

May 6, 1947.

F. R. LAMBERTY
COMMUNICATION SYSTEM

2,419,958

Filed Aug. 23, 1944

3 Sheets-Sheet 1

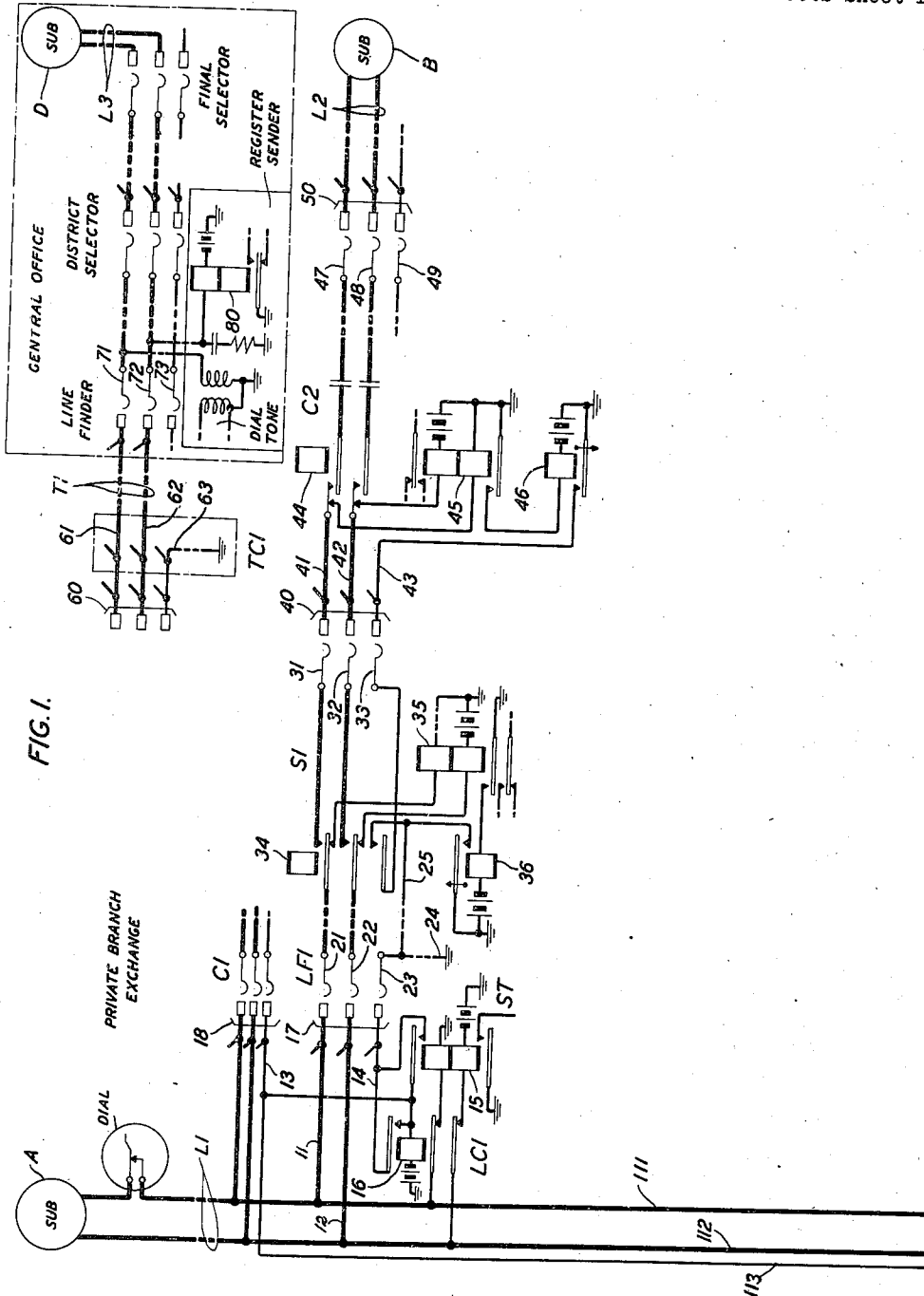


FIG. 1.

