 224 to battery. Relay 224 operates and locks in a circuit through its winding and inner left contact to the grounded conductor 219. Relay 212 is also operated by means of the circuit closed through the outer left contact of either relay 214 or relay 224 to the grounded conductor 219. As previously explained relay 212 removes the shunt from around the winding of relay 114 which brings about a restoration of the counting relays and the deenergization of the relay 213.

Lastly, the calling subscriber transmits a series of four impulses to establish a record on the last register 203, which as observed is identical with the register 201 shown in detail. At the end of the third impulse the relay 123 is operated and relays 121 and 122

are deenergized. On the fourth and last interruption of the line the relay 119 energizes and closes the above traced circuit from battery over conductor 132, inner lower back contact of relay 124, inner lower front contact of relay 123, winding of relay 124, inner lower back contact of relay 125 to the grounded conductor 133. Relay 124 operates and locks in a circuit from battery through the resistance 130, inner upper contact and winding of said relay, inner lower back contact of relay 125 to ground over conductor 133. Relay 124 at its lowermost contact opens the holding circuit of relay 123, permitting this relay to become released.

After an interval following the end of the series the slow-to-release relay 118 deenergizes and the circuit previously traced from ground over conductor 134 now leads through the right front contacts of relays 204, 212 and 222 in series, conductor 225, right back contact of relay 223 to the winding of a relay corresponding to relay 213. Relay 213, for example, operates and extends the control conductors through to the register relays of the set 203. Since the counting relay 124 alone is operated a circuit is traceable from ground over conductor 133, lowermost back contact of relay 121, conductor 147, uppermost contact of relay 124, conductor 139, middle right contact of relay 213, winding of relay 226 to battery. Relay 226 operates and locks in a circuit through its winding and inner left contact to ground over conductor 218. Relay 226 closes a circuit from battery through the winding of relay 212, outer left contact of relay 226 to the grounded conductor 218. As already explained relay 212 causes the operation of relay 114, which in turn brings about a restoration of the relays energized. Thus, at the end of the fourth series of impulses the relay 208 of the first register 200 is energized, relay 214 of the second register 201 is energized, the relays corresponding to relays 214 and 224 of the third register 202 are energized and a relay corresponding to the relay 226 of the fourth register is energized.

The variable settings of these registers represent the different digits of the wanted designation and circuits controlled by said registers may be closed in an obvious manner for determining the selective operation of the switches such as switch 106. For example, the trunks 142, 143, 144, etc. which may represent different numerical groups may be controlled by magnets or relays 108, 109, 110, etc. These magnets are selectable in any suitable manner by circuits controlled by the relays of the registers 200, 201, 202 and 203.

When the last digit has been recorded on the register 203 some element individual to said register such as the relay 223 may operate to close circuits for relays 210 and 215 in an obvious manner. Relay 210 completes a circuit from ground through its contact, right front contact of register relay 208, innermost right back contact of register relay 206, next to the innermost right back contact of register relay 209 to conductor 227. The conductor 227 may extend directly or through intermediate controlling devices to select a magnet 108, 109 and 110 representing an outgoing trunk identified by the registration on the register 200.

Similarly, relay 215 completes a circuit from ground through its innermost contact, right back contact of relay 224, right back contact of relay 226, outer right back contact of relay 228, outermost right front contact of relay 214, thence to conductor 229. The conductor 229 may correspondingly extend to cause the selection of a trunk at a succeeding switch for further extending the desired call. Also the setting of the registers 202 and 203 correspondingly determine the selections at succeeding switching stages. Inasmuch as this principle of governing the selective operation of switches in accordance with the designations registered on registers is well known and since it plays no important part with the subject-matter of the present invention, it is not believed necessary to disclose and describe the same in further detail.

Thus far only the first four digits of the numerical series, namely digits 1, 2, 3 and 4 have been considered. In order to illustrate the operation of the counting relay series, a description will now be given of the manner in which the apparatus functions in response to series of impulses identifying the remaining six digits.

Assume, that a series of five impulses is received. It will be recalled that at the end of a series of four impulses relay 124 is energized and all remaining relays are deenergized. On the fifth line interruption relay 119 becomes energized and the circuit over conductor 132 extends through the innermost lower front contact of relay 124, uppermost back contact of relay 125, winding of relay 125, to ground over conductor 133. Relay 125 operates and locks in a circuit from battery through resistance 131, inner upper contact and winding of relay 125 to the grounded conductor 133. Relay 125 opens the holding circuit of relay 124 and this latter relay becomes released. At the end of the series when relay 118 becomes deenergized and relay 205, for example, becomes energized to extend the control conductors 137, 138, 139, etc. through to the register 200, a circuit may be traced from ground over conductor 133, lowermost contact of relay 125, inner lower contact of relay 126, conductor 140, next to the outer contact of relay 205, winding of relay 209

to battery. Thus, the register relay 209 is operated.

