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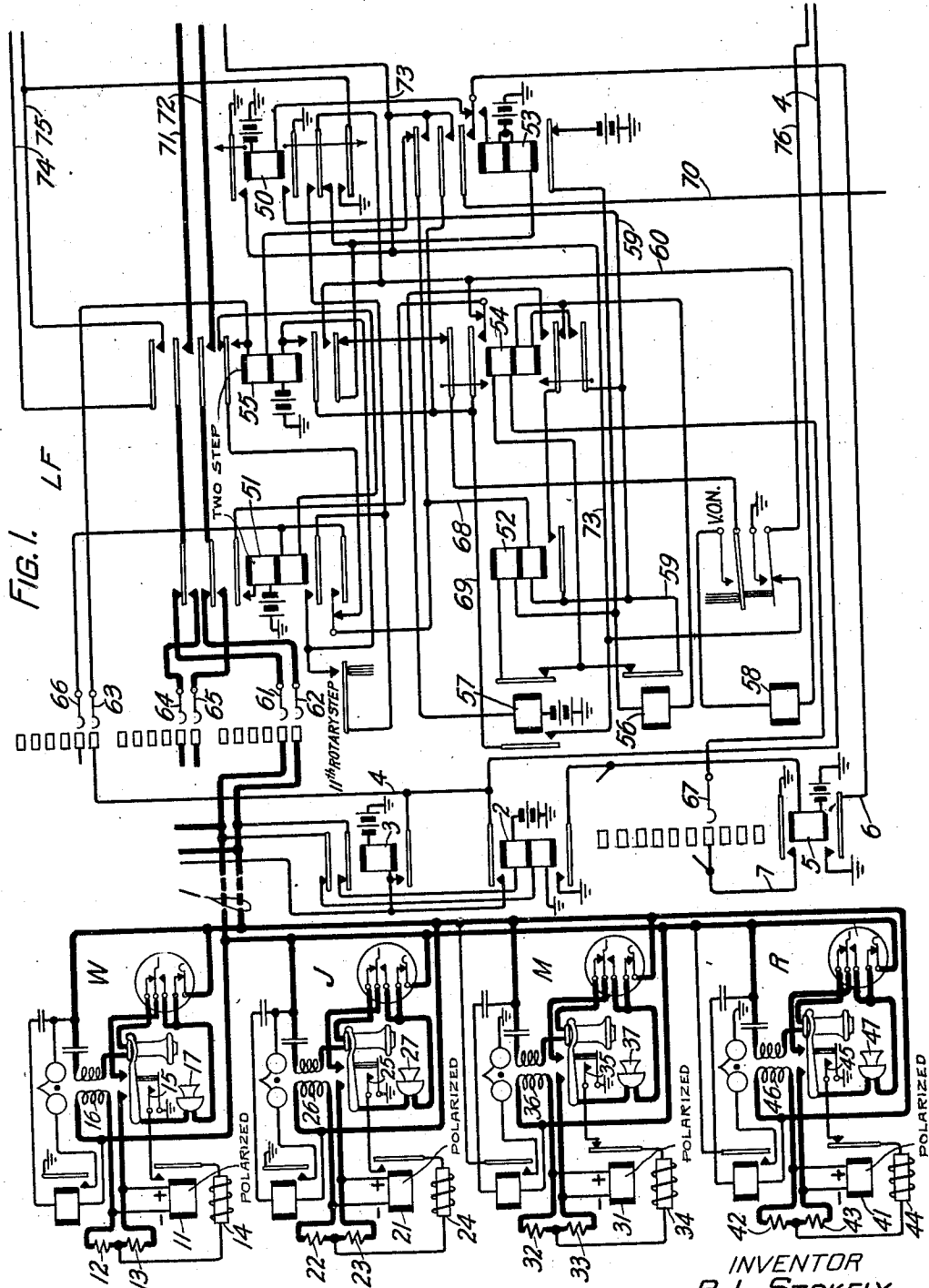
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1,799,654

TELEPHONE EXCHANGE SYSTEM

Filed June 28, 1929

4 Sheets-Sheet 1



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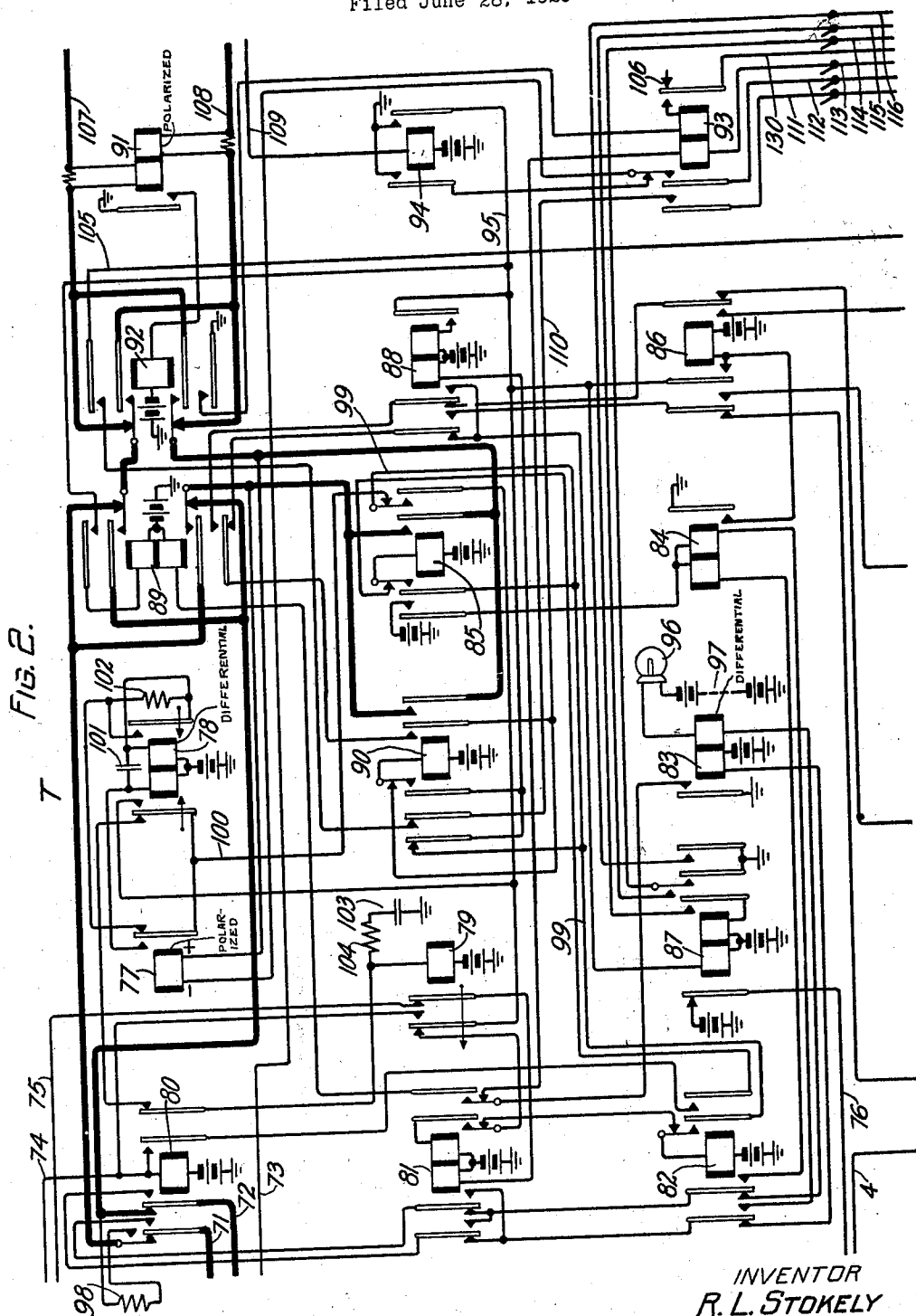
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4 Sheets-Sheet 2



