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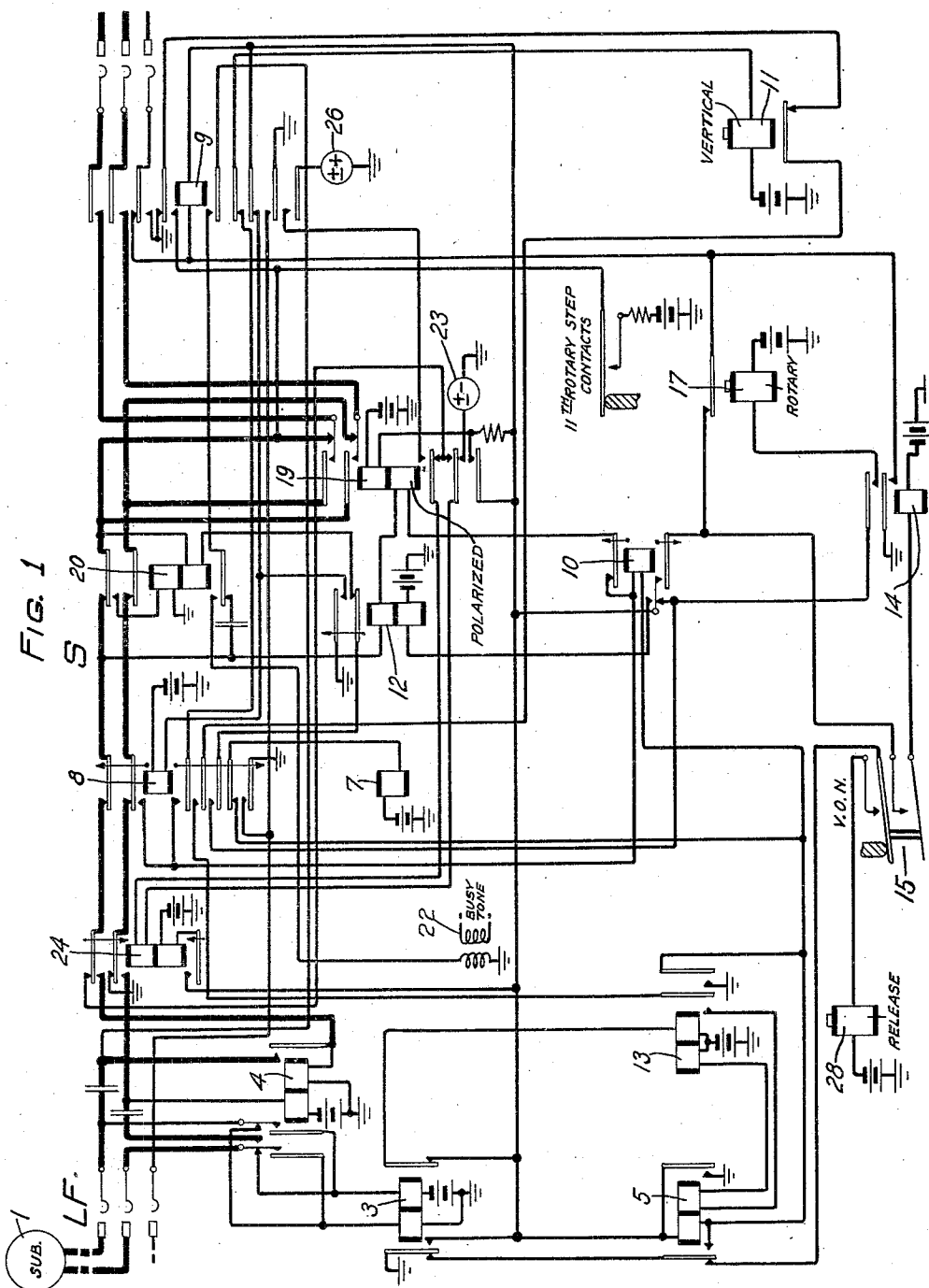
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1,850,608