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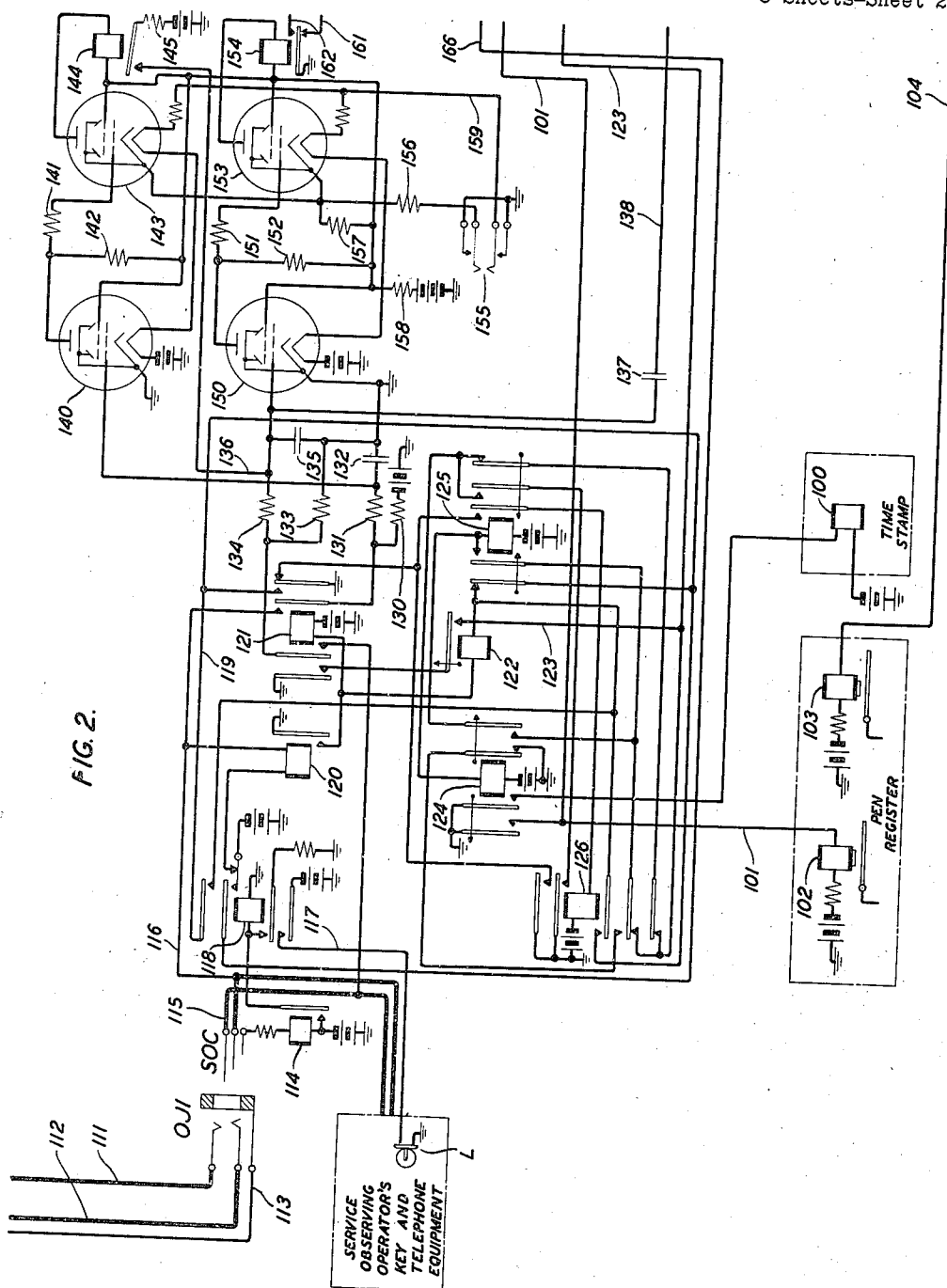
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3 Sheets-Sheet 2



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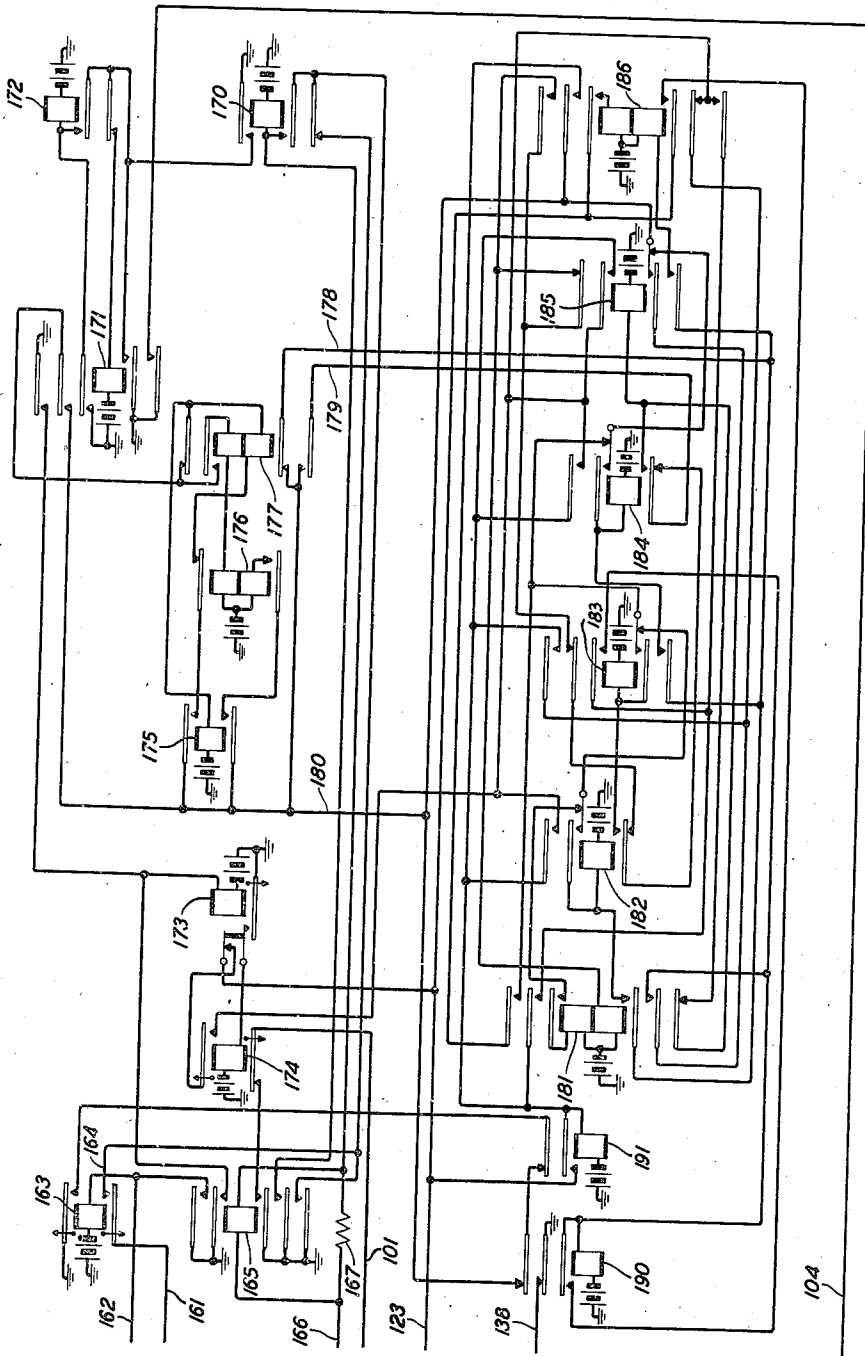
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3 Sheets-Sheet 3

FIG. 3.