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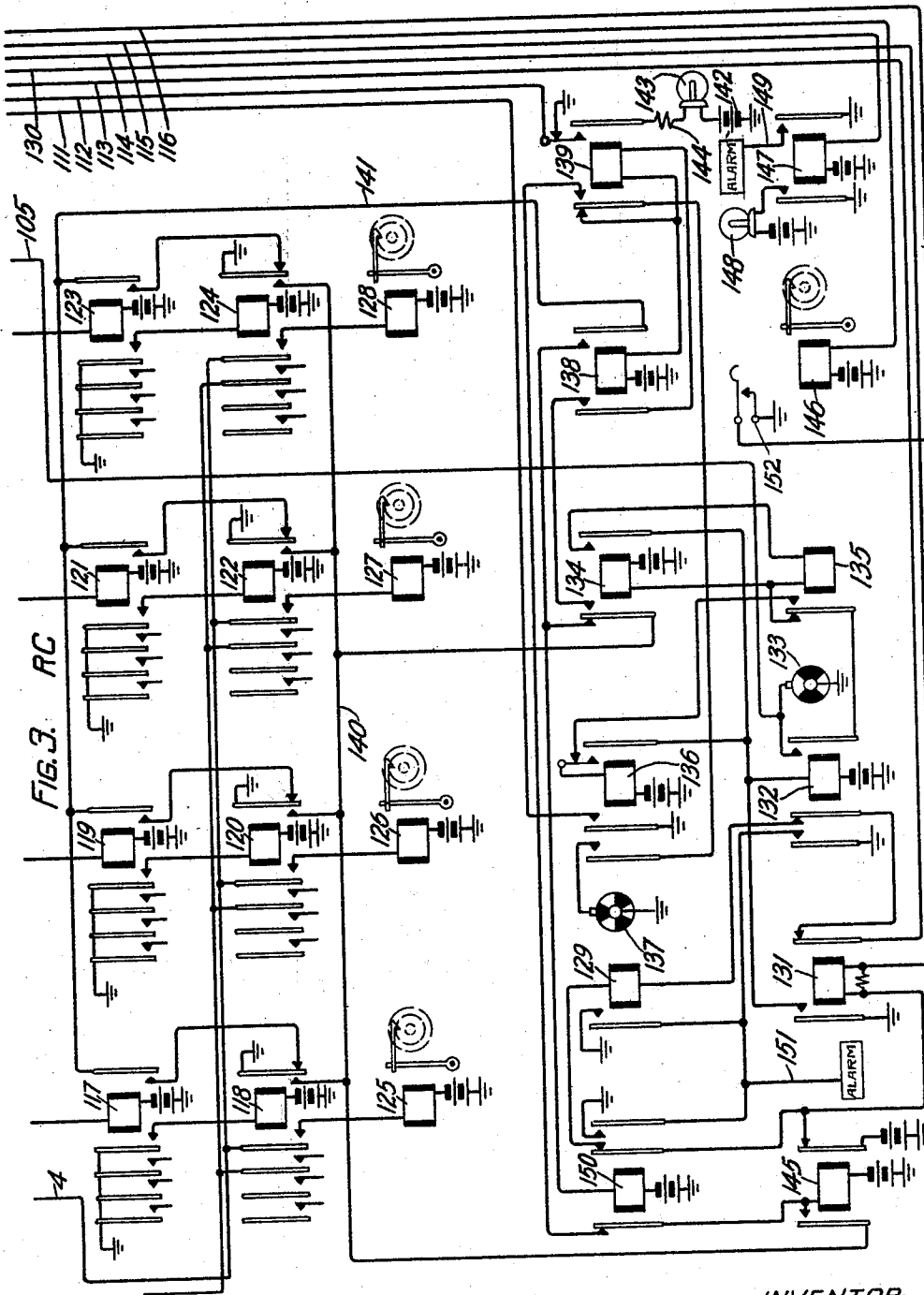
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4 Sheets-Sheet 3



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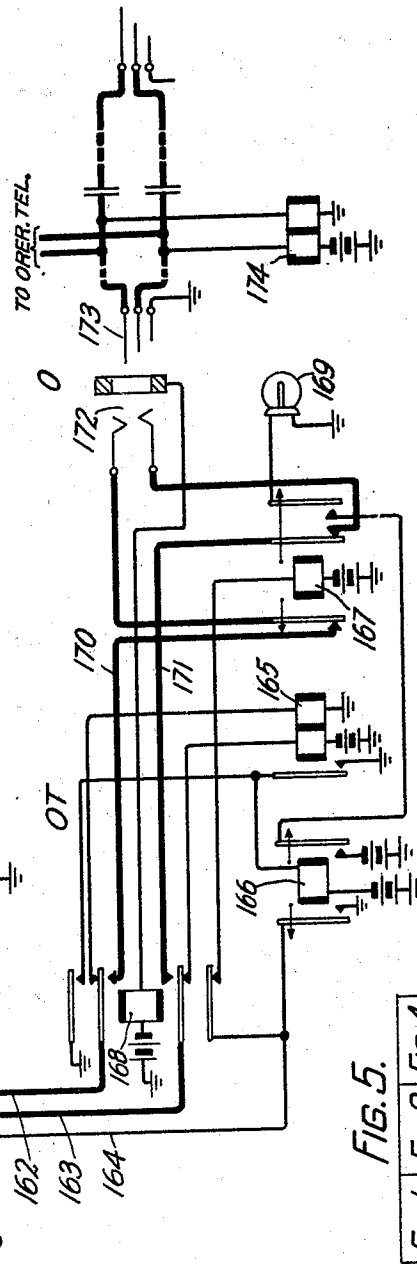
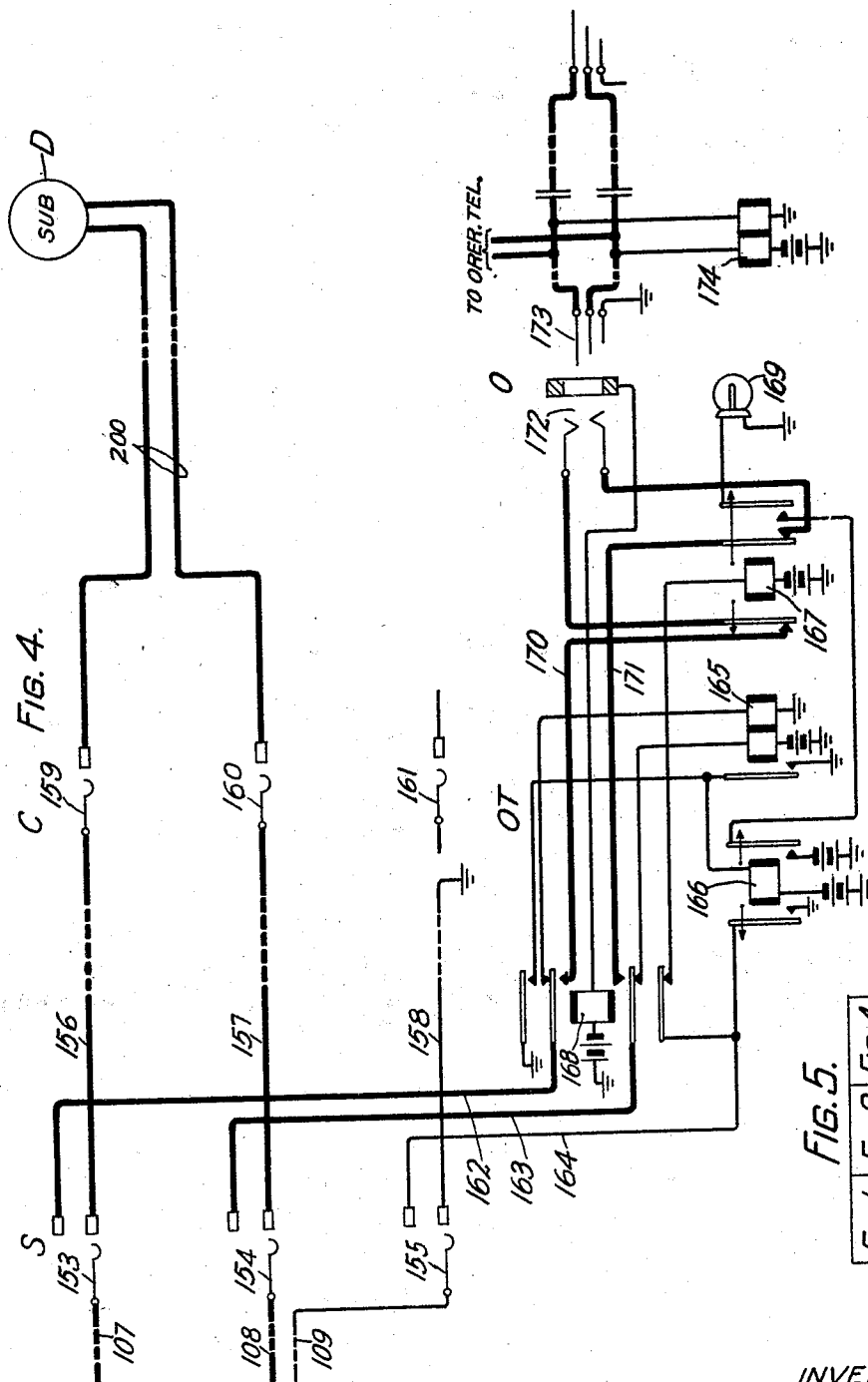
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4 Sheets-Sheet 4



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TELEPHONE-EXCHANGE SYSTEM

Application filed June 23, 1929. Serial No. 374,320.