TELEPHONE SYSTEM

Filed July 31, 1930

2 Sheets-Sheet 1



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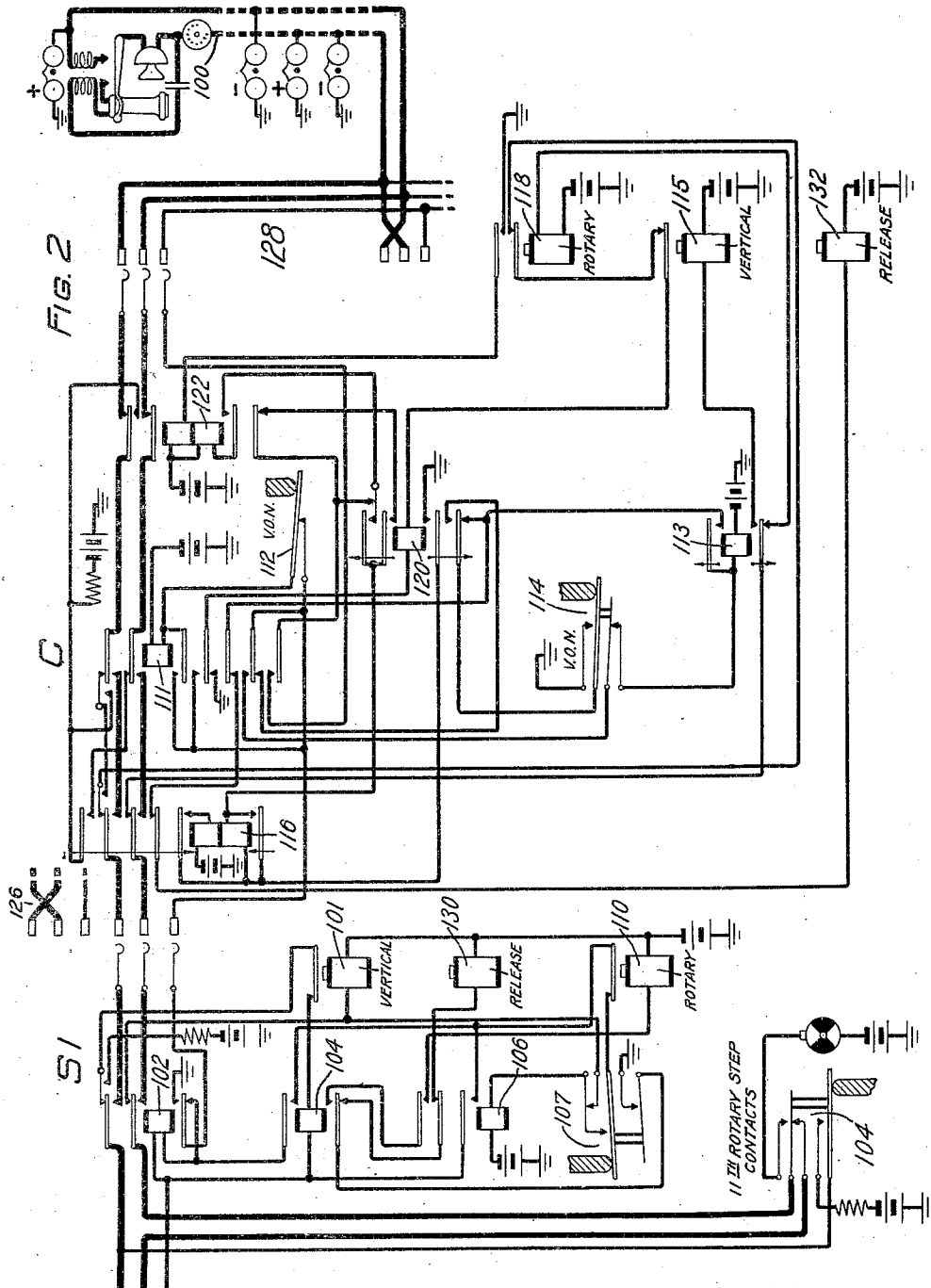
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2 Sheets-Sheet 2



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TELEPHONE SYSTEM

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This invention relates to telephone systems and particularly to machine switching systems.

The object of the invention is to simplify the equipments and circuits for the automatic switches employed in establishing telephone connections.

Heretofore systems have been used whereby, in the control or pulsing relay equipment for switches, the usual holding relay is maintained operated during pulsing due to its slow-to-release characteristics. The control equipment for a train of switches has also been centralized in one switch. For example, the pulsing arrangement for controlling the operating magnets in the first and succeeding selector switches and the connector switch may be located in the first selector switch. In these prior systems the ringing and busy tone equipments may also be located in a preceding switch.

It is a feature of this invention to provide in a switch a pulsing relay arrangement in which the holding relay is maintained operated by means of a locking winding under control of the operating magnets of said switch.

It is another feature of this invention to provide in systems where the control equipment for a train of switches is located in a preceding switch, means whereby the locking winding of the holding relay is controlled by the operating magnets in succeeding switches in the train, as they are connected during the process of establishing a connection.

Another feature relates to the selection and application of party line signaling currents of different characteristics and comprises; means whereby battery and ground connections on the tip and ring conductors respectively or vice versa are established to the preceding switch, in which the signal selecting equipment is located, by the selection of the group in which an idle succeeding switch is found and over which a connection is established; means whereby the particular battery and ground connection selected cause signaling current of a corresponding characteristic to be applied, and means whereby the selected signal is applied to the connected party line

in response to the removal of battery and ground from the conductors when the connection is completed to this line.

Another feature relates to the application of busy tone to the calling line and comprises means whereby battery and ground are momentarily disconnected from the tip and ring conductors leading to a preceding switch when the line to which the connection has been extended is busy and means whereby said momentary removal and subsequent restoration of the battery and ground connection causes the application of the busy tone to the calling line from said preceding switch.

This invention has been illustrated in the accompanying drawings in which Fig. 1 shows a calling subscriber's line and a line finder in diagrammatical form, and a first selector switch embodying features of this invention, while Fig. 2 shows an intermediate selector and a connector, embodying other features of this invention. This figure also shows a called four-party line in diagrammatic form.

