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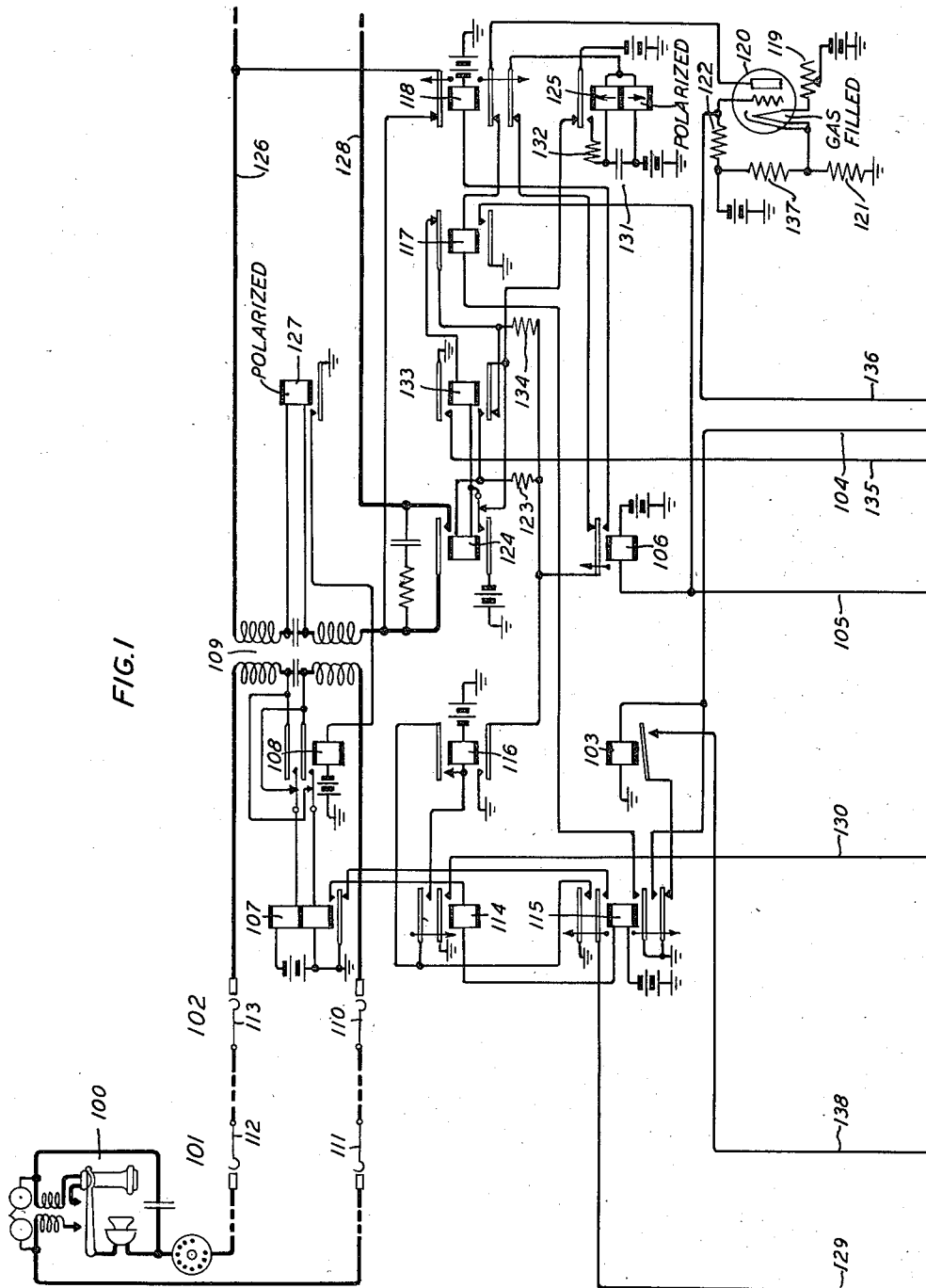
J. B. McKIM