This invention relates to telephone exchange systems and more particularly to measured service for party lines.

The object of this invention is to increase the reliability of the tests made to determine which of the stations on a party line has originated a call, to eliminate the possibility of charging the wrong subscriber, and to obviate the necessity of providing impulse repeating means in each of the trunks used in connecting calling lines to idle selectors.

According to this invention a polarized relay is located at each station of a party line to enable the identification of the calling station by testing means associated with the trunk used in extending the line to an idle selector. The testing means are connected to the line, before the calling subscriber begins dialing, to partially identify the calling station, are connected to the line a second time as soon as the first digit of the called number has been dialed by the calling subscriber to check the previous partial identification, and are again connected to the line as soon as the second digit of the called number has been dialed to complete the identification of the calling line.

According to this invention means are provided whereby the dialing of a second digit is simulated, in case the number of the called station is composed of only one digit, so that the calling station can be completely identified by the third test of the line.

According to another feature of this invention means are provided for reversing the direction of current flow over the calling subscriber's line, if the identifying ground connection is closed at the calling station, so as to free the line from this ground connection before dialing begins and thereby obviate the necessity of including pulse repeating means in the trunk used in extending the line to a selector circuit. In case the current flow over the calling line after the called subscriber or operator has answered, is in such a direction as to cause the identifying ground to be again connected to the line, the line is again reversed with respect to the talking battery supply so as to free the line

of the ground connection during conversation.

Another feature of the invention resides in the arrangement whereby the means for delaying the operation of the calling subscriber's message register, to make certain that the apparent answer of the called subscriber is not caused by other temporary conditions, is common to a group of trunks used in extending calling lines to idle selectors.

A system in which this invention is embodied is shown diagrammatically in the drawing which comprises five figures. Fig. 1 shows a line-finder circuit LF and four subscriber's stations, designated W, J, M and R, respectively, connected by a common line to terminals in the bank of the line-finder switch. Fig. 2 shows a trunk circuit T which is individual to the line-finder circuit LF. Fig. 3 shows a register control circuit RC which is common to a plurality of trunks, such as T. Fig. 4 shows a selector circuit S, a connector circuit C, a subscriber's station D, a trunk circuit OT, and a cord circuit at an operator's position O. The line-finder, selector and connector switches are of the well-known Strowger type, but the invention may be applied to systems using other types of switches. Fig. 5 shows how Figs. 1 to 4, inclusive, should be arranged.

Each of the substations W, J, M and R are arranged to close an identifying ground connection, when a call is originated thereat, as controlled by a polarized relay which is in series with the line. A retard coil is included in the identifying ground connection so as to minimize the effect of this ground during conversation in case the called station is on the same line as the calling station, the retard coil being connected between two resistances which are bridged in series across the winding of the polarized relay. Each station is also equipped with a dial for controlling the operation of the switches used in extending a connection to the called station. The polarized relays 21 and 31, at stations J and M, are so connected as to operate in series with the windings of the line relay 2 when the receiver is removed from the re-

ceiver hook to originate a call. The polarized relays 11 and 41, at stations W and R are so connected as to remain normal when connected in series with the windings of relay 2 and to operate when the current over the line is reversed. At stations W and J the operation of the polarized relay closes the identifying ground connection while at stations M and R the identifying ground connection is normally closed and the operation of these relays opens this connection.

The line-finder switch is equipped with two banks and two sets of brushes similar to the switch disclosed in United States Patent 1,567,240 issued to Carpenter on December 29, 1925, but the associated circuit is somewhat different from that shown in the patent to Carpenter. Upon the origination of a call at any one of stations W, J, M and R of line 1, the line-finder LF (or, if this line-finder is busy, some other line-finder to whose terminal bank the line 1 is multiplied) is effective to advance one of its sets of brushes into contact with the terminals to which this line is connected. The calling line is thereupon extended to the trunk circuit T this trunk circuit serving to connect the line-finder with its associated selector circuit S.

The trunk circuit T is arranged to make three tests of the calling line. The first of these tests takes place as soon as the calling line is extended through the line-finder to the trunk T, the two windings of test relay 83 being connected to the tip and ring conductors, respectively, of the calling line. One of the windings of relay 83 is connected to the negative pole of the 48 volt central office battery, while the other is connected to the negative pole of the special 110 volt test battery. The windings of this relay oppose each other when a metallic line loop is connected thereto so as to prevent its operation; but when a grounded line loop is connected across its windings, the relay operates. The current over the line during the first test maintains the polarized relay at the calling station in the same condition, normal or operated, as when the windings of line relay 2 were connected to the line. Thus if the call originated at station W polarized relay 11 is normal, the line is not connected to ground, and test relay 83 does not operate; if the call originated at station J polarized relay 21 is operated, the line is connected to ground, and test relay 83 operates; if the call originated at station M polarized relay 31 is operated, the line is not connected to ground, and test relay 83 does not operate; and if the call originated at station R polarized relay 41 is not operated, the line is connected to ground, and test relay 83 operates. If test relay 83 operates on the first test it closes a circuit for operating the auxiliary relay 89. If operated, the auxiliary relay 89 reverses the line conductors with respect to line relay of the

selector S so that the polarized relay at the calling station (either J or R) will release or operate to open the identifying ground connection and thereby render the dialing circuit more effective in controlling the selector S.

After the first digit has been dialed the windings of relay 83 are again connected to the conductors of the calling line for a second test; but the winding formerly connected to the tip conductor is now connected to the ring conductor and the winding formerly connected to the ring conductor is now connected to the tip conductor. Thus if the call originated at station W polarized relay 11 is operated, the line is connected to ground, and test relay 83 operates; if the call originated at station J polarized relay 21 is not operated, the line is not connected to ground, and test relay 83 does not operate; if the call originated at station M polarized relay 31 is not operated, the line is connected to ground, and test relay 83 operates; and if the call originated at station R polarized relay 41 is operated, the line is not connected to ground, and test relay 83 does not operate. If test relay 83 operates during the second test it closes a circuit for operating a second auxiliary relay. The second test is, therefore, effective to check the results of the first test and the operation of test relay 83 on both the first and second tests of the line indicates that some ground other than the proper identifying ground is connected to the line and is preventing the identification of the calling station.

After the second digit of the called number has been dialed, or, if the called number consists of only one digit as is often the case on calls to an operator, after the dialing of a second digit has been simulated, a third test is made by connecting the windings of test relay 84 to the tip and ring conductors respectively of the calling line. Since the windings of relay 84 are connected to battery in parallel, there is no current through the winding of the polarized relay at the calling station; and relay 84 is operated only if the call originated at station M or at station R, at either of which the line is connected to ground when the polarized relay is normal. If test relay 84 operates it closes a circuit for operating a third auxiliary relay. The third test is, therefore, effective in combination with the first test to completely identify the calling station; and the operation or non-operation of the above mentioned auxiliary relays selects, and partially closes a circuit for operating that one of the four register control relays 117, 119, 121 and 123 which corresponds to the calling station.

The selector switch S is represented by brushes 153, 154 and 155 and by the terminals with which these brushes are shown to be in contact. The connector switch C is represented by brushes 159, 160 and 161 and

by the terminals with which they are shown to be in contact. Those portions of the selector and connector circuits which have been omitted are represented by the broken lines leading to their brushes. For a detailed description of the operation of these switches reference may be had to pages 57 to 65 inclusive of the second edition of "Automatic Telephony" by Smith and Campbell.