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COMMUNICATION SYSTEM

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Application August 23, 1944, Serial No. 550,699

11 Claims. (Cl. 179-175.2)

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This invention relates to telephone systems and particularly to systems comprising dial impulse controlled automatic switches for completing connections between calling and called subscribers' stations.

Objects of this invention are the improvement of service observing equipment in automatic telephone systems, the provision of more reliable means for service observing and prevention of false operations of the number recorder.

This invention is a service observing circuit arrangement for an automatic telephone system; which arrangement, according to one feature of the invention, comprises means including impulse counting relays for varying the capability of the impulse receiving means according to the character of the selector or register to which the impulses are being transmitted.

Another feature of the invention is the provision of means for preventing false operation of the impulse recorder in a service observing equipment when, during establishment of a desired connection on a call initiated over the subscriber's line to which the service observing equipment is connected, the connection is extended from one switch to the next.

A better understanding of the invention will be facilitated by describing a telephone system in which the invention is embodied, one such system being shown in the drawing which forms a part of this specification. The invention is, however, not limited in its application to the specific system shown but is generally applicable to automatic telephone systems.

Referring to the drawing:

Fig. 1 represents a telephone system comprising a private branch exchange and a central office; and

Figs. 2 and 3 represent service observing equipment, in the private branch exchange, embodying applicant's invention.

The private branch exchange is represented in Fig. 1 by a subscriber's station A, line L1 and line circuit LC1, a line finder LF1 and connector C1 having access to the line L1, a first selector S1, another connector C2, a subscriber's station B connected by a line L2 to terminals in the bank of connector C2, and a trunk circuit TC1 individual to a trunk T1 extending to the central office. The central office is represented by a line finder, a district selector, a register sender, a final selector and a subscriber's line L3 and station D.

The subscribers' stations A, B and D are of the usual type provided in automatic telephone systems, a dial or other impulse sending device

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being provided at each station for controlling the switches through which connections are established. The line finder, selector and connector switches in the private branch exchange are of the well-known two-motion step-by-step type. Reference may be had to pages 53 to 65, inclusive, of the second edition of "Automatic Telephony," by Smith and Campbell, for a detailed description of the structure and operation of such switches when used as selectors and connectors. Reference may be had to the patent to R. L. Stokely No. 1,799,654, dated April 7, 1931, for a description of the operation of step-by-step line finders. The switches in the central office are of the panel type arranged for revertive control. Reference may be had to the patent to Stearn and Scudder No. 1,395,977, dated November 1, 1921, for a detailed description of the operation of a register sender and the operations of district and final selectors of the panel type. Each of the line finder, selector and connector switches is represented by a set of brushes and either one or two sets of terminals, only so much of the associated apparatus being shown as is required for a full and complete description of applicant's invention. The line finder LF1 is represented by brushes 21, 22 and 23 and a set of terminals 17 to which the line L1 is connected. The connector C1 is represented by a set of brushes and a terminal set 18, to which the line L1 is connected. The selector S1 is represented by brushes 31, 32 and 33 and two sets of terminals 40 and 60; the set of terminals 40 represents a level in the bank of selector S1 giving access to connectors, the terminal set 40 being connected to the connector C2; and the set of terminals 60 represents a level in the bank of selector S1 giving access to trunks to the central office, the terminal set 60 being connected to trunk circuit TC1. The connector C2 is represented by brushes 47, 48 and 49 and a set of terminals 50 to which the line L2 is connected.

The service observing equipment shown in Figs. 2 and 3 is connected by means of a service observing cord SOC and jack OJ1 with any subscriber's line on which it is desired to observe. The jack OJ1 is shown directly connected by conductors 111, 112 and 113 to the line circuit LC1 of the subscriber station A; but this connection may be made in the manner described in the patent to J. W. Gooderham, No. 1,504,230, dated August 12, 1924. The service observing equipment includes key and telephone equipment for a monitoring operator and time and pulse recording equipment comprising a pen register mech-

anism for recording the dial impulses created by the operation of the dial at the station which is under observation on calls initiated at this station, and an electrically controlled time stamp for recording the time at which a call is initiated and the time the call is terminated. The pen register mechanism comprises two electromagnets 102 and 103 the operation of each of which is effective to advance and mark the tape. The operation of electromagnet 102 at the beginning of each call provides a space between calls and makes sure that the time stamp will not register twice in the same place. The time stamp is represented by the operating electromagnet 100. The time and pulse recording equipment further comprises a sleeve relay 118, a line relay 120, auxiliary relays 121, 122, 124, 125 and 126, thermionic valves 140, 143, 150 and 153, impulse relays 144 and 154, auxiliary relays 163, 165, 170 to 177, inclusive, impulse counting relays 181 to 186, inclusive, and auxiliary relays 190 and 191. A key 155 is provided for controlling the filament and anode-cathode voltages of valves 140, 143, 150 and 153.