If a series of six impulses are transmitted relay 119, on deenergizing in response to the sixth interruption, closes the circuit traced over conductor 132, thence through the inner lower back contacts of relays 124, 123, 122 and 121 in series, winding of relay 121, lowermost back contact of relay 122 to the grounded conductor 133. Relay 121 operates and locks in a circuit from battery through the resistance 127, inner upper contact and winding of relay 121, lowermost back contact of relay 122 to the grounded conductor 133. Thus, at the end of a series of six impulses the series of counting relays 121, 122, 123, 124 and 125 have been operated once in succession, relays 121, 122, 123 and 124 having been successively deenergized, relay 125 remaining energized and the first relay 121 of the series again operated. With relays 121 and 125 operated conditions are placed on certain of the control conductors to cause the energization of register relays 206 and 209 of the register 200.

If a series of seven impulses are transmitted, relay 119, on energizing when the seventh interruption occurs, closes a circuit over conductor 132, through the inner lower back contacts of relays 124, 123 and 122, inner lower front contact of relay 121, winding of relay 122, lowermost back contact of relay 123 to grounded conductor 133. Relay 122 operates and locks as described and also opens the holding circuit of relay 121. Furthermore, relay 122 completes a circuit from battery through the winding of relay 126, uppermost contact of relay 122, inner lower front contact of relay 125 to ground over conductor 133. Relay 126 now operates and locks in a circuit from battery through its winding and inner upper contact to ground over conductor 133. Hence, at the end of seven impulses the counting relays 122, 125 and relay 126 are operated, and control circuits are prepared for relays 208 and 209 of register 200.

If a series of eight impulses are transmitted, the relay 119 upon energizing in response to the eighth interruption closes the circuit over conductor 132, through the inner lower back contacts of relays 124 and 123, inner lower front contact of relay 122, winding of relay 123, lowermost contact of relay 124 to ground over conductor 133. Relay 123 operates, locks and opens the holding circuit of relay 122. Hence at the end of a series of eight impulses counting relays 123, 125 and relay 126 are energized and control circuits for relays 206, 208 and 209 are prepared.

Should the subscriber transmit a series of nine impulses, relay 119 upon energizing in response to the last interruption, closes the circuit traced over conductor 132 through the inner lower back contact of relay 124, inner lower front contact of relay 123, winding of relay 124, lowermost contact of relay 126 to ground over conductor 133. Relay 124 operates and locks in a circuit from battery through the resistance 130, inner upper contact and winding of relay 124, lowermost contact of relay 126 to ground over conductor 133. Relay 124 also opens the holding circuit of relay 123. Therefore, for a series of nine impulses the counting relays 124 and 125 and the relay 126 are operated and control circuits for register relays 207 and 209 are prepared.

Lastly in response to a series of ten impulses the relay 119 energizes on the last interruption and closes the above traced circuit over conductor 132, inner lower front contact of relay 124, uppermost front contact of relay 125, winding of relay 121, lowermost back contact of relay 122 to the grounded conductor 133. Thus at the end of a series of ten impulses the counting relays have been operated twice, the relay 125 remaining energized and irresponsive to further impulses at the end of the first operation, relay 124 remaining energized and irresponsive to further impulses at the end of the second operation and relay 121 being energized upon the third operation of the series.

Consider the registration of the series of ten impulses, the counting relays 121, 124 and 125 and relay 126 being energized. Only one circuit is closed as follows: ground over the conductor 133, lowermost front contact of relay 121, conductor 146, uppermost front contact of relay 126, conductor 141, outermost right contact of relay 205, winding of relay 211 to battery. Relay 211 operates and locks in a circuit through its winding and inner left contact to the grounded conductor 145. Relay 211 being energized, it records the fact that a series of ten impulses was transmitted by the subscriber.