The trunk circuit OT which leads to the operator's position at O is connected to terminals in the bank of the selector S so that a calling line may be extended thereto by the dialing of only one digit. The trunk is arranged to temporarily open the connection from the calling line when the operator inserts the plug of the answering cord in the jack at which this trunk terminates. This temporary opening of the circuit which includes the calling line simulates the dialing of a second digit and renders the trunk circuit T effective to make the aforementioned third test of the calling line and thereby complete the identification of the calling station.

The register control circuit is arranged to control the operation of the message registers of the stations of all of the lines to which this control circuit is common—that is, of all of the lines which terminate in the banks of the line-finders associated with the trunks to which the control circuit RC is common. Conductor 130 leads from the winding of relay 131 of the control circuit to relay 93 of trunk T, thence over conductor 106 to the corresponding relay of the next trunk and so on to each of the trunks with which the control circuit is operated. The control relays 117, 119, 121 and 123 each controls one or more auxiliary relays of the multi-contact type; and the auxiliary relay or relays, associated with each of the control relays, in turn control the message registers of all of the stations of like designation. Thus control relay 117 and the auxiliary relay 118 control the message registers of the W stations, control relay 119 and auxiliary relay 120 control the message registers of the J stations, control relay 121 and auxiliary relay 122 control the message registers of the M stations, and control relay 123 and auxiliary relay 124 control the message registers of the R stations.

When a connection (for which the calling subscriber should be charged) is established, the usual reversal of the current over the calling subscriber's line is effective to operate the polarized supervisory relay 91 in the trunk T. With relay 91 and its auxiliary relay 92 operated, the register control circuit RC (if not in use with some of the trunks to which it is common) is effective to delay the operation of the message register of the calling station for an interval of from two to four seconds. This delay is introduced to prevent the operation of the calling subscriber's message register in case relay 91

is momentarily operated. The interrupter 133 and the counting relays 134 and 135 measure this interval and upon its expiration the previously selected control relays are operated to connect the windings of the register of the calling station to the booster-battery 142. These operations are best explained by a detailed description of the operation of the circuits shown in the drawing.

Assume that a call is originated at one of stations W, J, M and R, that station D is the called station and that the call is one for which the calling station should be charged. When the receiver is removed from the receiver hook at the calling station, line relay 2 operates in an obvious circuit over line 1. The current over the line is in such a direction that polarized relay 21 operates if the call originated at station J or polarized relay 31 operates if the call originated at station M; but if the call originated at either of stations W or R the current over the line is ineffective to operate either of relays 11 or 41, respectively. In operating, relay 2 connects the winding of the cut-off relay 3 over sleeve conductor 4 to the sleeve terminal of the line 1 in the line-finder banks to which line 1 is multiplied. Relay 2 closes a circuit for operating group relay 5, which is common to all of the lines in the group with line 1. In operating, relay 5 connects ground to starting conductor 6 and also connects ground over conductor 7 to the commutator segment, of all of the line-finders having access to line 1, which corresponds to the level in which the terminals of line 1 are located. Conductor 7 is shown connected to the fourth commutator segment of the line-finder LF, and line 1 is, therefore, assumed to be connected to terminals in the fourth level of the bank of this line-finder.

Assuming that the line-finder LF is idle, starting relay 50 of the line-finder LF operates in the circuit from battery through its winding, inner upper back contact of relay 53, over conductor 6, to ground at relay 5. In operating, relay 50 connects ground to the sleeve conductor 73 of the trunk T and closes a circuit from ground at its outer lower front contact, over conductor 75 of trunk T, through the inner back contact of relay 79 to the left-hand winding of test control relay 81. Relay 81 operates thereby preparing the trunk circuit for the first identification test of the calling line. Relay 50 also closes a circuit from ground through its inner lower front contact, over conductor 59, back contact of the vertical stepping magnet 56, back contact of the rotary stepping magnet 57, upper winding of stepping relay 52, and through the outer lower back contact of relay 53, to battery. The stepping relay 52 operates thereby closing a circuit from the ground at relay 50 over conductor 59, through the front contact of relay 52,

inner lower back contact of relay 54, winding of the vertical stepping magnet 56, and through the lower back contact of relay 53, to battery. The vertical magnet 56 operates thereby stepping the shaft and brushes 61 to 66 inclusive up to the level of the first group of line terminals. The vertical off-normal springs VON are actuated as soon as the shaft is moved out of its normal position, ground being thereby connected through the lower front contact of these springs to conductor 60. In operating, magnet 56 opens the circuit through the winding of stepping relay 52. The commutator brush 67 is now in contact with the segment of the commutator which corresponds to the group of lines which are connected to terminals in the first level of the multiple bank. Brush 67 is connected through the upper winding of relay 54, back contact of rotary stepping magnet 57, upper winding of stepping relay 52, and through the lower back contact of relay 53, to battery; but the stepping relay 52 releases when magnet 56 operates since the upper windings of relays 52 and 54 are not energized until the brush 67 makes contact with the fourth commutator segment (to which ground was connected by the operation of group relay 5). In releasing, relay 52 opens the circuit through the winding of the vertical magnet; and the release of the vertical magnet again closes the operating circuit through the lower winding of relay 52. The stepping relay 52 and vertical magnet 56 alternately operate and release to move the line-finder shaft up step-by-step until the commutator brush 67 makes contact with the segment (in this case the fourth segment) which corresponds to the level in which the terminals, to which the calling line connects, are located.

When brush 67 makes contact with the fourth segment, relay 54 operates and relay 52 is held operated in the circuit through their upper windings. Relay 54 locks in a circuit from battery through the lower back contact of relay 53, winding of vertical magnet 56, lower winding and outer lower front contact of relay 54, and over conductor 59 to ground at relay 50; this circuit is not effective to hold magnet 56 operated. In operating, relay 54 opens the operating circuit through the winding of the vertical stepping magnet 56 and closes a circuit from battery through the winding of the rotary stepping magnet 57, inner lower front contact of relay 54, front contact of relay 52, over conductor 59, to ground at relay 50. Magnet 56 releases and magnet 57 operates. In operating, magnet 57 opens the circuit through the upper windings of relays 52 and 54 and advances the two sets of multiple brushes (61 to 63 inclusive and 64 to 66 inclusive) into contact with the first two sets of terminals in the selected level of the line-finder bank. Relay

54 is slow in operating so that the brushes will not be vibrating when they enter the banks. If the calling line is not connected to either of the first two sets of terminals relay 52 releases when the circuit through its upper winding is opened. In releasing, relay 52 opens the circuit through the winding of rotary magnet 57 and the release of magnet 57 again closes the circuit through the upper winding of relay 52. The stepping relay 52 and rotary magnet 57 are, therefore, alternately operated and released to advance the line-finder brushes step-by-step until sleeve brush 63 or sleeve brush 66 makes contact with the sleeve terminal of the set to which the calling line is connected.

If and when brush 63 makes contact with the sleeve terminal of the calling line a circuit is closed from battery through the winding of cut-off relay 3, upper front contact of line relay 2, conductor 4, brush 63, upper winding of relay 55, outer upper back contact of relay 53, conductor 68, lower winding of relay 52, and over conductor 59 to ground at relay 50; the cut-off relay 3 operates and relay 55 is sufficiently energized to close its inner lower front contact. The lower winding of relay 55 is thereby energized in a circuit from battery through this winding and locking contact, over conductor 69, through the front contact of magnet 57 and over conductor 73 to ground at the upper contact of relay 50. Relay 55, which is completely operated in the circuit through its lower winding, extends the connection from brushes 61 and 62 to the trunk conductors 71 and 72.