Assume now that the subscriber at station A initiates a call by removing the receiver from the receiver hook thereby closing a circuit for operating the line relay 15. The operation of relay 15 connects the winding of relay 16, through conductor 14, to the test terminal of the line L1 in the banks of a group of line finder switches including the switch LF1. The operation of relay 15 also connects ground to the start lead ST thereby effecting the starting of an idle line finder in the group having access to the line L1 in the manner set forth in the aforementioned patent to R. L. Stokely. Assuming the finder LF1 to be the one started in search of the calling line, ground is temporarily connected through conductor 24, to the test brush 23 of line finder LF1; and, when the brushes 21, 22 and 23 engage the terminal 17 connected to the line L1, a circuit is closed for operating the cut-off relay 16. The closure of this circuit is effective to stop the operation of the line finder with the brushes 21, 22 and 23 in engagement with the terminals 17 thereby completing a circuit for operating the line relay 35 of the first selector S1. The operation of relay 35 closes a circuit for operating the slow-to-release relay 36 whereby ground is connected to sleeve conductor 25 to hold the line finder operated and to hold the cut-off relay 16 after the ground temporarily connected to conductor 24 of the line finder is disconnected therefrom. The line relay 15 releases after the cut-off relay 16 operates thereby disconnecting ground from the start lead ST. When the calling subscriber dials the first digit of the number of the subscriber's station with which connection is desired, the line relay 35 is alternately released and reoperated thereby advancing the brushes 31, 32 and 33 to the corresponding level of the terminal bank. Selection of an idle set of terminals in the selected level and operation of the cut-through relay 34 are completed in usual and well-known manner, the connection from the calling line being thereby extended through brushes 21 and 22, through front contacts of relay 34 and brushes 31 and 32, to the trunk, intermediate selector or connector connected to the terminals engaged by the brushes.

If the call is a local call and there are no intermediate selectors, the calling line is extended through brushes 31, 32 and 33 to conductors 41, 42 and 43 of the connector C2. The line relay 45

of the connector is thereupon operated in series with the conductors of the calling line, thereby closing a circuit for operating the slow-to-release relay 46. Relay 46 connects ground through sleeve conductor 43, brush 33 of selector S1 and a front contact of relay 34 of selector S1 to the sleeve conductor 25 to hold the relay 34 operated and to hold the line finder and cut-off relay 16 all in usual manner. The aforementioned operation of relay 34 disconnects the line relay 35 thereby causing the successive release of relays 35 and 36. When the calling subscriber dials the last two digits of the called subscriber's number, the connector is operated under the control of the line relay 45 to select the terminals 50 connecting to the called line L2 and called subscriber's station B. When the called subscriber answers, relay 44 is operated in usual manner to reverse the connection between the windings of line relay 45 and conductors 41 and 42 thereby to effect any desired supervisory or charging operation as is well known in the art. When the connection is released at the called station, relay 44 releases to restore the normal connection between the windings of line relay 45 and conductors 41 and 42. When the calling subscriber releases, relays 45 and 46 release in succession and the connector C2 is restored to normal in usual manner. The release of relay 46 disconnects ground from conductor 43 thereby causing the release of selector S1, the release of line finder LF1 and the release of the cut-off relay 16.

If the call is one completed through the central office the digit dialed by the calling subscriber effects the operation of the selector S1 to select a level in which the terminals are connected to trunks to the central office, one such trunk T1 being shown connected through trunk circuit TC1 to the set of terminals 60. The trunk circuit TC1 may be similar to the trunk circuit T-2 disclosed in the patent to H. Hovland No. 2,247,055, dated June 24, 1941. Upon selection of the trunk circuit TC1, ground is connected to the sleeve conductor 63 to hold selector S1 and line finder LF1 and a calling condition is established over trunk T1 whereby a line finder in the central office is operated to connect with the trunk T1 thereby to effect the extension of the connection from the calling subscriber's line in the private branch exchange to a district selector and to an idle register sender in the central office. The impulse relay 80 in the register sender is operatively responsive to the impulses created by the dialing of the succeeding digits of the called subscriber's number, and these digits are thereby registered in the register sender. The district selector and succeeding selectors including a final selector are operated under control of the sender to extend the connection to a called subscriber's line L3 and station D.

Assume now that key 155 is operated to prepare the time and impulse recorder for operation and that there is no call in progress over the connected subscriber's line. The operation of key 155 connects ground to conductor 159 to energize the filaments of valves 140, 143, 150 and 153 and completes a circuit through potentiometer resistors 156, 157 and 158 to supply the desired anode-cathode and control grid voltages. Since the cathode of valve 140 is connected to ground and the control grid of valve 140 is connected through resistors 131 and 130 to negative battery, the control grid is negative with respect to the cathode and there is no current in the anode-cathode circuit of valve 140 and there-

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fore no voltage drop through resistor 142. With no voltage drop through resistor 142, the control grid of valve 143 is positive with respect to the cathode due to the voltage drop through resistor 157; and therefore the winding of relay 144 is operatively energized by the current in the anode-cathode circuit of valve 143. With relay 144 operated, conductor 136 is disconnected from negative battery through resistor 145. Since both the control grid of valve 150 and the cathode are at ground potential, there is current in the anode-cathode circuit of valve 150; and the voltage drop through resistor 152 in the anode-cathode circuit of valve 150 is sufficient to make the control grid of valve 153 negative with respect to the cathode, so that there is no current in the anode-cathode circuit of valve 153.