2,050,722

TELEPHONE SYSTEM

Filed March 20, 1935

2 Sheets-Sheet 1



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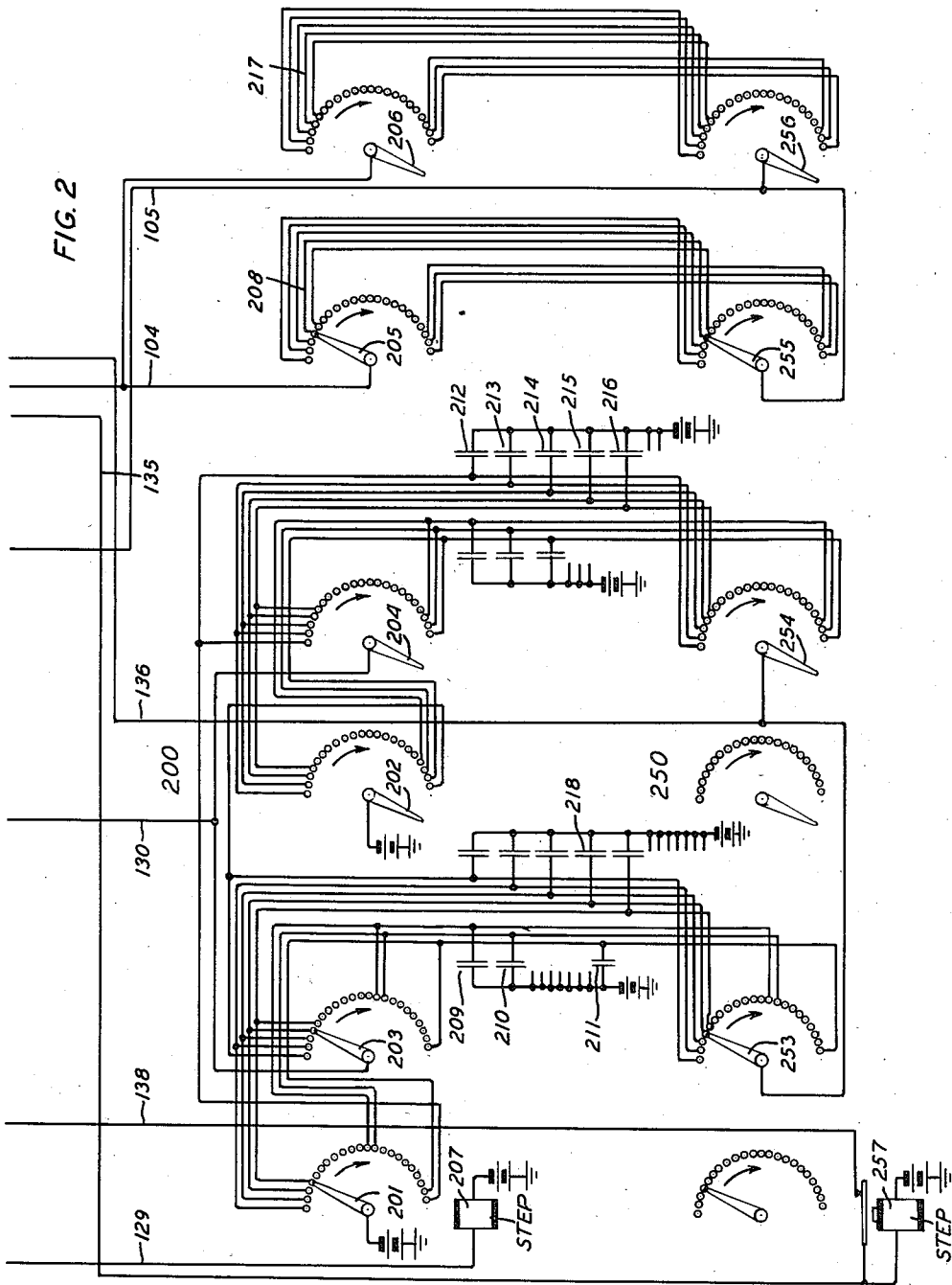
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UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

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Application March 20, 1935, Serial No. 11,927

10 Claims. (Cl. 179—16)

This invention relates to automatic or semi-automatic telephone systems and more particularly to repeaters for use therein.

In multi-office exchange areas it is often necessary to employ long inter-office trunks to interconnect the more widely separated offices. Consequently such trunks must be equipped with repeaters to improve the voice current transmission and to enable the transmission of impulses dialed at the originating office for setting selector switches in the terminating office. When dialed impulses are transmitted through repeaters there is a distinct tendency for the repeated impulses to become distorted to such an extent that they are not fully suitable for controlling the accurate setting of selector switches. To obviate this difficulty repeaters have been proposed heretofore for introducing a correction in the character and speed of the retransmitted impulses.

The present invention has for its object the improvement of the impulse correcting repeaters heretofore proposed in that the outgoing impulses may be transmitted at a predetermined constant speed commensurate with the speed at which selector switches are accurately responsive and with a fixed percentage of break period to make period regardless of the speed and percentage of break period to make period of the dialed or incoming impulses.

In accordance with the present invention, the improved repeater functions much in the manner of a register sender in that the incoming impulses are stored and outgoing impulses are transmitted in accordance with the stored impulses. For storing the incoming impulses a single register switch of the rotary step-by-step type is employed which advances a number of steps for each dialed impulse series commensurate with the numerical value of the digit in such a manner that the impulse series are additively stored therein. A small condenser is connected to each terminal of certain banks of the switch and provision is made for placing a positive charge on such ones of the condensers as are connected to the bank terminals of the register upon which a brush of the register comes to rest at the termination of each successive incoming impulse series. Such condensers as thus become charged in response to the dialing of series of impulses serve as markers to indicate the numerical value of each incoming impulse series.