If and when brush 66 makes contact with the sleeve terminal of the calling line, a circuit is closed from battery through the winding of the cut-off relay 3, upper front contact of relay 2, conductor 4, brush 66, lower winding of relay 51, inner upper back contact of relay 55, lower back contact of relay 51, lower winding of relay 52, and over conductor 59 to ground at relay 50; the cut-off relay 3 operates, relay 52 is held operated, and relay 51 is sufficiently energized to close its inner upper front contact. The upper winding of relay 51 is then energized in a circuit from battery through this winding and locking contact, through the inner upper front contact of relay 54, conductor 69, front contact of magnet 57, and over conductor 73 to ground at relay 50. Relay 51, which is completely operated in the circuit through its upper winding, closes a circuit for operating relay 55; this circuit may be traced from battery through the lower winding of relay 55, inner lower front contact of relay 51, middle lower front contact of relay 50, and over conductor 60 to ground at the VON springs. With relays 51 and 55 both operated the connection from brushes 64 and 65 is extended to the trunk conductors 71 and 72. The circuits for completely operating

and locking relays 51 and 55 are opened each time the rotary magnet releases so as to prevent the complete operation of either or both of these relays if either or both of brushes 63 and 66 make contact during their rotary movement with terminals of busy lines.

If brush 63 finds the calling line the complete operation of relay 55 is effective to short circuit its upper winding and if brush 66 finds the calling line the complete operation of relay 51 is effective to short circuit its lower winding so that in either case the cut-off relay 3 is held operated over conductor 68, in series with the lower winding of relay 52, thence over conductor 59 to ground at relay 50. The complete operation of relay 55 is, in either case, also effective to open the circuit through the lower winding of relay 51, to close a circuit for operating relay 53, and to connect ground through the outer lower front contact of relay 50 and the outer upper front contact of relay 55 to the trunk conductor 74. The circuit for operating relay 53 may be traced from battery through its lower winding, through the outer lower front contact of relay 55, and over conductor 60 to ground at the VON springs. In operating relay 53 disconnects the upper winding of relay 55 from conductor 68 and connects this conductor, through the outer upper front contact of relay 53, over sleeve conductor 73, to ground at relay 50 thereby holding the cut-off relay 3 operated but short circuiting the lower winding and causing the release of relay 52. The release of relay 52 opens the circuit through the winding of the rotary magnet. In operating, relay 53 also connects conductor 68 through its outer upper front contact to conductor 73 in parallel with the front contact of the rotary magnet 57 so that relay 55 and relay 51 if operated, do not release when magnet 57 releases. In operating, relay 53 opens the circuit through the lower winding of relay 54 so that relay 54 releases. The release of relay 54 disconnects the locking winding of relay 51, if operated, from conductor 69 and connects this winding over conductor 69 to ground at the VON springs. In the remainder of this description it is assumed that brushes 61 to 63 are in contact with the terminals of the calling line and that relay 51 is not operated.

In operating, relay 53 is also effective to close a circuit from battery through its upper winding and front contact to the starting conductor 6 and to extend this conductor through its inner front contact, over conductor 70, to the next line-finder in the same group with the line-finder LF. Relay 53 also disconnects the winding of relay 50 from starting conductor 6. Relay 50 is slow in releasing so that the ground at its upper front contact is not disconnected from sleeve conductor 73 until after ground has been connected to this conductor by the operation of

relay 94, as is hereinafter described. Relay 50, in releasing, disconnects ground from conductors 74 and 75, and connects its middle lower back contact in parallel with the outer lower front contact of relay 55, thus rendering the circuit through the lower winding of relay 53 independent of the continued operation of relay 55.

The aforementioned operation of the cut-off relay 3 opens the circuit through the windings of the subscriber's line relay 2. The release of relay 2 opens the circuit through the winding of group relay 5 and relay 5 releases unless a call has been originated by a subscriber on some other line in the group with line 1. The release of relay 5 disconnects the ground at its front contact from starting conductor 6.

When the calling line is extended, by the operation of relay 55 in the line-finder circuit as hereinbefore described, a circuit is closed from battery through one of the windings of the line relay (not shown) of selector S, over the ring conductor 108, through the right hand winding of polarized relay 91, lower back contact of relay 92, winding of relay 77, inner lower back contact of relay 89, inner left hand back contact of relay 80, conductor 72, next-to-the-inner upper front contact of relay 55, inner upper back contact of relay 51, brush 62, over the ring conductor of line 1 and through the calling subscriber's instrument, back over the tip conductor of line 1, brush 61, outer upper back contact of relay 51, next-to-the-outer upper front contact of relay 55, conductor 71, outer left hand back contact of relay 80, upper back contacts of relays 89 and 92, left hand winding of relay 91 and tip conductor 107, and through the other winding of the line relay of selector S, to ground. At the same time that the line relay of the selector and relay 77 of trunk T are being energized in this circuit, the auxiliary test control relay 80 is being energized in a circuit over conductor 74, through the outer upper front contact of relay 55, to ground at the outer lower front contact of relay 50. The operation of relay 80 does not interfere with the operation of the line relay of selector S and relay 77 of trunk T, because the resistance 98 is bridged across tip and ring conductors 107 and 108 of the trunk to the selector before these conductors are disconnected from tip and ring conductors 71 and 72 of the trunk to the line-finder. The polarized relay 91 of trunk T is not operated at this time since the current through its windings is not in the proper direction. The operation of the line relay of selector S causes ground (not shown) to be connected to the sleeve conductor 109 thereby operating the sleeve relay 94 of trunk T. Relay 94 connects ground through the left hand back contact of relay 93 over sleeve conductor 73 of the line-finder circuit LF; this

ground is effective to hold relay 55 of the line-finder circuit after the slow-to-release starting relay 50 disconnects ground from conductor 73, as is hereinbefore described. In
 5 operating, relay 94 also connects ground to conductor 95. The test control relay 81 is held operated after relay 50 releases in a circuit from battery through its right hand winding and inner right hand front contact,
 10 outer back contact of relay 79, left hand front contact of relay 78, conductor 100, right hand back contact of relay 85, conductor 99, outer back contact of relay 90, and over conductor 95 to ground at relay 94. The operation of
 15 relay 77 of the trunk circuit T closes a circuit from battery through the left hand winding of relay 78, front contact of relay 77, conductor 100, right hand back contact of relay 85, conductor 99, outer left hand back
 20 contact of relay 90, and over conductor 95 to ground at relay 94. Relay 78 operates to close the aforementioned circuit for holding relay 81 operated preventing the operation of relay 79.
 25 The aforementioned operation of relay 80 is also effective to connect conductor 72 through its inner left hand front contact, outer left hand front contact of relay 81, inner left hand back contact of relay 82, and
 30 through the right hand winding of test relay 83 and resistance lamp 96 to the negative pole of the special charging battery 97, and to connect conductor 71 through the outer left hand front contact of relay 80, inner left
 35 hand front contact of relay 81, outer left hand back contact of relay 82, and through the left hand winding of test relay 83 to the negative pole of the regular central office battery. Test relay 83 operates if the line is
 40 connected to ground and does not operate if the line is not connected to ground. If the call originated at station W, the current through the winding of polarized relay 11 is ineffective to operate this relay and the identifying ground at contact 15 is not connected
 45 to the line, so that test relay 83 does not operate. If the call originated at station J relay 21 is already operated and the current through the test circuit holds this relay so
 50 that the identifying ground remains connected from contact 25 through the front contact of relay 21, thence through retard coil 24, resistance 22 and winding 26 of the induction coil to the ring conductor of line
 55 1, and through resistance 23 and transmitter 27 to the tip conductor of line 1; as a result the currents through the windings of test relay 83 are effective to operate the test relay. If the call originated at station M relay 31 is
 60 already operated and the current through the test circuit holds this relay operated, so the identifying ground at contact 35 is not connected to the line and the test relay 83 does not operate. If the call originated at
 65 station R the current through the winding

of polarized relay 41 is ineffective to operate this relay so that the ground at contact 45 remains connected through the back contact of relay 41 to retard coil 44, thence through resistance 42 and the winding 46 of the induction coil to the ring conductor of line 1, and through resistance 43 and transmitter 47 to the tip conductor of line 1; the currents
 70 through the windings of test relay 83 are, therefore, effective to operate the test relay. If relay 83 operates at this time, it closes an obvious circuit through the lower winding of relay 89; relay 89 operates and locks in a circuit through its upper winding and front
 75 contact over conductor 95 to ground at relay 94.