The winding of relay 120 is normally connected between battery at the upper back contact of relay 118 and the ring conductor of the plug of service observing cord SOC; so that, when this plug is inserted in jack OJ1 the winding of line relay 120 is connected to the ring conductor 12 of line L1 in parallel with the lower winding of the line relay 15 of line circuit LC1. When the subscriber at station A removes the receiver to initiate a call, relays 15 and 120 are both operatively energized. Relay 120 closes a circuit for operating relay 121. The operation of relay 121 connects the ring conductor 116 of cord SOC to battery through resistor 130 in parallel with the winding of relay 120; and the control grid of valve 140 continues to be negative with respect to the cathode. The operation of relay 121 connects the control grid of valve 150 to the tip conductor 11 of line L1, this connection being traced through resistor 134, inner left front contact of relay 121, tip conductor 115 of cord SOC, tip conductor of jack OJ1 and conductor 111. The control grid of valve 150 is thus rendered negative with respect to the cathode, the difference in potential being equal to the voltage drop in the upper winding of relay 15. The current in the anode-cathode circuit of valve 150 is thereby ended and the control grid of valve 153 becomes positive with respect to the cathode; whereupon relay 154 is operatively energized by current in the anode-cathode circuit of valve 153. Relay 154 closes a circuit for operating relay 163, relay 163 being a slow-to-release relay which remains operated during the response of relay 154 to dial impulses as hereinafter described.

When the line finder LF1 connects to the line L1, the connection of ground to conductor 14 effects the operation of cut-off relay 16 and the operation of sleeve relay 114 of the service observing cord. Relay 16 causes the release of line relay 15 and also causes the release of relay 120 in case the operation of relay 16 occurs before the line is connected through the line finder to the line relay 35 of the selector S1. The operation of relay 16 also extends the ground from conductor 14, through conductor 113, to maintain the operation of sleeve relay 114 after the line relay 15 releases. Relay 114 closes a circuit for operating relay 118; and relay 118 connects battery to conductor 117 to light the lamp L at the service observing operator's position to indicate that a call is in progress over the line which is connected to the service observing cord SOC. If relay 120 releases prior to the operation of relay 118, relay 121 is held operated and relay 122 is operated by current in a circuit traced from battery through the windings of relay 121 and 122 in series, a back contact of relay 125 and

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the outer right front contact of relay 121. The operation of relay 118 disconnects battery from the winding of relay 120 to cause the release of relay 120 if not previously released as hereinbefore described. The operation of relay 118 connects battery to conductor 166 and closes another circuit for operatively energizing the windings of relays 121 and 122, this circuit being traced from ground at the outer right front contact of relay 121, through conductor 119, and a front contact of relay 118. The operation of relay 122 closes a circuit through the outer left front contact of relay 121, front contact of relay 122, outer lower back contact of relay 126, outer right back contact of relay 125, and the winding of relay 124. Relay 124 operates, closing a circuit for operating the time stamp electromagnet 100 and closing a circuit for operating the pen register electromagnet 102. The operation of relay 124 also closes a circuit for operating relay 125, this circuit being traced from battery through the winding of relay 125, right front contact of relay 124, inner lower back contact of relay 126, front contact of relay 122 and outer left front contact of relay 121. Relay 125 locks to the same ground independent of relay 124 and causes the release of relay 124. The release of relay 124 opens the circuits for operating the time stamp electromagnet 100 and the pen register electromagnet 102.

When the line conductors 11 and 12 are connected through brushes 21 and 22 of line finder LF2, to the windings of line relay 35 of selector S1, the control grid of valve 150 continues to be negative with respect to its cathode due to the voltage drop through the upper winding of relay 35; and the control grid of valve 140 continues to be negative with respect to its cathode due to the voltage drop in the upper winding of relay 35 and the voltage drop in the station loop. When the calling subscriber dials the first digit of the called number, the line relay 35 is alternately released and reoperated to selectively control the operation of the selector. The control grid of tube 140 remains negative during dialing; but each time the dial opens the operating circuit of relay 35, the potential of the control grid of tube 150 is changed to ground potential since there is no longer any voltage drop in the upper winding of relay 35. Each time the control grid is at ground potential, the current in the anode-cathode circuit of tube 150 causes a voltage drop through resistor 152 which makes the control grid of tube 153 sufficiently negative with respect to its cathode to stop the current in the anode-cathode circuit and thereby cause the release of relay 154. Each time the dial recloses the circuit for operating relay 35, the control grid of tube 150 is rendered negative with respect to its cathode, the potential of the control grid of tube 153 is again rendered positive with respect to its cathode, and relay 154 reoperates. The release of relay 154 closes a circuit for operating relay 165, this circuit being traced from battery through the inner upper front contact of relay 118, conductor 166, winding of relay 165, lower back contact of relay 170, lower front contact of relay 163, and conductor 161 to ground at the back contact of relay 154. Relay 165 locks under control of relay 170, closes a circuit for operating relay 173, closes a circuit for operating the pen register electromagnet 102, closes a circuit for maintaining the operation of relay 163, and closes a circuit for operating relay 170. Relay 173 closes a circuit for operating relay 174; and the operation of relay 174 releases pen register elec-