For generating impulses for retransmission, a condenser timed relay is provided, the operating and releasing time of which can be very accurately determined. This relay in turn controls

the operation and release of a pair of relays, one of which controls the making and breaking of the outpulsing circuit and the other of which controls the stepping of a second register or impulse counting switch of the rotary step-by-step type. The condensers are also connected respectively to terminals of certain of the banks of the counting switch and the brushes which cooperate with these terminals are connected to the control electrode of a gas-filled tube. Under the control of the impulse generating and transmitting relays the counting switch is advanced during the transmission of the first series of outgoing impulses until a terminal is reached which is associated with the first charged marking condenser at which time as many outgoing impulses will have been transmitted as were recorded on the first switch in response to the first digit dialed. The first charged condenser is now connected to the control electrode of the tube and the normal biasing potential on the control electrode is now made more positive whereby the tube immediately flashes to operate a relay to arrest the further generation and transmission of impulses. Through the operation of relay means the reoperation of the timed relay and the impulse transmitting relays is delayed to measure off a predetermined period before the transmission of the next series of outgoing impulses and to deionize the tube. Upon the termination of the delay interval the timed relay and impulse transmitting relays again function to transmit a second series of impulses over the outpulsing path and to further advance the counting switch until it reaches a terminal which is associated with the second charged marking condenser at which time as many outgoing impulses will have been transmitted as were recorded on the first switch in response to the second digit dialed. The tube again flashes to terminate the transmission of the second series of impulses. In this manner as many series of impulses are transmitted as were registered upon the first register.

Since the operating and releasing time of the timed relay may be very accurately determined, the speed at which impulses are transmitted over the outpulsing circuit and the percentage of break period to make period thereof may be very accurately adjusted.

For a clearer understanding of the invention, reference may be had to the following detailed description taken in connection with the accompanying drawings in which:

Fig. 1 shows a subscriber's line, the schematic representation of a line finder and a first selector

switch, and an outgoing trunk circuit to which the selector switch has access, equipped with a voice current repeating coil and a dial impulse repeater; and

- 5 Fig. 2 shows an impulse storage and counting circuit which functions with the impulse repeater of Fig. 1.

The digit registering switch 200 and the impulse counting switch 250 of Fig. 2 are of the well-known rotary step-by-step type having no normal position and each being provided with six brushes and associated arcuate terminal banks and a stepping magnet. The banks and brushes of each switch are arranged in pairs, brushes 201 and 202, 203 and 204, 205 and 206 of switch 200 being thus paired and brushes 253 and 254, 255 and 256 of switch 250 being also so paired. In this connection it is to be noted that the brushes constituting each such pair are positioned on the driving shaft 180° apart so that one brush, for example 202, enters its bank of associated terminals one step after its paired brush 201 leaves the last terminal of its bank. The line finder 101 and selector switch 102, schematically illustrated in Fig. 1, may be of the well-known construction employed generally in dial systems of the step-by-step type.

The tube illustrated at 120 is of the gaseous discharge type filled with a low pressure gaseous content, which may be neon, argon, helium, mercury vapor or combinations of gases of this group. The tube has a certain characteristic, namely, that the gaseous content will become ionized and thus conducting on one potential determined by the electrode design, the nature of the gaseous content and its pressure, but once rendered conducting will maintain this condition of conductivity on a much lower potential. The tube may be of the hot cathode type, as disclosed, having a cathode heated conductively from a filament illuminated by a source of direct current, or the filament may itself serve as the cathode or be illuminated by a source of alternating current. A tube of the cold cathode type might also be employed.

It will be assumed that at the time the subscriber at substation 100 initiates a call by removing his receiver from the switchhook that switches 200 and 250 are resting with their brushes in the position indicated and that relay 103 is normally operated over the circuit extending from ground through its winding, conductor 104, brush 205, conductor 208, brush 255, conductor 105, winding of relay 106, to battery. Relay 106 is not operated over this circuit. In response to the initiation of the call, the calling line is extended in the well-known manner through the operation of line finder 101 to the first selector switch 102. It will further be assumed that the calling subscriber desiring a connection with a subscriber's line located in a distant office dials the directory number of such line which, for the purposes of illustration, may be Main 9913.

In response to the dialing of the office code letter M, which has the numerical equivalent of 6, the brushes of the first selector 102 are stepped to a position opposite the sixth bank level and are then rotated over this level to hunt for an idle trunk. It will be assumed that the trunk disclosed in Fig. 1 is idle and that the brushes of selector 102 come to rest upon the terminals of this trunk. The dialing loop is now extended from battery through the upper winding of re-

lay 107, upper normal contacts of relay 108, lower left winding of repeating coil 109, ring brushes 110 and 111 of selector 102 and line finder 101 over the calling subscriber's line, tip brushes 112 and 113 of line finder 101 and selector 102, upper left winding of repeating coil 109, lower normal contacts of relay 108, to ground through the lower winding of relay 107.