Referring to these drawings, a description will now be made of a call from the calling subscriber at 1 through line finder LF, selector S, selector S1, connector C, and a subscriber on a line 100. When the calling subscriber at 1 has been connected through line finder LF in the usual manner a circuit is completed through the subscriber's loop from battery and ground, windings of relay 3, armatures and back contacts of relay 4, and the tip and ring conductors connected to this subscriber's loop. Relay 3 operates in this circuit and closes a circuit for the operation of relay 5 from battery impedance coil 7, fourth lower armature and back contact of relay 8, left hand winding of relay 5 to ground at the left-hand armature and front contact of relay 3. Relay 3 in operating also closes a circuit for the operation of relay 8 from battery, winding of relay 8, third lower armature and back contact of relay 9 to ground at the left hand armature and front contact of relay 3. Ground is also supplied for this circuit through right hand armature and front contact of relay 5. Relay 8 in operating closes a circuit as follows: battery, winding of ver-

tical magnet 11, second lower armature and back contact of relay 9, inner lower armature and front contact of relay 8, winding of relay 10, left-hand winding of relay 5 to ground at the left hand armature and front contact of relay 3. The vertical magnet and relay 10 do not operate in this circuit.

When relay 3 is released at the first impulse received from the calling subscriber to select the desired subscriber's line the so called help relay 13 is operated over a circuit from battery, right hand winding of this relay, right hand armature and back contact of relay 3 to ground at the right hand armature and front contact of relay 5. Relay 13 in operating closes a locking circuit for itself and for relay 5 from battery, left hand winding of relay 13, right hand winding of relay 5, right hand armature and front contact of relay 13, second lower armature and front contact of relay 8, armature and back contact of the vertical magnet 11 to ground at the upper inner armature and back contact of relay 9. Relay 3 in releasing also shunts the left hand winding of relay 5 by applying ground through the left hand armature and back contact of relay 3 and the left hand armature and front contact of relay 5 to one end of the left hand winding of relay 5. It should be noted that the opposite end of the left hand winding of relay 5 is connected to ground at the right hand armature and front contact of relay 5. The inductive kick produced by this shunting of the left hand winding of relay 5 serves to make relay 5 slow-to-release. It should be noted that on the release of relay 3 a circuit is completed for the vertical magnet 11 and relay 10, eliminating the left hand winding of relay 5, to ground through the left hand armature and back contact of relay 3 and left hand armature and front contact of relay 5. The relay 10 and the vertical magnet will operate in this circuit, and the vertical magnet advances the brushes of this selector S one step. Relay 10 in operating closes a circuit for relay 12 from battery, lower winding of relay 12, inner lower made contacts of relay 10 to ground at right hand armature and front contact of relay 5. Relay 12 provides an obvious locking circuit for relay 8 and also a locking circuit for itself to ground at its upper inner armature and front contact through the armature and back contact of the rotary magnet 17. When the vertical magnet operates the above mentioned locking circuit for relays 13 and 5 is opened at the armature and back contacts of this magnet. Relay 13 will then release provided the relay 3 has again operated for the second impulse as both the locking circuit and the energizing circuit for this relay will be opened, the locking circuit is opened by the vertical magnet and the energizing circuit is opened by relay 3. As soon as the vertical magnet has taken one step, relay 14 operates from battery, winding

of this relay, vertical off normal contacts 15, lower armature and front contact of relay 10 to ground at the left hand armature and front contact of relay 5. Relays 5, 10, 12 and 14 will remain operated during the remaining impulses of the first digit. Relay 10 will remain operated due to its slow-to-release characteristics. The vertical magnet will respond each time relay 3 releases and relay 13 will be maintained operated during the release periods of relay 3 and release as stated each time the vertical magnet operates provided the relay 3 has operated at this time. Relay 5 will therefore be positively locked during the release periods of relay 3 under control of the vertical magnet.

When the impulses of the first digit have been sent and relay 3 is finally operated, relay 10 will release due to the final release of relay 13. The release of relay 10 will also cause the release of relay 12 to open the locking circuit of relay 8. Relay 8 will therefore now be held solely by the ground supplied at the left hand armature and front contact of relay 3 and under control of relay 9. The release of relay 10 closes a circuit for the rotary magnet which now will be operated to hunt for an idle second selector. This circuit for the rotary magnet 17 may be traced from battery, winding of magnet 17, upper outer armature and front contact of relay 14, lower normal contacts of relay 10 to ground at the left hand armature and front contact of relay 3. The operation of magnet 17 opens the locking circuit for relay 14 at its armature and back contact to cause relay 14 to release and this relay in releasing in turn opens the circuit for the rotary magnet. If now a first selector is busy a ground will be supplied on the sleeve conductor thereof to cause the reoperation of relay 14 from battery, winding of this relay made vertical off-normal contacts 15, armature and back contacts of magnet 17, second upper armature and back contacts of relay 9 to the sleeve conductor to ground of the busy selector. The operation of relay 14 will again close the above mentioned circuit for the rotary magnet 17 to cause it to take another step and cause the release of relay 14. This alternate operation and release of relay 14 and magnet 17 will continue as long as ground is found on the sleeve conductor of a busy selector.