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tromagnet 102. Relay 170 locks to ground at the outer lower front contact of relay 165 and also through the lower front contact of relay 163 and back contact of relay 154. The operation of relay 170 causes the release of relay 165 and causes the operation of relay 171 in a circuit which includes the back contact of relay 172. Relay 171 locks under control of relay 172, closes a circuit for operating relay 172, closes a circuit for holding relay 173 operated, closes a circuit through conductor 184 for operating the pen register electromagnet 103, and closes a circuit from ground through a front contact of relay 163, back contacts of relays 190 and 191, conductor 180, middle upper front contact of relay 171, and upper back contact of relay 177 for operating relay 175. The release of relay 165 opens the operating circuit of relay 173 and opens the holding circuit of relay 163. Relay 172 locks under the separate control of each of relays 171 and 170; and the operation of relay 172 causes the release of relay 171. The release of relay 171 opens the holding circuit for relay 173, releases the pen register electromagnet 103, and renders effective a circuit for holding relay 175 operated and for operating relay 177. The last-mentioned circuit is traced from battery through the winding of relay 175, lower winding of relay 177, back contact of relay 176, upper front contact of relay 175, conductor 180, back contacts of relays 190 and 191, to ground at the upper front contact of relay 163. The operation of relay 177 connects grounded conductor 189 to conductor 179 to effect operation of the counting relay 181. Relay 181 locks through its upper winding, back contacts of relays 182, 183, 184 and 185, conductor 180, back contacts of relays 190 and 191, to ground at the upper front contact of relay 163. When relay 154 reoperates at the end of the first dial impulse, relay 170 releases; and the release of relay 170 causes the release of relay 172. The release of relay 154, responsive to a second dial impulse in the train corresponding to the first digit dialed, causes relays 165, 170, 171 and 172 to function in similar manner to that above described. The operation of relay 171 responsive to a second dial impulse closes a circuit from battery through the upper winding of relay 176, upper winding and front contact of relay 177, middle upper front contact of relay 171, conductor 180, back contacts of relays 190 and 191 to ground at the upper front contact of relay 163. Relay 176 opens the circuit through the winding of relay 175 and lower winding of relay 177, and locks through its lower winding until relay 175 releases. When relay 171 again releases responsive to the reoperation of relay 154 at the end of the second dial impulse, relays 176 and 177 release thereby connecting conductor 189 to conductor 178 to operate counting relay 182. Thus relays 175, 176 and 177 are operated under the control of relay 171 to connect ground to conductor 179 responsive to each odd numbered dial impulse in a train and to connect ground to conductor 178 responsive to each even numbered dial impulse in a train. The counting relays are thereby operated in succession to indicate the digit dialed. The operation of each of relays 182, 183, 184 and 185 effects the release of the preceding counting relay and prepares an operating circuit for the succeeding counting relay. Relay 186 operates responsive to a sixth impulse but does not cause the release of relay 185. Relay 186 locks over conductor 123 under the control of relays 122 and 121 and prepares for the reoperation of relay 181. A seventh im-

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pulse reoperates relay 181 and causes the release of relay 185. Relays 182, 183 and 184 are successively reoperated by eighth, ninth and tenth impulses, respectively. Each operation of relay 171 closes the circuit for operating the pen register electromagnet 103 so as to mark the pen register tape for each impulse. The electromagnet 102 is operated at the beginning of each digit slightly in advance of the operation of electromagnet 103 so as to insure a full length mark for the first impulse and to separate the markings for each train of dial impulses. If the tape is not already in motion when the electromagnet 103 is operated responsive to the first dial impulse, the impulse mark may be too short for positive identification due to the inertia of the pen register mechanism. Relays 171 and 172 provide a timed closure for pen register electromagnet 103. Being slow to release, relays 173 and 174 remain operated under control of relays 165 and 171 during response to each train of dial impulses. If the dial impulses are short so that relay 154 reoperates as soon as relay 165 operates, relay 170 is not locked under control of relay 154; and relay 170 releases as soon as relay 165 releases. In order to hold relay 170 operated long enough to effect the operation of relay 171, relay 165 is rendered slightly slow to release by connecting the non-inductive resistor 167 in parallel with the winding of relay 165.

When relay 34 of the selector S1 operates to transfer the line L1 from the windings of relay 35 to the line relay of the next switch of the train, battery through the lower winding of relay 35 may be disconnected from the ring conductor of line L1 before ground through the upper winding of relay 35 is disconnected from the tip conductor of the line; and the control grid of valve 150 will be connected to ground through the upper winding of relay 35 while the negative battery through the lower winding is disconnected. Current in the anode-cathode circuit of valve 150 then effects a voltage drop through resistor 152 which renders the control grid of tube 153 negative with respect to the cathode of tube 153, and relay 154 may start to release; but valves 140 and 143 operate to prevent an impulse registration. Since at the time relay 34 is operating, the control grid of valve 140 is connected through the station loop and the upper winding of relay 35 to ground, the grid is rendered positive with respect to its cathode; and the current in the anode-cathode circuit of valve 140 effects a voltage drop through resistor 142 which renders the control grid of valve 143 positive with respect to its cathode, causing the release of relay 144. Since the capacity of condenser 132 is less than that of condenser 135, valves 140 and 143 respond to the operation of relay 34 slightly in advance of the response of valves 150 and 153. Consequently the release of relay 144 connects negative battery through resistor 145, the back contact of relay 144, and conductor 136 to the control grid of valve 150 to block valve 150; and before relay 165 can operate, relay 154 is reoperated by current in the anode-cathode circuit of valve 153. Thus the momentary release of relay 144 prevents the registration of an impulse when the connection is switched from one selector to the next.

The control grid of valve 150 is normally connected to ground through condensers 135 and 137 in parallel, the capacitance thus connected between the control grid of valve 150 and ground being such as to enable satisfactory operation of valve 150 responsive to dial impulses transmitted

to the line relays of step-by-step selectors or connectors; but when the call is one completed over a trunk to the central office and the dial impulses are being transmitted to the line relay 80 of the connected register sender; and the characteristics of this line relay are such as to require a smaller capacitance to enable satisfactory operation of valve 150 than is required when the dial impulses are being transmitted to the line relay of a step-by-step selector or connector. The counting relays are provided to count the impulses created by the dialing of the first digit; and, if the central office code digit "9" is dialed to operate selector S1 to select the level giving access to trunks to the central office, counting relays 183 and 186 will also be operated responsive to the dial impulses. When relay 173 releases, at the end of the train, a circuit is closed for operating relay 190 before relay 174 releases; this circuit is traced from the winding of relay 190, inner upper front contact of relay 183, outer lower front contact of relay 186, front contact of relay 174, back contact of relay 173, conductor 123, front contact of relay 122, and front contact of relay 121 to ground. The release of relay 174 opens this circuit but relay 190 locks under control of relay 186 to the same ground. The operation of relay 190 disconnects ground from conductor 180 to release the counting relays which are operated, and disconnects ground from conductor 138 so that condenser 135 alone connects the control grid of valve 150 to ground. Valve 150 will then respond satisfactorily when the succeeding trains of dial impulses are transmitted to the impulse relay 80 of the register sender in the central office. Relays 186 and 190 remain operated so that the counting relays are not operated responsive to the succeeding trains of impulses.