When the ground at starting relay 50 is disconnected (by the release of relay 50 as hereinbefore described) from conductors 74 and 75, relay 80 releases thereby disconnecting
 80 conductors 71 and 72 from the windings of the test relay 83 and reconnecting these conductors to the windings of the line relay (not shown) of selector S. If operated, test relay 83 releases but relay 89 holds; if relay 89 is operated the connections between conductors 71 and 72 and the windings of the
 85 line relay are reversed so that the current over the line 1 is effective to free the line of the identifying ground connection at the calling station so that this ground will not interfere with the alternate release and re-operation of the selector and connector line
 90 relays during the dialing of the number of the called station. Thus, with relay 89 operated, if the call originated at station J relay 21 releases and if the call originated at station R relay 41 operates, in either case to disconnect the identifying ground. But, with
 95 relay 89 not operated, relay 11 remains non-operated or relay 31 remains operated (according to whether the call originated at station W or station M) so as to keep the identifying ground disconnected from the conductors of line 1. The polarized relays
 100 are slow-to-release so that they hold during transfer from the pulsing relay to the test relay or vice versa.

When the first digit of the number of the called station is dialed relay 77 of the trunk circuit and the line relay (not shown) of the selector S are alternately released and reoperated. The selector switch S is thereby controlled to select a group of trunks each of
 105 which terminates at a connector switch having access to the line of the called station. The selector automatically selects an idle trunk which, in the drawing is represented by conductors 156, 157 and 158, terminating at the connector C. The selector then disconnects its line relay from tip and ring
 110 conductors 107 and 108 of trunk T and extends these conductors through its brushes 153 and 154 to the windings of the line relay (not shown) of the connector circuit C. The re- 115

lease of the line relay of the selector disconnects the holding ground in the selector circuit from the sleeve conductor 73; but the sleeve relay 94 is held operated through brush 155 to ground in the connector circuit, the closure of this holding ground being caused by the operation of the line relay of the connector circuit as hereinafter described.

When relay 77 of trunk T releases, upon receipt of the first pulse created by the dialing of the first digit of the called station's number, relay 78 also releases and relay 79 operates in a circuit which may be traced from battery through its winding, right hand back contact of relay 80, back contact of relay 78, to conductor 100 and thence to ground at relay 94 as hereinbefore described. Relay 78 is differentially wound so that it is fast to release; and condenser 101 and resistance 102 are so connected in combination with the winding of relay 78 as to make this relay slow in operating. The condenser 103 and resistance 104 are so connected in combination with the winding of relay 79 as to make relay 79 slow in releasing. As a result relay 77 releases and reoperates in response to each impulse created by the dialing of the first digit, relay 78 releases upon the first release of relay 77 but does not reoperate until all of the impulses have been received, while relay 79 operates upon the release of relay 78 and holds until after relay 78 has reoperated. The operation of relay 79 causes the release of relay 81.

During the interval between the reoperation of relay 78 and the opening of the contacts of slow-to-release relay 79 a second test of the calling line is made to further identify the calling station. With relay 79 operated the reoperation of relay 78 closes a circuit for operating control relay 80, from battery through the winding of relay 80, front contact of relay 79, left hand front contact of relay 78, to conductor 100 and thence to ground at relay 94 as hereinbefore described. In operating, relay 80 opens the circuit through the winding of relay 79 and as soon as relay 79 releases the circuit through the winding of relay 80 is opened and relay 80 releases. While relay 80 is operated conductors 71 and 72 are connected through the back contacts of relays 81 and 82 to the windings of the test relay 83, and resistance 98 is bridged across conductors 107 and 108 to operate the line relay of connector C. The windings of the test relay having been reversed at the contacts of relay 81 with respect to the tip and ring conductors of the calling line the current over the line is in the opposite direction to the current on the preceding test. If the call originated at station W relay 11 operates thereby connecting the ground at contact 15 to the retard coil 14, thence through resistance 12 and winding 16

of the induction coil to the tip conductor of the line and through resistance 13 and transmitter 17 to the ring conductor of the line; this results in the operation of test relay 83. If the call originated at station J relay 21 does not operate so that the identifying ground connection is not closed and test relay 83 does not operate. If the call originated at station M relay 31 releases thereby connecting the ground at contact 35 through retard coil 34 to the tip and ring conductors of the line so that test relay 83 is operated. If the call originated at station R relay 41 remains operated so as to prevent the ground at contact 45 from being connected to the line and thereby prevent the operation of test relay 83. If relay 83 operates it closes a circuit, for operating relay 88, from ground at the front contact of relay 83, outer right hand back contact of relay 81, and through the left hand winding of relay 88; relay 88 locks through its right hand winding and front contact, over conductor 95 to ground at relay 94, if operated relay 83 releases when relay 80 releases. The release of relay 79 closes a circuit for operating relay 82, this circuit may be traced from battery through the winding and right hand back contact of relay 82, inner right hand back contact of relay 81, outer back contact of relay 79, left hand front contact of relay 78, to conductor 100, and thence to ground at relay 94. Relay 82 locks through its inner right hand front contact, conductor 99 and the outer back contact of relay 90 to the same ground.

With relay 80 released the connection over conductors 71 and 72 from the calling line is extended over conductors 107 and 108 and through selector brushes 153 and 154 and conductors 156 and 157, to the windings of the line relay (not shown) of connector C. When the calling subscriber dials the remaining digits of the called station's number the connector switch is effective, in the usual manner, to make connection with the terminals to which the line 200 of the called station D is connected.

During the dialing of the second digit, relays 77, 78 and 79 of the trunk circuit T function in the same manner as during the dialing of the first digit. The reoperation of relay 78, after all of the pulses created by the dialing of the second digit, again closes a circuit for operating control relay 80 as hereinbefore described. Relay 80 connects conductors 71 and 72 through its front contacts, the back contacts of relay 81, and through the front contacts of relay 82 to the windings of test relay 84. Relay 80 opens the circuit through the winding of relay 79 and closes a circuit for operating relay 85; this circuit may be traced from battery through the winding and the left-hand back contact of relay 85, outer right-hand front contact of relay 82, to the right-hand front contact of relay 80, and

thence to ground as traced for operating relay 80. Relay 85 locks through its inner left-hand front contact, conductor 99, outer back contact of relay 90, over conductor 95 to ground at relay 94. Until relay 79 releases, the circuit through the winding of relay 80 is now traced through the outer right-hand front contact of relay 85 instead of through the front contact of relay 78 and the right-hand back contact of relay 85. Relay 85 connects battery through its outer left-hand front contact to the windings of test relay 84 thus completing the circuit for testing the calling line. Since the same potential is connected to both sides of the line the polarized relay 11 remains normal if the call originated at station W, the polarized relay 21 releases if the call originated at station J, the polarized relay 31 remains normal if the call originated at station M, and the polarized relay 41 releases if the call originated at station R. Relay 84 is, therefore, operated if the call originated at either of stations M or R, the identifying ground connection being closed; but relay 84 does not operate if the call originated at either of stations W or J, the identifying ground connection being open. If relay 84 operates it closes an obvious circuit for operating relay 86; and relay 86 locks through its inner left-hand front contact, over conductor 95 to ground at relay 94. As soon as relay 79 again releases relay 80 releases thereby closing the connection between the calling line and the connector so that the dialing of the third digit of the called number is effective to control the operation of the connector switch. With relay 85 operated the winding of relay 77 is short-circuited so that relays 77 and 78 release; and relay 77 is not included in the dialing circuit.

Assume that the line of the called station is found idle, that ringing potential is connected to this line and that the subscriber at the called station answers the call. When the subscriber answers, the connector circuit reverses the connections between the windings of the line relay and the tip and ring conductors of the calling line so that the current through the windings of the polarized supervisory relay 91 of trunk T is effective to operate this relay. Relay 91 closes the circuit for operating reversing relay 92. Relay 92, in operating, reverses the connection from the calling line over conductors 71 and 72 with respect to conductors 107 and 108 so that the current through the polarized relay at the calling station continues in the direction which prevents the closing of the identifying ground connection. If the identifying ground connection were closed during conversation the quality of the transmission would be affected.