When an idle selector is found relay 14 will not be operated and selector S will therefore stop on the terminals of this selector which may in this case be considered as the selector S1. Relay 9 will now operate over a circuit as follows: battery, winding of relay 14, vertical off-normal contacts 15, armature and back contact of rotary magnet 17, winding of relay 9 to ground at the left hand armature and front contact of relay 3. It should be noted that the reason relay 9 did not operate as long as a ground was found on the sleeve

conductor is that this relay will be short-circuited by said ground. Relay 9 in operating applies a busy ground to the sleeve of the selector S1 at its second upper armature and front contact. The operation of relay 9 opens the circuit for relay 8 and closes the tip and ring conductors of the selector S through to the selector S1 at its two upper armatures and front contacts. The relay 8 does not release as it is slow in releasing and will be maintained by relay 12 which will be operated as soon as relay 9 applied the busy ground to the sleeve. The operation of relay 9 closes a circuit for relay 12 as follows: battery, vertical magnet 101, upper inner armature and back contact of relay 102, eleventh rotary step contacts 104, ring conductor of selectors S1 and S, third upper armature and front contact of relay 9, inner upper make-before-break contacts of relay 19, upper inner armature and back contact of relay 20, upper inner armature and front contact of relay 8, upper armature and back contact of relay 10, lower winding of relay 19, upper winding of relay 12, upper outer armature and back contact of relay 20, upper outer make-before-break contacts of relay 19, upper outer armature and front contact of relay 9, tip conductor of selectors S and S1, upper outer armature and back contact of relay 102, armature and back contact of vertical magnet 101, winding of relay 104, sleeve conductor of selectors S1 and S, second upper armature and front contact of relay 9 to ground. Relay 12 in operating closes the above mentioned circuit for maintaining relay 8 operated. The vertical magnet 101 does not operate in this circuit, but relay 104 operates with relay 12. Relay 19 is polarized and does not operate with the current in the direction as traced to this circuit, that is, with the battery on the ring conductors. The purpose of relay 19 will be explained in connection with the application of ringing current.

The next series of dialing impulses will intermittently connect a ground to the ring conductor causing the vertical magnet 101 to operate. The circuit for the vertical magnet may be traced from battery through the windings of magnet 101, upper inner armature and back contact of relay 102, eleventh rotary step contacts 104, ring conductor of switches S1 and S, third upper armature and front contact of relay 9, upper make-before-break contacts of relay 19, upper inner armature and back contact of relay 20, upper inner armature and front contact of relay 8, winding of relay 10, left hand armature and front contact of relay 5, left hand armature and back contact of relay 3 to ground or outer right hand armature and front contact of relay 13 to ground directly from the winding of relay 10 as relay 13 operates on each release of relay 3. Relay 106 also operated in this circuit, on the first release of relay 3,

from battery, winding of relay 106, vertical off-normal contacts 107 to the ground over the ring conductor. On the first step of switch S1 due to the operation of the vertical magnet 101 the circuit for relay 106 will be shifted to be controlled over the vertical off-normal contacts 107, armature and back contact of the rotary magnet 110, armature and front contact of relay 106 to the ground on the sleeve supplied at the second upper armature and front contact of relay 9. Relay 104 releases when the vertical magnet is operated as its circuit is controlled through the armature and back contact of this magnet and when the series of impulses ceases relay 104 will again be operated. Relay 12 is held operated during the pulsing through the circuit completed by the inner lower contacts of relay 10 to ground at the right hand armature and front contact of relay 5. The holding circuit for relay 13 during pulsing will be controlled by the circuit through the armature and back contact of the vertical magnet 101 in the same manner as it was controlled through the armature and back contact of the vertical magnet 11 in selector S. This circuit may be traced from battery left hand winding of relay 13, right hand winding of relay 5, inner right hand armature and front contact of relay 13, second lower armature and front contact of relay 8, armature and back contact of magnet 11, upper inner armature and front contact of relay 9, upper outer make-before-break contacts of relay 19, upper outer armature and front contact of relay 9, tip conductor of selectors S and S1, upper outer armature and back contact of relay 102, armature and back contact of magnet 101, winding of relay 104, sleeve conductor to ground at the second upper armature and back contact of relay 9.

When relay 104 operates it closes a circuit for the energization of the rotary magnet 110 as follows: battery, windings of the rotary magnet 110, upper outer armature and front contact of relay 106, lower armature and front contact of relay 104, vertical off-normal contacts 107 to ground. When the rotary magnet operates relay 106 releases, due to opening of the circuit therefor at the armature and back contact of magnet 110 and this relay in turn opens the circuit for the rotary magnet 110 to cause it to release. If the first connector is busy the rotary magnet in releasing will again close the circuit for relay 106 from battery windings of this relay, vertical off-normal contacts 107, armature and back contacts of magnet 110, upper armature and front contacts of relay 104, lower armature and back contact of relay 102 to ground on the sleeve of this busy connector. This alternate operation and release of relay 106 and rotary magnet 110 will continue until an idle connector is found. A circuit will then be completed for relay 102 as follows: battery

winding of relay 111, vertical off-normal contacts 112, sleeve of connector C and selector S1, lower armature and back contact of relay 102, winding of relay 102 to ground at the second upper armature and front contact of relay 9.