If the first digit dialed is any other than the digits 1 or 9, the release of relay 173 at the end of the last impulse of the train closes a circuit for operating relay 191. When relay 174 releases, the circuit for operating relay 191 is opened; but relay 191 is locked through conductor 123 until the calling subscriber releases the connection. The operation of relay 191 prevents the operation of the counting relays responsive to the succeeding digits dialed at the subscriber's station. If a preliminary impulse is created prior to connection of the line L1 to a first selector, relay 154 releases and reoperates; but relay 165 is not operated because battery is not connected to the winding of relay 165 until relay 118 has operated. If the first digit dialed is the digit 1, or a preliminary impulse is created after the operation of relay 118, relay 165 will operate and the counting relay 181 will be operated. When relay 173 releases at the end of this impulse, relay 190 is operated thereby causing the release of relays 175, 177 and 181. The release of relay 181 causes the release of relay 190 since the locking path of relay 190 includes a front contact of relay 186. The counting relays are now ready to respond to the impulses created by the dialing of a first digit other than the digit "1."

When the call initiated at station A is ended by restoring the telephone to normal, the switches are restored to normal and the disconnection of ground from conductor 14 causes the successive release of relays 114 and 118. The release of relay 118 extinguishes the lamp L at the service observing position, and causes the release of relays 121 and 122. The release of relay 121 closes a circuit for operating relay 126, disconnects the control grids of valves 140 and

150 from the conductors of line L1, causes the release of any of relays 186, 190 and 191 which may be operated, and opens the locking circuit of relay 125. The operation of relay 126 closes another locking circuit for relay 125 and closes a circuit for operating relay 124. Relay 124 operates the time stamp magnet 100, operates pen register magnet 102 and causes the release of relay 125. The release of relay 125 causes the release of relays 124 and 126. The release of relay 124 releases electromagnets 100 and 102; and the release of relay 126 prepares the time and impulse recorder for the next call. If relay 121 is reoperated by the initiation of a new call before relays 124 and 125 have completed their operations, relay 126 is held operated under control of relay 125 so that the time stamp is operated only once. In this case, relay 126 closes a temporary circuit through its inner lower front contact for holding relays 121 and 122 operated until relay 118 is operated.

If the line L1 is seized by a connector C1 on an incoming call, the ground connected through the sleeve brush to conductor 13 to effect the operation of cut-off relay 16 also causes the successive operation of relays 114 and 118. Relay 118 lights lamp L at the observing operator's position and opens the circuit for operating relay 120 before relay 120 can be operated. When such a connection is released, the disconnection of ground from conductor 13 causes the successive release of relays 114 and 118 to extinguish the lamp L.

It is of course obvious that the central office code may be a digit other than "9" and that the central office code may consist of more than one digit. In any case, the arrangement would be such as to effect the change in grid capacity at the end of the central office code.

What is claimed is:

1. In a service observing equipment connected to a subscriber's line and comprising impulse responsive means and means for recording dial impulses transmitted over said line, means for counting the impulses of a train of impulses transmitted over said line, means for preventing the response of said impulse counting means to succeeding trains of impulses, and means rendered effective by said counting means in the event said train of impulses consists of a particular number of impulses to vary the capability of the impulse responsive means.

2. In an impulse controlled switching system, a line, means for transmitting trains of current impulses over said line, switching means selectively controlled by said trains of impulses, impulse responsive means connected to said line, means controlled by said impulse responsive means for counting the impulses of a train transmitted over said line to said switching means, means effective only if said train consists of a particular number of impulses to vary the capability of said impulse responsive means, and means for preventing the operation of said counting means responsive to trains of impulses following said train.

3. In a communication system comprising subscribers' stations and lines, impulse transmitting means at each station and impulse controlled switching means for establishing connections between lines, means connected to one of said lines for responding to trains of impulses transmitted over said one line to said switching means, means controlled by said impulse responsive means for counting the impulses in a train transmitted over said line, means for preventing the

counting of the impulses of trains following said train, and means effective only if said train consists of a particular number of impulses to change the capability of said impulse responsive means.

4. In a communication system comprising a subscriber's station and line, impulse transmitting means at said station, impulse responsive means of a first character, impulse responsive means of a second character, means including a selector connected to said line and responsive to impulses transmitted from said station over said line for extending the connection from said line to said impulse responsive means of said first character or to said impulse responsive means of said second character, other impulse responsive means connected to said line, and means controlled by said other impulse responsive means for changing the capability of said other impulse responsive means upon extension of the connection from said line to said impulse responsive means of a second character but not upon extension of the connection from said line to said impulse responsive means of a first character.

5. In a communication system comprising a subscriber's station and line, impulse transmitting means at said station, impulse responsive means of a first character, impulse responsive means of a second character, means including a selector connected to said line and responsive to a first train of impulses transmitted from said station over said line for extending the connection from said line to said impulse responsive means of said first character or to said impulse responsive means of said second character depending upon the number of impulses in said first train, other impulse responsive means connected to said line, and means including impulse counting means controlled by said other impulse responsive means for changing the capability of said other impulse responsive means upon extension of the connection from said line to said impulse responsive means of a second character but not upon extension of the connection from said line to said impulse responsive means of a first character.