It frequently happens that the calling subscriber in attempting to initiate a call causes a preliminary impulse to be sent to the office accidentally. This impulse, if recorded on the register 200 would mutilate the call and prevent the subscriber from obtaining the proper connection. Accordingly, means are provided for eliminating a first impulse when received at the central office. Assume that in initiating a call the subscriber accidentally sends a single impulse. This impulse is received and causes the operation of the first counting relay 121. After an interval the slow relay 118 becomes deenergized and the circuit of relay 205 is closed as hereinbefore explained. With relay 121 operated a circuit is completed from ground over conductor 133, lowermost front contact of relay 121, conductor 146, uppermost back contact of relay 126, conductor 137, inner-

most contact of relay 205, winding of relay 206 to battery. Relay 206 operates and closes a circuit from battery through the winding of relay 204, left contact of relay 206, thence through the inner right contact of relay 205 to ground over conductor 137 as traced. It will be noted that relay 206 cannot close a locking circuit for itself as is the case of the remaining relays 208, 207 and 209. Immediately that relay 204 operates it removes the shunt from around the winding of relay 114. Relay 114 operates to open the circuit of relay 116, which in turn opens the circuit of relays 114 and 205. Immediately that relay 205 releases it opens the circuit of relay 206, which in turn opens the circuit of relay 204. Hence, for a single preliminary impulse, register 200 is immediately restored to its normal position such that when the first and regular series of impulses are transmitted, a record of the same may be placed on the register 200 in the proper manner.

When the recording mechanism is no longer required the circuit of relay 111 is opened in any well-known manner causing in turn the release of slow relay 115 and the removal of ground from conductor 145. All relays of the recording mechanism are thereupon released.

What is claimed is:

1. In combination a series of relays arranged for more than two successive and repeated operations in response to a series of impulses and means for varying the number of relays in said series responsive to impulses with progressive operations of said series of relays.

2. In combination a series of relays arranged for more than two successive and repeated operations in response to a series of impulses, a variably operable device, and means for operating said device according to the number of times the series of relays is operated.

3. In combination, a series of relays arranged for more than two successive and repeated operations in response to a series of impulses, a variably operable register, and means for setting said register according to the number of times said series of relays is operated and according to the number of relays last operated in said series.

4. In combination, a series of relays arranged for more than two successive and repeated operations in response to a series of impulses, a plurality of variably operable registers, and means for setting each register according to the number of times the operation of said series of relays is repeated for a series of impulses and according to the particular relay energized on the last operation of said series of relays.

5. In combination, a series of relays arranged to operate successively and repeatedly in response to a series of impulses, and means for diminishing the number of relays in said series responsive to impulses with progressive operations of said series of relays.

6. In combination, a series of relays arranged to operate successively and repeatedly in response to a series of impulses, and means for rendering one relay irresponsive to impulses with each progressive operation of said series of relays.

7. In combination, a series of relays arranged to operate successively and repeatedly in response to a series of impulses, and means for maintaining operated the last and a different relay to be operated for each progressive operation of said series of relays.

8. In combination, a series of relays arranged to operate successively and repeatedly in response to a series of impulses, each relay deenergizing on the energization of the succeeding relay, and means for varying the number of relays in said series responsive to impulses with progressive operations of said series of relays.

9. The combination in a mechanism for recording designations of a series of relays arranged to operate successively and repeatedly in response to a series of impulses, the number of relays being less than the possible number of impulses in said series, and means for varying the number of relays in said series responsive to impulses with progressive operations of said series of relays.

10. The combination in a mechanism for recording designations of a series of relays arranged to operate successively in response to a series of impulses, the number of relays being less than the possible number of impulses in said series, each relay deenergizing on the energization of the succeeding relay, and means for changing the number of relays in said series responsive to impulses with progressive operations of said series of relays.

11. The combination in a recording mechanism of a variably operable register consisting of relays for registering series of impulses, means for operating said relays in response to the receipt of series of impulses, and means when a single impulse is registered on said relays for automatically erasing said registration.

12. The combination in a recording mechanism of a plurality of registers each comprising a number of relays, each register serving to record a series of impulses by operating a variable number of said relays, means for directing series of impulses to said registers in succession for registration, and means effective when a certain registration is set up on a given register for automatically erasing said registration and placing said register in condition to register the next succeeding series of impulses.

13. The combination in a recording mech-

anism of a plurality of registers, each comprising a number of relays for recording designations, a set of counting relays variably operable in response to series of impulses, means for setting said registers in accordance with the operation of said counting relays, and a relay for each register for causing the restoration of the counting relays and for associating said counting relays with the next register in order.

In witness whereof I hereunto subscribe my name this 18th day of April, A. D. 1922.

SAMUEL B. WILLIAMS, JR.