Relay 102 in energizing applied at ground at its lower armature and front contact to the sleeve of the connector C. Relay 106 does not operate in the circuit in series with the winding of relay 102 from battery winding of relay 106, off-normal contacts 107, armature and back contact of magnet 110, upper armature and front contact of relay 104, winding of relay 102 to ground at relay 9 as the resistance characteristics of the winding of relay 102 are such as to prevent it. Relays 102 and 104 are now held operated until the connection is released, the operation of relay 102 closing a holding circuit for relay 104 from battery through a resistance and upper make-before-break contacts of relay 102, armature and back contact of the vertical magnet 101, winding of relay 104 to ground at the second upper armature and front contact of relay 9.

This direct ground applied to the sleeve of the connector C causes the operation of relay 111 over the above traced circuit for this relay. Relay 111 did not operate in the above circuit when in series with relay 102 due to the resistance characteristics of relay 102. Relay 111 in operating closes a locking circuit for itself to ground at relay 102 over its lower inner armature and front contact. Relay 113 now operates through the operation of relay 111, over a circuit from battery, winding of relay 113, vertical off-normal contacts 114, fourth lower armature and front contact of relay 111, the sleeve conductor to ground at the relay 102. A circuit will thereby be closed for maintaining relay 12 operated. It should be noted that relay 12 is slow in releasing so as to permit relays 111 and 113 to operate after the circuit for relay 12 has been opened by the operation of relay 102 for again closing this circuit. This circuit for relay 12 may be traced from battery, winding of vertical magnet 115, lower armature and front contact of relay 113, third upper armature and back contact of relay 116, ring conductor from the connector C to the selector S1, inner upper armature and front contact of relay 102, 11th rotary step contacts 104, ring conductor to the selector S, third upper armature and front contact of relay 9, inner upper make-before-break contacts of relay 19, upper inner armature and back contact of relay 20, upper inner armature and front contact of relay 8, upper armature and back contact of relay 10, lower winding of relay 19, upper winding of relay 12, upper outer armature and back contact of relay 20, upper outer make-before-break contacts of relay 19, fourth upper ar-

mature and front contact of relay 9, tip conductor to switch S1, upper outer armature and front contact of relay 102, tip conductor to connector C, fourth upper armature and back contact of relay 116, upper inner armature and back contact of the rotary magnet 118, armature and back contact of vertical magnet 115, winding of relay 120, second lower armature and front contact of relay 111, sleeve conductor to ground at the lower armature and front contact of relay 102. Relay 12 is thereby maintained operated to hold relay 8 operated through its locking circuit.

The circuits are now ready for the sending of the third digit. Relay 120 is operated in the above mentioned circuit but releases as soon as the vertical magnet is operated and remains released during the sending of the vertical impulses. The release of relay 3 in response to the first impulse closes a circuit from ground at the left hand armature and back contact of this relay, left-hand armature and front contact of relay 5 through the winding of relay 10, back over the tip conductor through the switches S, S1 and C through the winding of the vertical magnet 15 to battery over the connections hereinbefore described. This causes the operation of relay 10 which opens the circuit for relay 12 but this relay is maintained operated during the operation of relay 10 over a circuit as hereinbefore described through the lower inner contacts of relay 10 to ground at the right-hand armature and front contact of relay 5. Relay 10 remains operated as usual during the sending of the pulses. The relay 120 as stated, releases not only due to the opening of the circuit through the upper armature and back contact of relay 10 but also through the opening of a circuit through the armature and back contact of vertical magnet 115. The usual holding circuit for relays 13 and 5 while the pulsing relay is released may be traced in this case from battery through the left hand winding of relay 13, right hand winding of relay 5, inner right hand armature and front contact of relay 13, second lower armature and front contact of relay 8, armature and front contact of vertical magnet 11, upper inner armature and front contact of relay 9, upper outer make-before-break contacts of relay 19, over the above traced connection for the tip conductor through selector S1 and connector C and upper inner armature and front contact of rotary magnet 18 and armature and back contact of the vertical magnet 15 to the ground at relay 102. This holding circuit is therefore dependent upon the operation of vertical magnet 15 in the same manner as it was dependent upon the operation of the vertical magnet 11 in selector S and the vertical magnet 101 in selector S1. The resistance of the windings of relays 13 and 5 prevent

the relay 120 from operating in this circuit. The purpose of having relay 120 released during the pulsing is to provide a holding circuit for relay 113 as the original energizing circuit for relay 113 is opened at the vertical
 5 off-normal contacts 114 on the first step of the vertical magnet. This holding circuit may be traced from battery through the winding of relay 113 and its upper armature
 10 and front contact, lower outer armature and back contact of relay 120 through the vertical off-normal contacts 114 to ground. When the last impulse in this digit has been sent relay 120 will again operate and thereby
 15 cause the release of relay 113. The circuits are now ready for the reception of the last digit.

The release of relay 113 closes a circuit for the rotary magnet 118 from battery, winding
 20 of this magnet, lower armature and back contact of relay 113 over the same circuit as was hereinbefore traced for the vertical magnet 115 and the impulses in this last digit will now operate the rotary magnet to advance the switches to the desired party line
 25 terminals of the wanted subscriber's line. The relays 12 and 8 will be maintained operated and relay 10 will operate during the pulsing while the holding circuit for relays
 30 13 and 5 will pass through the inner upper armature and front contact of magnet 118 and depend upon the operation of this magnet in the same manner as it was depending upon the operation of the vertical magnet
 35 115. Relay 120 releases during the sending of the pulses in this digit in the same manner as during the sending of the pulses for the vertical magnet and is operated again when the pulsing ceases.