6. In a communication system comprising a subscriber's station and line, impulse transmitting means at said station, a first impulse responsive means, a second impulse responsive means, a third impulse responsive means, a fourth impulse responsive means, said first and second impulse responsive means being of a first character, said third impulse responsive means being of a second character, means connecting said first impulse responsive means to said line, means including a selector controlled by said first impulse responsive means for extending the connection from said line to said second impulse responsive means or to said third impulse responsive means depending upon the number of impulses in a train transmitted from said station over said line, means connecting said fourth impulse responsive means to said line, and means including impulse counting means controlled by said fourth impulse responsive means for changing the capability of said fourth impulse responsive means upon extension of the connection from said line to said third impulse responsive means but not upon extension of the connection from said line to said second impulse responsive means.

7. In a switching system, a line, a station comprising impulse transmitting means connected to said line, a first selector, means connecting said first selector to said line, impulse responsive

means in said selector controlled over said line by the impulse transmitting means at said station, other selectors each having impulse responsive means similar to the impulse responsive means of said first selector, said other selectors connected to terminals in one or more levels of the bank of said first selector, a group of trunks connected to the terminals in another level of the bank of said selector, register senders each including impulse responsive means of a character different from the impulse responsive means of said first selector, means in said first selector controlled by the impulse responsive means therein for selecting an idle one of said other selectors or an idle one of said trunks depending upon the number of impulses in a train transmitted over said line from said station to said selector, means responsive to the selection of one of said trunks for extending the connection of said line over said one trunk to the impulse responsive means of an idle one of said register senders, other impulse responsive means connected to said line for response to all of the trains of impulses transmitted over said line, means controlled by said other impulse responsive means for changing the capability of said other impulse receiving means in the event said impulses effect the selection of one of said trunks by said first selector.

8. In a switching system, a line, a station comprising impulse transmitting means connected to said line, a first selector, means connecting said first selector to said line, impulse responsive means in said selector controlled over said line by the impulse transmitting means at said station, other selectors each having impulse responsive means similar to the impulse responsive means of said first selector, said other selectors connected to terminals in one or more levels of the bank of said first selector, a group of trunks connected to the terminals in another level of the bank of said selector, register senders each including impulse responsive means of a character different from the impulse responsive means of said first selector, means in said first selector controlled by the impulse responsive means therein for selecting an idle one of said other selectors or an idle one of said trunks depending upon the number of impulses in a train transmitted over said line from said station to said selectors, means responsive to the selection of one of said trunks for extending the connection of said line over said one trunk to the impulse responsive means of an idle one of said register senders, other impulse responsive means connected to said line for response to all of the trains of impulses transmitted over said line, means controlled by said other impulse responsive means for counting the impulses which effect the operation of said first selector to select one of said other selectors or to select one of said trunks, means controlled by said counting means for changing the capability of said other impulse receiving means in the event said impulses effect the selection of one of said trunks by said first selector, and means for preventing the counting of trains of impulses transmitted over said line following the train which selectively controls the operation of said first selector.

9. In combination in a signaling system, a line over which train of current impulses are transmitted, a thermionic valve, means connecting the control grid of said valve to a conductor of said line, means including a battery having its positive pole connected to ground for rendering

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said control grid negative with respect to the cathode of said valve when no impulse is being transmitted over said line and for rendering said control grid positive with respect to said cathode when an impulse is being transmitted over said line, means having a certain required capacitance connecting said control grid to ground, an impulse relay, means for effecting the operation of said relay when said control grid is negative and for effecting the release of said relay when said control grid is positive with respect to said cathode, counting means controlled by said relay, and means operated in the event a train of impulses transmitted over said line consists of a particular number of impulses for changing the capacitance of the connection between the control grid and ground.

10. In a combination according to claim 7, means effective to prevent the operation of said counting means in response to trains of impulses following a first train transmitted over said line.

11. In combination in a switching system, a line, a group selector, means connecting said selector to said line, a station comprising an impulse transmitter, second selectors connected to a group of terminals in the bank of said first selector, impulse receiving means in said first selector responsive to a first train of impulses transmitted over said line, means in said first selector for selecting an idle set of terminals in the group identified by said first train of impulses, impulse receiving means in the second selector connected to a selected set of terminals in the bank of said first selector, means in said first selector effective to transfer said line from connection with the impulse receiving means of said first selector to the impulse receiving means of the selected second selector, a first thermionic valve, means connecting the control grid of said valve to a first conductor of said line, means including a battery having its positive pole connected to ground for rendering said control grid negative with respect to the cathode of said valve when no impulse is being transmitted over said line and for rendering said control grid positive

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with respect to said cathode when an impulse is being transmitted over said line, an impulse relay, means for effecting the operation of said relay when said control grid is negative and for effecting the release of said relay when said control grid is positive with respect to the cathode, means controlled by said impulse relay for recording the impulses transmitted over said line, a second thermionic valve, means connecting the control grid of said second valve to a second conductor of said line, means including said battery rendering the control grid of said second valve negative with respect to its cathode while said line is connected to the impulse receiving means of said first selector and to the impulse receiving means of a selected one of said second selectors and for rendering the control grid of said second valve positive with respect to its cathode in the event said transfer means in the first selector disconnects said first conductor of the line from the impulse receiving means of said first selector before it disconnects said second conductor of the line from the impulse receiving means of said first selector, and means rendered effective when the control grid of said second valve becomes positive with respect to its cathode for rendering the control grid of said first valve negative with respect to its cathode so as to prevent release of said impulse relay for a long enough interval of time to effect the operation of said recording means when said transfer means in said first selector is operated, thereby to prevent a false operation of said recording means.

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