Relay 107 operates establishing a circuit which extends from ground at its front contact serially through the windings of slow-to-operate relay 114 and slow-to-release relay 115 to battery. Relays 114 and 115 both operate and establish an operating circuit for relay 116 extending from battery through the winding of relay 116, upper front contact of relay 114, to ground at the upper front contact of relay 115. Relay 116 operates and locks in a circuit from battery through its winding and upper front contact to ground at the upper front contact of relay 115 independent of the continued operation of relay 114. Relay 115 upon operating connects ground over its outer lower front contact in shunt of the winding of relay 103 thereby causing the release of relay 103 and the operation of slow-to-release relay 106; prepares the operating circuit of stepping magnet 207 of switch 200 over its inner upper front contact and, at its inner lower front contact, connects the positive or grounded terminal battery to the anode of tube 120 over a circuit extending through the winding of the anode relay 117, the inner lower back contact of relay 118.

The filament of tube 120 is heated in a circuit from battery through rheostat 119 and resistance 121 and the grid is normally negatively biased in a circuit from the negative terminal of battery through resistance 122 so that tube 120 will not ionize. However, should either brush 253 or 254 of switch 250 be in engagement with a bank terminal to which a positively charged condenser, such as 218 or 216 is connected, positive potential will be applied from such condenser over brush 253 or brush 254, conductor 136 to the grid of tube 120 thereby causing the tube to ionize and operate the anode relay 117.

With relay 116 operated a circuit is established from ground over the lower contact thereof through resistance 123, winding and normal contacts of relay 124 to battery over the back contact of relay 125 and in parallel over the front contact of relay 106 to battery through the winding of relay 118. Relays 124 and 118 both operate, relay 124 locking in a circuit from ground at the lower contact of relay 116, through resistance 123, winding and lower alternate contacts of relay 124, to battery, and closing the outgoing loop from conductor 126, upper right winding of repeating coil 109, winding of supervisory relay 127, lower right winding of repeating coil 109, upper contacts of relay 124 to conductor 128. Relay 118 upon operating opens the cathode-anode circuit previously traced through the winding of anode relay 117 at its inner lower back contact, opens the operating circuit of the pulse generating relay 125 at its lower back contact and at its upper back contact opens the outputting circuit which extends from conductor 126 over the upper back contact of relay 118 and the upper front contact of relay 124 to conductor 128. The circuits are now ready to receive incoming impulses resulting from the operation of the substation dial for the first numerical digit 9 of the desired line number.

In response to the operation of the dial for the second dialed digit 9, relay 107 releases nine times and upon each release closes the operating circuit for stepping magnet 207 of switch 200 which may be traced from ground at the back contact of relay 107, inner upper front contact of relay 115, conductor 129, to battery through the winding of magnet 207. Upon the first release of relay 107 the operating circuit for relays 114 and 115 is opened and relay 114 releases but relay 115 being slow-to-release remains operated over the short intervals that relay 107 is deenergized during its response to the series of impulses and holds relay 116 operated. Relay 114 being slow-to-operate does not operate again until relay 107 remains steadily energized at the end of the dialed impulse series. In response to the nine impulses transmitted through stepping magnet 207 the magnet steps the brushes of switch 200 forward nine steps.

As brush 201 encounters the successive terminals of its arc it causes the successive discharge of the condensers connected to such terminals, condenser 209 becoming discharged in a circuit extending from the negative terminal of grounded battery over brush 201, through condenser 209 to the negative terminal of grounded battery when brush 201 encounters the twelfth terminal of its arc and condenser 210 becoming discharged when brush 201 encounters the thirteenth terminal of its arc. When relay 107 reenergizes following the completion of the dialing of the second digit 9, relay 114 reoperates and a charging path for condenser 209 is extended from ground at the inner contact of relay 114, conductor 130, brush 203, the thirteenth terminal of its arc, condenser 209 to the negative terminal of grounded battery. Condenser 209 therefore becomes positively charged with respect to negative battery.

In response to dialing the next digit assumed to be 9, relay 107 transmits nine stepping impulses to magnet 207 to advance the brushes of switch 200 nine further steps and, upon its first release in response to the first dialed impulse, causing the release of relay 114. As brush 201 encounters successive terminals of its arc it causes the successive discharge of the condensers connected to such terminals, condenser 211 becoming discharged when brush 201 encounters the twenty-first terminal of its arc and condenser 212 becoming discharged when brush 201 encounters the twenty-second terminal of its arc. When relay 107 reenergizes following the completion of the dialing of the third digit 9, relay 114 reoperates and a charging path for condenser 211 is established from ground at the inner contact of relay 114, conductor 130, brush 203, the twenty-second terminal of its arc, condenser 211 to the negative terminal of grounded battery. Condenser 211 therefore becomes positively charged with respect to negative battery.