It should be noted that relay 122 is operated when the rotary magnet is operated over an obvious circuit to prepare the connector for a busy test when the rotary magnet ceases to operate. On the last step of the rotary magnet relay 122 will not release if the desired
 45 line is busy as a ground will be found on the sleeve terminal of this line. This ground closes a locking circuit for relay 122 before it has time to release from battery, lower
 50 winding of relay 122 and its lower inner armature and front contact, upper make-before-break contacts of relay 120 before it is actuated at the end of the series of the rotary magnet impulses, lower outer armature and
 55 front contact of relay 111 to ground on the sleeve of the wanted line. When relay 120 operates, this locking circuit is transferred through the upper outer armature and front contact of relay 120, lower winding of relay
 60 116, lower inner armature and front contact of relay 120 to ground. Relay 116 is operated in this circuit and locks from battery through its upper winding and upper inner armature and front contact to ground
 65 at relay 120. Relay 116 in operating removes

battery and ground connections from the tip and ring conductors towards the selectors S1 and S due to the opening of the connections for these conductors at the third and fourth
 70 upper armatures and back contacts of this relay. This causes the release of relays 12 and 8. However, the operation of relay 116 connects a battery through a resistance to the tip conductor for the operation of relay 20. This circuit may be traced from battery
 75 through the resistance, upper outer armature and front contact of relay 122, upper outer armature and front contact of relay 111, fourth upper armature and front contact of relay 116 over the tip conductor through
 80 selectors S1 and S through the lower winding of relay 120, inner upper armature and back contact of relay 12, third lower armature and front contact of relay 8, before this relay is released after the release of relay 12,
 85 lower make-before-break contacts of relay 10, left hand armature and front contact of relay 3 to ground. Relay 20 in operating provides a locking circuit for itself from ground through its upper outer armature and front
 90 contact over the tip conductor to the battery applied by relay 116. Relay 20 in operating applies a busy tone from source 22 through the lower armature and front contact of relay 20, lower inner armature and front contact of relay 9 to the tip conductor
 95 leading through the line finder LF to the calling subscriber's station.

If the called subscriber's line is not busy there is no ground on the sleeve of his line and therefore relay 122 will release. However, a circuit is completed for the operation of relay 116 after the operation of relay 120 as follows: Battery through the line relay of the called line over the sleeve conductor,
 100 lower outer armature and front contact of relay 111, lower outer armature and back contact of relay 122, inner upper armature and front contact of relay 120, lower winding of relay 116 and to ground on the lower
 105 inner armature and front contact of relay 120. Relay 120 is maintained operated after relay 116 is operated although the original circuit for this relay is opened. The new circuit for relay 120 may be traced from battery
 110 through a resistance, upper make-before-break contact of relays 111 and 116, upper inner armature and back contact of rotary magnet 118, armature and back contact of vertical magnet 115, winding of relay 120,
 115 second lower armature and front contact of relay 111 to the ground at relay 102. The operation of relay 116 opens the connection to battery and ground for the tip and ring conductors to cause the release of relays 12
 120 and 8 but there is no battery supplied on the tip conductor in this case as relay 122 is released and therefore relay 20 will not operate. Instead ringing current is applied to the called subscriber's line in this case from the
 125
 130

negative source at 23, second lower armature and back contact of relay 19, upper winding of ringing trip relay 24, inner lower armature and back contact of relay 19, upper armature and back contact of relay 24, over the tip conductor through switches S, S1 and the connector C to the tip conductor of the called subscriber's line and through his bell and back over the ring conductor through the connector C, selectors S1 and S through the upper outer armature and back contact of relay 24 to ground. When the called subscriber removes his receiver in response to this ringing signal relay 24 operates and opens the ringing circuit. This relay in operating closes a locking circuit for itself from battery through its lower winding and lower armature and front contact to ground at the left hand armature and front contact of relay 3. The operation of relay 24 also establishes a connection through its upper armatures and front contacts to battery and ground for the tip and ring conductors through the windings of relay 4 which now operates through the called subscriber's loop and reverses at its left-hand armatures and contacts the connection from battery and ground through the windings of relay 3 to the calling line. Talking battery for the calling subscriber is supplied from battery and ground through the winding of relay 3 and talking battery for the called subscriber is supplied from battery and ground through the windings of relay 4.

To select and ring a desired subscriber on a four party line, the connectors C may be segregated in two groups either one of which may be selected by the selector S1. In one group the tip and ring conductors are shown as in connector C and in the other group the tip and ring conductors are reversed as indicated at the terminals 126. The condition of the tip and ring conductors in this respect will determine the polarity of ringing current to be applied to the called subscriber's line. A selected connector may then select either one out of two sets of terminals associated with a called party line arranged as shown at 128 and thereby causes the signaling current of one polarity or the other to be applied to one side or the other of the party line 100 to ring the desired subscriber's bell. These bells are connected as shown with like bells of two subscribers responsive to opposite polarities of signaling current connected to each side of the line.