In operating, relay 92 also connects ground to the right-hand winding of relay 93

and connects interrupter 133 (shown in Fig. 3) over conductor 105, through the outer upper front contact of relay 92, middle back contact of relay 90, left-hand winding of relay 93, conductor 113, back contacts of relays 131 and 132, winding of alarm relay 129, right-hand back contact of relay 150, and through the back contact of relay 145 to battery. Assume that the common register control circuit RC is not in use. Interrupter 133 alternately closes and opens a connection to ground; the closed periods have a duration of approximately one-quarter of a second and the open periods a duration of approximately two seconds. With the interrupter brush connected to ground, or as soon as it is so connected, relay 93 of trunk T and alarm relay 129 of the register control circuit operate. In operating, relay 93 disconnects conductor 130 from conductor 106 and closes a circuit from ground at the outer lower front contact of relay 92, right-hand winding and front contact of relay 93, over conductor 130, winding of relay 131, to battery at the back contact of relay 145. Relay 93 locks and relay 131 operates in this circuit. By disconnecting conductor 130 from conductor 106 no other of the trunks to which the control circuit RC is common can make use of the control circuit until relay 93 releases. Relay 131 closes an obvious circuit for operating relay 132 and opens the circuit through the left-hand winding of relay 93 and the winding of relay 129 so as to release relay 129. Should relay 131 fail to operate relay 129 remains operated and the ground connected through its front contact to conductor 151 is effective to operate an alarm.

In operating, relay 132 connects ground to alarm lead 151, and connects the windings of counting relays 134 and 135 to interrupter 133. As soon as interrupter 133 closes the circuit through its winding relay 134 operates, thereby connecting the winding of relay 135 through the right-hand front contact of relay 134 to ground at relay 131. As long as the ground connection at interrupter 133 is closed the winding of relay 135 is short-circuited but as soon as this ground is opened relay 135 operates in series with the winding of relay 134 to the ground at relay 131; relay 134 is locked in this circuit. In operating, relay 135 transfers the connection from interrupter 133 to the winding of relay 136 and when the ground connection is again closed at interrupter 133 relay 136 operates. Relay 136 locks through its right-hand front contact to the ground at relay 131. Relay 136 closes a circuit for operating relay 90 of the trunk T; this circuit may be traced from ground through the inner left-hand front contact of relay 136, conductor 111, outer left-hand front contact of relay 93 of trunk T, conductor 110, and through the inner left-hand back contact and winding of relay 90

to battery. Relay 90 locks through its inner left-hand front contact over conductor 95 to ground at relay 94. In operating, relay 93 disconnects the sleeve conductor 73 of the line-finder LF from the ground at relay 94 and connects conductor 73, through the inner left-hand front contact of relay 93, over conductor 112, to ground at the right-hand back contact of relay 139 of the register control circuit RC. The line-finder relay 55 and the cut-off relay 3 of line 1 are thus held operated under control of relay 139 to prevent the release of the connection until the message register of the calling station has been operated. The operation of relay 90 is effective to release relay 85 but the winding of relay 77 remains short-circuited by the outer right-hand front contacts of relay 90 after relay 85 has been released. Relay 90 also opens the connection between the left-hand winding of relay 93 and interrupter 133, and connects the ground at relay 136 of the register control circuit RC over conductor 111, through the outer left-hand front contact of relay 93, conductor 110, and through the inner right-hand front contact of relay 90 and through the contacts of relays 89, 88 and 86 to the winding of one of relays 117, 119, 121 and 123 according to whether relays 89, 88 and 86 are normal or operated. If the call originated at station W relays 86 and 89 are normal and relay 88 is operated so that relay 117 operates; if the call originated at station J relays 86 and 88 are normal and relay 89 is operated so that relay 119 operates; if the call originated at station M relay 89 is normal and relays 86 and 88 are operated so that relay 121 operates; and if the call originated at station R relay 88 is normal and relays 86 and 89 are operated so that relay 123 operates. If relay 117 operates it closes a circuit for operating relay 118 and relay 118 connects the winding of message register 125 to the sleeve conductor 4 of the line 1 in parallel with the winding of the cut-off relay 3; if relay 119 operates it closes a circuit for operating relay 120 and relay 120 connects the winding of message register 126 to conductor 4; if relay 121 operates it closes a circuit for operating relay 122 and relay 122 connects the winding of message register 127 to conductor 4; and if relay 123 operates it closes a circuit for operating relay 124 and relay 124 connects the winding of message register 128 to conductor 4. The operation of any one of relays 118, 120, 122 and 124 is also effective to connect ground to conductor 140.

The aforementioned operation of relay 136 was also effective to connect interrupter 137 through its outer left-hand front contact and the left-hand back contact of relay 139 to the windings of relays 138 and 139. Interrupter 137 alternately closes a connection to ground for three-tenths of a second and opens the connection for two-tenths of a second. As soon after the operation of relay 136 as the ground connection is closed at interrupter 137, relay 138 operates. Relay 138 closes a circuit from battery through the windings of relays 138 and 139 in series and through the left-hand front contacts of relays 138 and 134 and over conductor 140, to ground at one of relays 118, 120, 122 and 124 which has been operated as hereinbefore described. The winding of relay 139 is short-circuited until the ground connection at interrupter 137 is opened at which time relay 139 operates and with relay 138 is locked in the circuit to ground over conductor 140. The operation of relay 139 disconnects conductor 112 from the ground at its right-hand back contact and connects this conductor through its right-hand front contact, resistance 144, and through lamp 143 to booster battery 142, thereby holding the cut-off relay 3 and operating the message register of the calling station. The operation of relay 139 is also effective to transfer the connection from interrupter 137 from the windings of relays 138 and 139 through the left-hand front contact of relay 139 and left-hand back contact of relay 150 to the winding of relay 145. As soon thereafter as the ground connection at interrupter 137 is again closed relay 145 operates. Relay 145 locks through its front contact to ground on conductor 140. In operating relay 145 opens the circuit through the winding of relay 131 and through the locking winding of relay 93 thus causing the release of these relays. The release of relay 131 causes the release of relays 132, 134, 135 and 136. The release of relay 132 opens the connection to interrupter 133 to prevent the reoperation of relay 134 and disconnects ground from alarm conductor 151. The release of relay 134 causes the release of relays 138 and 139. The release of relay 136 disconnects ground from conductor 111 thereby releasing whichever two of relays 117, 118, 119, 120, 121, 122, 123 and 124 were operated; the release of relay 136 also opens the connection to interrupter 137 to prevent the reoperation of relay 138. The release of relay 139 disconnects the booster battery 142 from conductor 112 and reconnects this conductor to ground. The release of relay 93 reconnects the sleeve conductor 73 to ground at relay 94 to hold relay 55 of the line-finder circuit and the cut-off relay 3 of the line 1 until the connection is released. The release of the register control relay 118, 120, 122 or 124 disconnects ground from conductor 140 thereby causing the release of relay 145. With relay 145 released the register control circuit RC is normal ready for seizure and use by any other of the trunks with which this circuit is associated. When the calling subscriber replaces the receiver on the receiver hook the polarized supervisory relay 91 and the line relay (not shown) of connector circuit C release. The

release of the line relay of the connector is effective to disconnect ground from sleeve conductor 158 and when the called subscriber hangs up the receiver the connector switch returns to normal in the usual manner. With the holding ground opened in the connector circuit, the selector switch is returned to normal in the usual manner. Relay 94 releases when the holding ground is opened at the connector and the release of relay 94 disconnects ground from sleeve conductor 73 thereby causing the release of line-finder relay 55 and cut-off relay 3. The release of relay 55 closes a circuit for operating the release magnet 58 of the line-finder LF and the line-finder switch is returned to normal. When the switch reaches normal the VON springs are returned to their normal position thus opening the circuit through the lower winding of relay 53. Relay 53 releases unless the starting conductor 6 is grounded in which case relay 53 holds through its upper winding until ground is disconnected from this conductor.

If the line 1 were connected to ground in some manner other than by the proper closure of the identifying ground connection at the calling station test relay 83 would operate on the first and also on the second test of the line. Relays 89 and 88 would therefore both be operated and, if the connection is completed and the called subscriber answers, the operation of relay 90 as hereinbefore described is effective to operate relay 87 instead of operating one of relays 117, 119, 121 and 123. The circuit for operating relay 87 may be traced from battery through the left-hand winding of relay 87 thence through the inner front contact of relay 88 and the outer lower front contact of relay 89, inner right-hand front contact of relay 90, conductor 110, outer left-hand front contact of relay 93, conductor 111, to ground at relay 136. Or if there were a failure of the identifying ground at the calling station neither of relays 88 and 89 would be operated and the circuit for operating relay 87 would be traced through the back contacts of relays 88 and 89 to the ground at relay 136. Relay 87 connects ground over conductor 115 to the winding of register 146. Register 146 records the existence of a trouble condition and since none of relays 117, 119, 121 and 123 were operated, the register control circuit completes its cycle of operations without operating any of the message registers; and the connection is released in the usual manner.