In response to dialing the next digit, assumed to be 1, relay 107 transmits a single stepping impulse to magnet 207 to advance the brushes of switch 200 one step further. Relay 114 also releases as before described. Brushes 201, 203 and 205 are now advanced out of engagement with terminals of their arcs and brushes 202, 204 and 206 are advanced into engagement with the first terminals of their arcs, the engagement of brush 202 with the first terminal of its arc establishing a discharge path for condenser 213 extending from the negative

terminal of grounded battery over brush 202 through condenser 213 to the negative terminal of grounded battery. When relay 107 reenergizes following the completion of the dialing of the fourth digit 1, relay 114 reoperates and a charging path for condenser 212 is established from ground at the inner contact of relay 114, conductor 130, brush 204 and the first terminal of its arc, condenser 212 to the negative terminal of grounded battery. Condenser 212 is thus positively charged with respect to negative battery.

In response to the dialing of the last digit, assumed to be 3, relay 107 transmits three impulses to the stepping magnet 207 to advance the brushes of switch 200 three further steps. Relay 114 also releases as before described. As brush 202 encounters the second, third and fourth terminals of its arc, discharge paths are established thereover as previously described for condensers 214, 215 and 216. When relay 107 reenergizes following the completion of the dialing of the fifth and last digit 3, relay 114 reoperates and a charging circuit is established for condenser 215 from ground at the inner contact of relay 114, conductor 130, brush 204 and the fourth terminal of its arc, condenser 215 to the negative terminal of grounded battery. Condenser 215 is thus positively charged with respect to negative battery.

It is thus to be noted that switch 200, in advancing from its normal resting position to the position in which it stops upon the termination of the last dialed impulse series, has caused the successive discharge of all condensers connected to terminals with which brushes 201 and 202 engage, and has caused the recharging of the condensers connected to terminals upon which brushes 203 and 204 were stopped at the termination of each successive impulse series. Thus following the complete dialing of the desired line number condensers 209, 211, 212 and 215 remain positively charged to mark terminal positions in which brushes 203 and 204 stopped to register the successively dialed digits 9913.

At the time switch 200 took its first step to register the second dialed digit 9, the circuit previously traced through the winding of relay 106 is opened by the advance of brush 205 and relay 106 releases followed by the release of relay 118 as determined by their slow releasing characteristics. Relay 118 upon releasing reconnects positive anode potential to the anode of tube 120 through the winding of relay 117 and, with relay 106 released, establishes an operating circuit for pulse generating relay 125. This circuit may be traced from ground over the lower contact of relay 116, back contact of relay 106, lower back contact of relay 118, lower winding of relay 125 to battery and, in parallel therewith, through the upper winding of relay 125 and condenser 131 to battery. Relay 125 is differentially wound and the windings are so related that upon the establishment of the previously traced circuits there-through the upper winding overbalances the lower winding and the armature of the relay is thereby held against its back contact. As the condenser 131 becomes charged, the current flowing through the upper winding gradually diminishes until the lower winding overbalances the upper winding and the armature of the relay is moved to make its front contact. Thereupon a discharge path is established for condenser 131 from the negative terminal of grounded battery through condenser 131, resistance 132, front contact of relay 125 to

the negative terminal of grounded battery. After an interval determined by the value of resistance 132, condenser 131 becomes fully discharged and the upper winding of relay 125 becomes energized in a circuit from ground at the lower front contact of relay 116 over the back contacts of relays 106 and 118, upper winding of relay 125, resistance 132, front contact of relay 125 to battery. The upper winding of relay 125 now overbalances the lower winding and the armature of relay 125 is moved to make its back contact. This cycle of operations is repeated so long as relays 106 and 118 remain deenergized, relay 125 thus operating and releasing at a rate of twenty cycles per second.

On the first movement of the armature of relay 125 from its back contact to its front contact a shunt around the winding of relay 133 is opened. This shunt may be traced from battery over the back contact of relay 125, back contact of relay 133, back contact of relay 117, winding of relay 133, lower alternate contacts of relay 124 to battery. With this shunt opened, relay 133 now operates in a circuit extending from battery, lower alternate contacts of relay 124, winding of relay 133, upper back contact of relay 117, resistance 134 to ground at the lower front contact of relay 116. When relay 125 next moves its armature to its back contact, the winding of relay 124 is shunted over a path extending from battery, lower alternate contacts and winding of relay 124, lower front contact of relay 133, back contact of relay 125 to battery, relay 133 being held operated after the release of relay 124 over a circuit extending from battery, back contact of relay 125, lower normal contacts of relay 124, winding of relay 133, back contact of relay 117, resistance 134 and thence to ground at the lower contact of relay 116. On the next movement of the armature of relay 125 to its front contact this holding circuit of relay 133 is opened and relay 133 releases. As relay 125 continues to vibrate its armature relays 124 and 133 repeatedly operate and release in the sequence above described with the result that relay 124 makes and breaks the previously traced outpulsing loop over conductors 126 and 128 at the rate of ten cycles per second.

On each energization of relay 133, a circuit is established from ground at its upper contact over conductor 135, winding of stepping magnet 257 of switch 250 to battery and thus upon each operation and release of relay 133 magnet 257 advances the brushes of switch 250 one step. Each step of switch 250 corresponds to the transmission of one impulse over the outgoing pulsing loop under the control of relay 124.