As hereinbefore described, ringing current from source 23 was supplied when relay 19 was not operated and the tip and ring conductors of the connector C were arranged as shown. If the tip and ring conductors of the selected connector had been arranged as shown at 126 battery and ground from the connector would have been applied in the reverse order to the tip and ring conductors of the selectors S1 and S and thereby caused relay 19 which is polarized to operate in series with relay 12. A holding circuit for relay 19 which may be traced from battery through the upper winding of this relay and its lower outer armature and front contact to the ground at the right hand armature and front contact of relay 5 will maintain this relay operated as long as the connection remains. Relay 19 in operating reverses the connections for the tip and ring conductors at its upper armatures and front contacts. The operation of the system in regard to the operations of the vertical and rotary magnets in the selector S1 and connector C and the maintaining of the holding circuit for relays 13 and 5 during the pulsing will be exactly the same as hereinbefore described. The currents for the impulses will, however, pass over the tip and ring conductors in the reverse order between the connector C and the selector S but at connector C and selector S the current will pass in the same direction as hereinbefore described when relay 19 is not operated and the tip and ring conductors are not reversed in the connector. When the connection has been established to a called subscriber's line and ringing is applied with relay 19 operated, ringing current will be supplied from the positive source 26 through the lower outer armature and front contact of relay 9, lower inner armature and front contact of relay 19, upper winding of relay 24, second lower armature and front contact of relay 19, upper outer armature and back contact of relay 24 to the tip conductor. At relay 19 and its inner lower armatures and front contacts the ringing current will be transferred to the ring conductor and will continue over this conductor until it reaches the connector C where it is again applied to the tip conductor. Depending therefore on whether the current is received from the negative source 23 or the positive source 26 and whether the connector C has established connection with the called line 100 at the upper set of terminals or lower set of terminals at 128, the corresponding desired party line subscriber's bell will be actuated.

When the connection is released by the calling subscriber hanging up his receiver, the relay 3 in releasing causes the release of relay 5 and this relay in releasing opens the holding circuit for relays 24 and 9 and if relay 19 is operated the holding circuit for this relay will also be opened. A circuit for release magnet 28 will now be closed from battery, winding of this magnet, the vertical off-normal contacts 15, left-hand armature and back contacts of relays 5 and 3 to ground to release the selector S to normal when the release circuit is opened at the vertical off-normal contacts 15. When relay 9 releases the holding ground is removed from the sleeve of selector S1 to cause the release of relays 104 and 102

and close a circuit for the release magnet 130 from battery through the winding of this magnet, middle upper armature and back contact of relay 106, lower armature and back contact of relay 104 to the vertical off-normal contacts 107. Selector S1 is thereby released and when it has returned to normal the circuit for the release magnet 130 is opened at the vertical off-normal contacts 107. The removal of the ground from the sleeve at selector S1 by the release of relay 102 will release relays 111 and 120 and relay 120 in releasing will release relay 116. A circuit for the release magnet 132 is thereby completed from battery, winding of this magnet, second upper armature and back contact of relay 116, third lower armature and back contact of relay 111, lower outer armature and back contact of relay 120 to ground at the vertical off-normal contacts 114. The connector C is thereby released and the release circuit is opened on the return of the connector to normal by the opening of the connection to ground at the vertical off-normal contacts 114.

While this invention has only been illustrated in connection with a single system it should be understood that it may readily be applied to a plurality of other systems without departing from the spirit thereof.

What is claimed is:

1. In a telephone system, a switching device, an operating magnet therefor, a holding relay, a pulsing relay controlling said magnet, means for operating said holding relay responsive to the operation of the pulsing relay, and means for locking said holding relay in operated condition under control of the operating magnet.

2. In a telephone system, a switching device, an operating magnet for said device, a holding relay, a pulsing relay controlling the operations of said holding relay and said operating magnet, a locking circuit controlled by the operating magnet for maintaining said holding relay operated while the pulsing relay is released.

3. In a telephone system, a switching device, an operating magnet therefor, a holding relay, a pulsing relay, means for operating said holding relay in response to the operation of the pulsing relay, means responsive to the release of the pulsing relay for locking the holding relay in operated condition, means responsive to the holding relay and release of the pulsing relay for actuating said magnet, and means responsive to the operation of the magnet for disabling said locking means.

4. In a telephone system, a switching device, an operating magnet, a holding relay having two windings, a pulsing relay, means responsive to the operation of the pulsing relay for establishing an energizing circuit for said holding relay through one winding

thereof, means for establishing a locking circuit through the other winding of said holding relay in response to the release of the pulsing relay, means for establishing an energizing circuit for the operating magnet in response to the release of the pulsing relay and the operation of the holding relay, and means for opening said locking circuit in response to the actuation of the magnet.

5. In a telephone system, a switching device, an operating magnet, a holding relay having two windings, a pulsing relay, means responsive to the operation of the pulsing relay for establishing an energizing circuit for said holding relay through one winding thereof, means for short-circuiting said winding in response to the release of said pulsing relay, means for establishing a locking circuit through the other winding of said holding relay in response to the release of the pulsing relay, means for establishing an energizing circuit for the operating magnet in response to the release of the pulsing relay and the operation of the holding relay, and means for opening said locking circuit in response to the actuation of the magnet.