If the number of failures recorded by register 146 warrants, key 152 may be operated to prevent the release of the calling line although the selector and connector circuits are returned to normal in the usual manner. With key 152 operated relay 87 locks in a circuit through its right-hand winding and front contact, over conductor 116 to ground at key 152. In this case the release magnet of line-finder LF cannot operate since its circuit is held open at the left-hand contact of relay 87. With relay 87 operated ground is connected to conductor 95 to prevent the release of the relays which hold over this conductor when relay 94 disconnects ground therefrom and ground is also connected over conductor 114 to operate alarm relay 147 of the register control circuit. In operating, relay 147 closes the circuit for lighting lamp 148 and connects ground to conductor 149 to operate an alarm. Should relay 132 fail to operate after relay 129 has operated, or if relay 132 fails to release after its operation, the ground connected to lead 151 is effective to operate an alarm. If relay 134 fails to operate, the operation of any of relays 118, 120, 122 and 124 closes a circuit for operating relay 150; or if one of relays 117, 119, 121 and 123 operate but the corresponding one of relays 118, 120, 122 and 124 fails to operate a circuit is closed, when relay 138 operates, for operating relay 150. In either case the operation of relay 150 connects ground to alarm conductor 151.

If a connection is established between the calling subscriber's station and a called station for which no charge should be made, the current through the windings of the polarized supervisory relay 91 is not reversed and this relay does not operate. In this case the connection is released without making use of the register control circuit RC.

If the calling subscriber dials a number which consists of only one digit to establish connection with an operator the calling line is extended through the line-finder LF, trunk T, selector S and over the trunk OT to the operator's position at O. The line relay 165 of the trunk OT operates when the connection from the calling station is extended through brushes 153 and 154 of selector S and through the inner back contacts of relay 168 to the winding of relay 165. The operation of relay 165 causes the operation of slow-to-release relay 166. Relay 166 connects a busy and holding ground through its left-hand contact over conductor 164 and through brush 155 to the sleeve conductor 109 of selector S so as to hold relay 94 of trunk T operated. The ground at the left-hand contact of relay 166 is also connected through the back contact of relay 168 to the winding of relay 167. Relay 167 operates thereby disconnecting the tip and ring conductors 170 and 171 from the springs of jack 172 and closes a circuit for lighting line lamp 169. When the answering plug 173 of the operator's cord circuit is inserted in jack 172, relay 168 operates thereby transferring the connection from the calling line from the windings of relay 165 to conductors 170 and 171. Relay 168 in operating also opens the circuit through the winding of relay 167 and connects ground through its outer upper front

contacts to the winding of relay 166 so as to prevent the release of relay 166. Relay 167 is slow in releasing so that the circuit from the calling line through the line-finder LF, trunk T, selector S and trunk OT is opened long enough to release relay 77 in trunk T before the conductors 170 and 171 are extended through the back contacts of relay 167, springs of jack 172 and through the tip and ring of plug 173 to the windings of relay 174. Relay 77 of trunk T reoperates and relay 174 of the operator's cord circuit operates as soon as conductors 170 and 171 are thus extended. The release and reoperation of relay 77 of trunk T simulates the dialing of a second digit and is effective as hereinbefore described to cause the test relay 84 to be connected to the calling line for completing the identification of the calling station. If the call is a free call, relay 91 of trunk T is not operated and no use is made of register control circuit RC. But, if the call as completed through the operator's cord circuit is one for which a charge should be made, the reversal of the windings of relay 174 with respect to conductors 170 and 171 causes the operation of relay 91; the register control circuit is then effective to operate the message register of the calling station as hereinbefore described.

The invention is not limited in its application to the system herein disclosed, but is applicable to any automatic, or semi-automatic telephone system which is arranged for party line message rate service and in which the automatic switching mechanisms are directly controlled by the calling subscriber.

What is claimed is:

1. In a telephone system, a line, a plurality of subscribers' stations permanently connected to said line, means at each of said stations for distinguishing it from the others, a dial at each station, means including a trunk for extending said line when a call is originated at any of said stations, and means individual to said trunk for preventing said distinguishing means from interfering with the transmission of dial pulses.

2. In a telephone system, a calling subscriber's station, other subscribers' stations, a line common to said calling and said other station, an identifying connection at said calling station, a dial at said calling station, a called station, means for establishing a connection between said calling and said called stations, means for testing said line to determine the presence or absence of said identifying connection, and means for automatically controlling said identifying connection so as to prevent this connection from interfering with the transmission of dial impulses and from impairing the transmission of speech.

3. In a telephone system, a line having a plurality of subscribers' stations one of which is a calling station, an identifying connection

at each of said stations, means at each of said stations for controlling the identifying connection, an impulse sender at said calling station, means including a trunk for extending said line, and means associated with said trunk and cooperating with said controlling means to free said line of said identifying connection during the time that said impulse sender is being operated.

4. In a telephone system, a line having a plurality of subscribers' stations one of which is a calling station, a message register for each of said stations, a called station, trunks, means including one of said trunks for extending said line to said called station, means for selectively operating the message register of said calling station, and means common to all of said trunks for delaying the operation of the message register of said calling station.

5. In a telephone system, a line, a plurality of subscribers' stations permanently connected to said line, means at said stations for rendering each of them distinguishable from the others, a device at each of said stations for creating impulses, a trunk, means for connecting said line and said trunk when a call is originated at one of said stations, testing means effective as soon as said line is connected to said trunk for partially identifying the calling one of said stations, means associated with said trunk for receiving impulses, means effective as soon as a set of impulses has been received to check said partial identification, and means effective as soon as another set of impulses has been received to complete the identification of the calling one of said stations.

6. In a telephone system, a line, a plurality of subscribers' stations permanently connected to said line, a ground connection and a polarized relay for controlling said ground connection at each station, an impulse sender at each station, a trunk, a selector associated with said trunk, means effective upon the origination of a call at any of said stations to extend said line to said trunk, means for testing said line to partially identify the calling one of said stations, means dependent upon the presence of a ground connection at said calling station for reversing the conductors of said line with respect to said selector, means rendered effective by the transmission of a train of impulses created by the operation of said impulse sender for testing said line a second time, and means for testing said line a third time to complete the identification of said calling stations.

7. In a telephone system, a line having a plurality of subscriber's stations one of which is a calling station, a ground connection and means for controlling said connection at each station, a dial at said calling station, trunks, a selector, a called station,

means including one of said trunks and said selector for establishing a connection between said calling and said called stations, means for testing said line to partially identify said calling station, means dependent upon the presence of a ground connection at the time of said test for reversing the conductor of said line with respect to said selector so that said line will not be connected to ground during dialing, means for completing the identification of said calling station, a register individual to said calling station, charging means common to all of said trunks and rendered effective by the answer of the subscriber at the called station for operating said register, means common to said trunks for delaying the operation of said register, and means for freeing said line of said identifying ground connection during conversation.

8. In a telephone system, a line having a plurality of subscribers' stations one of which is a calling station, a dial at said calling station, means at each of said stations for distinguishing it from the others, means for testing said line to partially identify said calling station, an automatic switch selectively controlled by the operation of said dial, means for simulating the dialing of an additional digit, and means rendered effective by said simulation for completing the identification of said calling station.

9. In a telephone system, a line having a plurality of subscribers' stations one of which is a calling station, a dial at said calling station, means at each of said stations for distinguishing it from the others, a called station whose number consists of only one digit, means for establishing a connection between said calling and said called stations, means effective before the number of said called station is dialed for partially identifying said calling station, means effective immediately after the number of said called station is dialed for checking said partial identification, means for simulating the dialing of another digit, and means rendered effective by said simulation for completing the identification of said calling station.

In witness whereof, I hereunto subscribe my name this 27th day of June, 1929.

RAY L. STOKELY.