On the ninth operation of relay 133 and the following cyclic release of relays 124 and 133 nine impulses will have been transmitted to the outpulsing loop and the brushes of switch 250 will have been advanced nine steps with brush 253 in engagement with the thirteenth terminal of its arc to which the positively charged condenser 209 is connected. Thereupon a circuit is established from the negative terminal of grounded battery through condenser 209, over brush 253, conductor 136 to the grid of tube 120. The positive charge on condenser 209 thus applied to the grid of tube 120 overcomes the normal negative bias thereon to such an extent that the tube ionizes and operates the anode relay 117 over its cathode-anode circuit. This circuit may be traced from the negative terminal of grounded battery, through resistance 137, cathode and anode of tube 120, inner lower back contact of relay 118, winding of

relay 117 to ground at the inner lower front contact of relay 115.

Relay 117 upon operating opens the operating circuit of relay 133 at its back contact to prevent the transmission of further stepping impulses to the stepping magnet 257, thereby arresting switch 250 with its brushes in engagement with the thirteenth terminals of their arcs. Relay 117 also closes at its lower contact an obvious circuit for relay 106 which upon operating opens at its back contact the operating circuit for the impulse generating relay 125 and at its front contact establishes the operating circuit of relay 118. The operating circuit of relay 125 is opened at the time relay 125 has its armature in engagement with its back contact and therefore the previously traced operating circuit for relay 124 is established, relay 124 then operating, locking and maintaining the outgoing loop closed at its upper front contact.

Relay 118 upon operating opens the operating circuit of relay 125 at a second point and opens the cathode-anode path through tube 120. Tube 120 now deionizes releasing relay 117. Relay 117 upon releasing opens the circuit of relay 106 which, in turn, opens the circuit of relay 118. Relays 106 and 118 are made slow-to-release for the purpose of interposing a suitable delay interval to permit a trunk hunting operation of the selector switch operated by the preceding train of impulses transmitted over the outpulsing loop before the operating circuit of relay 125 is reestablished to start impulsing for the next digit series. Relay 117 upon releasing also prepares the operating circuit of relay 133.

When relays 106 and 118 finally both release relay 125 again functions to cyclically operate and release relays 124 and 133 in the manner previously described to transmit a further series of impulses over the outpulsing loop and to further advance the brushes of switch 250.

It was assumed that the second digit, registered by the advance of switch 200, was the digit 9 and that in response thereto condenser 211 was positively charged. When, therefore, the brushes of switch 250 are further advanced nine steps or to the twenty-second terminals of their arcs a circuit is established from the negative terminal of grounded battery through condenser 211 over brush 253, conductor 136, to the grid of tube 120. In the manner previously described tube 120 ionizes operating relay 117. Relays 124, 133, 106, 118 and 125 now function as previously described to terminate the transmission of further impulses over the outpulsing loop and to the stepping magnet 257 of switch 250 and to prepare the circuits for the transmission of the next train of impulses.

The next digit, registered by the advance of switch 200, was the digit 1 as indicated by the positively charged condition of condenser 212. When, therefore, the brushes of switch 250 are subsequently advanced one further step during the transmission of the next train of impulses under the control of relays 125, 124, and 133, brushes 253 and 255 are moved out of engagement with their terminal arcs and brushes 254 and 256 are moved into engagement with the first terminals of their respective arcs. A circuit is now established from the negative terminal of grounded battery through condenser 212, over brush 254, conductor 136 to the grid of tube 120. In the manner previously described tube 120 ionizes operating relay 117. Relays 124, 133, 106, 118 and 125 now function as previously described to ter-

minate the transmission of further impulses over the outpulsing loop and to the stepping magnet 257 of switch 250 and to prepare the circuits for the transmission of the next train of impulses.

5 The next digit, registered by the advance of switch 200, was the digit 3 as indicated by the positively charged condenser 215. When, therefore, the brushes of switch 250 are subsequently advanced three further steps during the trans-
10 mission of the next train of impulses under the control of relays 125, 124 and 133, brushes 254 and 256 will engage the fourth terminals of their respective arcs. A circuit is now established from the negative terminal of grounded battery
15 through condenser 215 over brush 254, conductor 136, to the grid of tube 120. In the manner previously described tube 120 ionizes operating relay 117. Relays 124, 133, 106, 118 and 125 now function as previously described to terminate the
20 transmission of further impulses over the outpulsing loop and to the stepping magnet 257 of switch 250, and to prepare the circuits for the transmission of the next train of impulses.

Since at this time trains of impulses corresponding to all of the dialed series of impulses registered by the advance of switch 200 have been transmitted, switch 250 will have advanced its brushes 254 and 256 to the fourth terminals of their respective arcs and as it will be recalled
30 that brushes 204 and 206 of switch 200 were arrested on the fourth terminals of their respective arcs at the termination of dialing, a circuit is established from ground at the lower front contact of relay 115, conductor 104, brush 206
35 and the fourth terminal of its arc, conductor 217, the fourth terminal of the arc with which brush 256 is engaged, brush 256, conductor 105, winding of relay 106, to battery. Thus relay 106 is held operated at the termination of the trans-
40 mission of the preceding impulse series, in turn holding relay 118 operated and therefore impulse generating relay 125 and relays 124 and 133 cannot function to transmit additional impulses. Relay 124 is, however, locked operated over its
45 lower alternate contacts to ground at the lower contact of relay 116 to maintain the talking circuit closed over the outgoing trunk conductors 126 and 128 through the right windings of repeating coil 109 and the winding of polarized super-
50 visory relay 127.

When the called subscriber responds, relay 127 operates in turn operating the reversing relay 108 which transposes the connection of battery and ground through the windings of relay 107 for
55 supervisory purposes. When the conversation over the circuit established from the calling line and trunk conductors 126 and 128 is terminated and the calling subscriber restores his receiver to the switchhook, relay 107 releases in turn causing
60 the release of relays 114, 115 and 116. Relay 116 upon releasing opens the circuits of relays 118 and 124 and these relays also release. Relay 115 upon releasing opens the shunt around the winding of relay 103 and relay 103 now operates in a
65 circuit extending from ground through its winding over conductor 104, brush 206, conductor 217, brush 256, conductor 105 to battery through the winding of relay 106. Relay 106 does not remain operated over this circuit due to the high re-
70 sistance of the winding of relay 103 and therefore releases.

Relay 124 upon releasing opens the outgoing trunk loop thereby initiating the release of other selector switches employed in the establishment
75 of the connection, the connector switch being re-

leased in the usual manner upon the restoration of the called subscriber's receiver to its switchhook. All apparatus used in the establishment of the described connection is now normal it being noted that relay 103 is normally operated and
5 that switches 200 and 250 normally stand in the position to which they were advanced in establishing the connection in which they were last employed.

Should a call be abandoned after the registra-
10 tion of digits by the advancement of switch 200, but before all trains of impulses have been transmitted over the outpulsing loop in accordance therewith, relays 107, 114, 115, and 116 will be released, in turn causing the release of relays 124,
15 133, 118 and 124 if any of these relays are at the time operated. Since switch 250 has not advanced either its brush 255 or its brush 256 to a position corresponding to that of brush 205 or
20 206 of switch 200, no circuit will be effective for relays 103 and 106 and these relays will also release. With both relays 115 and 103 released an interrupted stepping circuit will be closed for magnet 257 of switch 250 extending from ground
25 over the lower back contact of relay 115, back contact of relay 103, conductor 138, interrupter contacts and winding of magnet 257 to battery. Magnet 257 will thereupon advance the brushes of switch 250 until either brush 255 or brush 256
30 engages a terminal connected to a terminal upon which brush 205 or brush 206 of switch 200 is resting whereupon relay 103 will operate in a circuit over conductor 104, brush 205 or 206, a loop conductor such as 208 or 217, brush 255 or 256,
35 conductor 105, winding of relay 106 to battery. Relay 106 does not operate over this circuit but relay 103 upon operating will open the circuit of magnet 257 thereby arresting the brushes of switch 250 in a position corresponding to the position of the brushes of switch 200.

If at any time either switch 200 or 250 is advanced accidentally so that their brushes do not occupy corresponding positions, relay 103 will re-
40 lease and switch 250 will be advanced in the manner just described until the brushes of switch 250 are positioned on terminals of their arcs which correspond to the terminals of the arcs with which
45 the brushes of switch 200 are at the time in engagement.

What is claimed is:

1. In a telephone system, a repeater comprising
50 a register switch for successively and additively registering the plurality of series of incoming impulses of a call designation, an impulse transmitter for generating and transmitting series of
55 outgoing impulses, a counting switch for counting the impulses of each outgoing series of impulses, and means controlled by said impulse transmitter during the transmission of each outgoing series of impulses for advancing said counting
60 switch to a position corresponding to the position to which said register switch was set for registering the corresponding incoming series of impulses.

2. In a telephone system, a repeater comprising
65 a register switch for successively and additively registering the plurality of series of incoming impulses of a call designation, an impulse transmitter for generating and transmitting series of outgoing impulses, a counting switch for counting
70 the impulses of each outgoing series of impulses, means controlled by said impulse transmitter for operating said counting switch to successively and additively register therein said series of outgoing impulses, and means for terminating the
75

transmission of each series of outgoing impulses when said counting switch reaches a position corresponding to the position to which said register switch was set to register the corresponding series of incoming impulses.

3. In a telephone system, a repeater comprising a register switch for registering a series of incoming impulses, an impulse transmitter for generating and transmitting a series of outgoing impulses, a counting switch for counting a series of outgoing impulses, means controlled by said impulse transmitter for operating said counting switch, condensers connected to corresponding bank terminals of said switches, means operative upon the termination of an incoming series of impulses to place a charge on one of said condensers to mark the position to which said register switch was set in response thereto, and means controlled by said charged condenser to terminate said series of outgoing impulses when said counting switch is advanced to a terminal thereof to which said charged condenser is connected.

4. In a telephone system, a repeater comprising a register switch for registering a series of incoming impulses, an impulse transmitter for generating and transmitting a series of outgoing impulses, a counting switch for counting a series of outgoing impulses, means controlled by said impulse transmitter for operating said counting switch, condensers connected to corresponding bank terminals of said switches, means operative upon the termination of an incoming series of impulses to place a charge on one of said condensers to mark the position to which said register switch was set in response thereto, and means including a gas-filled tube controlled by said charged condenser to terminate said series of outgoing impulses when said counting switch is advanced to a terminal thereof to which said charged condenser is connected.

5. In a telephone system, a repeater comprising a register switch for registering a series of incoming impulses, an impulse transmitter for generating and transmitting a series of outgoing impulses, a counting switch for counting a series of outgoing impulses, means controlled by said impulse transmitter for operating said counting switch, condensers connected to corresponding bank terminals of said switches, means operative upon the termination of an incoming series of impulses to place a positive charge on one of said condensers to mark the position to which said register switch was set in response thereto, a gas-filled tube having its control electrode normally negatively biased to a potential below the ionization potential of said tube, a relay in the cathode-anode circuit of said tube, and means operative when said counting switch is advanced to a terminal thereof to which said charged condenser is connected to change the potential on said control electrode to cause said tube to ionize and operate said relay thereby terminating the operation of said impulse transmitter.

6. In a telephone system, a repeater comprising a register switch for successively and additively registering the plurality of series of incoming impulses of a call designation, an impulse transmitter for generating and transmitting series of outgoing impulses, a counting switch for counting the impulses of each outgoing series of impulses, means controlled by said impulse transmitter for operating said counting switch, condensers connected to bank terminals of said switches, means operative upon the ter-

mination of each incoming series of impulses to place a charge on the condenser which is connected to a terminal to which said register switch is advanced in response to such series of impulses, and means controlled by said condenser to terminate said series of outgoing impulses when said counting switch is advanced to terminals to which charged condensers are connected.

7. In a telephone system, a repeater comprising a register switch for successively and additively registering the plurality of series of incoming impulses of a call designation, an impulse transmitter for generating and transmitting series of outgoing impulses, a counting switch for counting the impulses of each outgoing series, means controlled by said impulse transmitter for operating said counting switch, condensers connected to bank terminals of said switches, means operative upon the termination of each incoming series of impulses to place a charge on the condenser which is connected to a terminal to which said register switch is advanced in response to such series of impulses, and means including a gas-filled tube controlled successively by said charged condensers to terminate said series of outgoing impulses when said counting switch is advanced to terminals thereof to which said charged condensers are connected.

8. In a telephone system, a repeater comprising a register switch for successively and additively registering the plurality of series of incoming impulses of a call designation, an impulse transmitter for generating and transmitting series of outgoing impulses, a counting switch for counting the impulses of each outgoing series of impulses, means controlled by said impulse transmitter for operating said counting switch to successively and additively register therein said series of outgoing impulses, condensers connected to bank terminals of said switches, means operative upon the termination of each incoming series of impulses to place a charge on the condenser which is connected to a terminal to which said register switch is advanced in response to such series of impulses, and means controlled by said charged condensers for terminating each series of outgoing impulses when said counting switch reaches a position corresponding to the position to which said register switch was set to register the corresponding series of incoming impulses.

9. In a telephone system, a repeater comprising a register switch for successively and additively registering the plurality of series of impulses of a call designation, an impulse transmitter for generating and transmitting series of outgoing impulses, a counting switch for counting the impulses of each outgoing series of impulses, means controlled by said impulse transmitter for operating said counting switch to successively and additively register therein said series of outgoing impulses, condensers connected to bank terminals of said switches, means operative upon the termination of each incoming series of impulses to place a charge on the condenser which is connected to a terminal to which said register switch is advanced in response to such series of impulses, a gas-filled tube having its control electrode normally negatively biased to a potential below the ionization potential of said tube, a relay in the cathode-anode circuit of said tube, and means operative each time said counting switch is advanced to a terminal thereof to which a charged condenser is connected to change the potential on said control electrode to cause said tube to ionize and operate said re-

lay thereby momentarily terminating the operation of said impulse transmitter.

10. In a telephone system, a repeater comprising a register switch for successively and additively registering the plurality of series of incoming impulses of a call designation, an impulse transmitter for generating and transmitting series of outgoing impulses, a counting switch for counting the impulses of each outgoing series of impulses, means controlled by said impulse transmitter for operating said counting switch to successively and additively register therein said

series of outgoing impulses, a gas-filled tube, a relay for arresting the operation of said transmitting means, means for causing said tube to ionize and operate said relay each time said counting switch reaches a position corresponding to any position to which said register switch was set, and means for measuring a delay interval following each ionization of said tube, for thereafter deionizing said tube and for restarting said impulse transmitter.

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