6. In a telephone system, a switching device, an operating magnet, a holding relay, a pulsing relay for controlling said operating magnet, means for operating said holding relay while the pulsing relay is operated, another relay, means for operating said second relay in response to the release of the pulsing relay and operation of the holding relay, means responsive to the operation of said second relay for establishing a locking circuit for the holding relay, means for opening said locking circuit in response to the operation of the magnet.

7. In a telephone system, a switching device, an operating magnet, a holding relay, a pulsing relay for controlling said operating magnet, means for operating said holding relay while the pulsing relay is operated, another relay, means for operating said relay and said magnet in response to the release of the pulsing relay and the operation of the holding relay, means responsive to the operation of said second relay for establishing a locking circuit for the holding relay and said second relay, and means for opening said locking circuit in response to the operation of the magnet.

8. In a telephone system, calling lines, party lines, groups of switches having access to party lines, preceding switches for connecting calling lines with idle switches in any of said groups of switches for establishing connections to party lines, sources of signaling current of different characteristics, a source of current in each of the group switches, means controlled by the selection by a preceding switch of the group of switches through one of which a connection is established and by current from the source in the

group switch through which the connection is established for selecting a signaling source of a particular character to be applied to the connected party line, and means in the preceding switch responsive to the completion of this connection to the desired party line for applying current thereto from the selected signaling source.

9. In a telephone system, calling lines, party lines, groups of switches having access to party lines, preceding switches for connecting calling lines with idle switches in any of said groups of switches for establishing connections to party lines, sources of signaling current of different characteristics associated with the preceding switches for calling connected party lines, a source of current in each of said group switches, means depending on the group of switches through which the connection is established by a switch thereof and controlled by the source of current in the group switch through which the connection is established for selecting a particular signaling source, and means in the preceding switch responsive to the completion of the connection to the desired party line for applying signaling current thereto from the selected source.

10. In a telephone system, calling lines, party lines, groups of final switches having access to party lines, preceding switches for connecting calling lines with party lines to switches in said groups, sources of signaling current of different characteristics associated with said preceding switches for signaling party lines, a source of current in each final switch, means for selecting the signaling source to be used responsive to the selection of the group in which the final switch used in establishing a connection is located and to current from the source in said final switch, a relay in this final switch operative on the completion of the connection and means in the preceding switch used in the connection responsive to the operation of said relay for applying signaling current from the selected source to the connected party line.

11. In a telephone system, calling lines, party lines, groups of final switches having access to said party lines, preceding switches for connecting calling lines with party lines through final switches, sources of signaling current of different characteristics associated with preceding switches for signaling party lines, relays in the preceding switches for controlling the selection of a signaling source, a current source in each final switch, means responsive to the establishing of a connection from a preceding switch to a final switch of one group and to current from the source in said final switch for controlling the relays in said connected preceding switch to select one signaling current source and responsive to a final switch of another group and to current from the source in said last mentioned

final switch for controlling the relays in the connected preceding switch to select another signaling current source and means responsive to the establishing of a connection to a party line for transmitting current from the selected signaling source.

12. In a telephone system, calling lines, party lines, groups of final switches having access to said party lines, preceding switches for connecting calling lines with party lines through final switches, sources of signaling current of different characteristics, means for establishing certain potential conditions on the conductors from the final switches in one group to preceding switches connected thereto and for establishing certain other potential conditions on the conductors from the final switches in another group to preceding switches connected thereto, means in a preceding switch responsive to the potential conditions established from a connected final switch for selecting a corresponding signaling source, and means for applying current from said selected signaling source to a connected party line in response to the establishing of the connection thereto.

13. In a telephone system, calling lines, party lines, groups of final switches having access to said party lines, preceding switches for connecting calling lines with party lines through final switches, sources of signaling current of different characteristics, means for establishing certain potential conditions on the conductors from the final switches in one group to preceding switches connected thereto, and for establishing certain other potential conditions on the conductors from the final switches in another group to preceding switches connected thereto, means including a relay in a preceding switch controlled by the potential conditions on the conductors from the connected final switch for selecting a corresponding signaling source, and means for applying current from the selected signaling source to the connected party line in response to the establishing of the connection thereto.

14. In a telephone system, calling lines, called lines, trains of switches for connecting a calling line with a called line, means in the last switch used in establishing a connection for applying battery to the tip conductor of the preceding switches in response to the calling line being already engaged in a previous connection, and means in a preceding switch responsive to this battery connection for applying busy tone to the calling line.

15. In a telephone system, calling lines, called lines, trains of switches for connecting a calling line with a called line, a connection to battery and ground for the last switch used in the establishing of a connection, means in the last switch for momentarily opening the connection to battery and for permanently opening the connection to

ground in response to the called line being busy, and means in a preceding switch responsive to said momentary removal of the battery connection and the permanent removal of the ground connection for applying busy tone to the calling line.

16. In a telephone system, calling lines, called lines, trains of switches for connecting a calling line and a called line, means in the last switch used in the establishing of a connection for normally connecting battery and ground to the tip and ring conductors for the preceding switches, a relay in said last switch, means for operating said relay during the operation of said last switch in search of the called line, means for releasing said relay if the called line when found is idle and for maintaining it operated if the called line is busy, means responsive to the maintaining of said relay operated at this time for momentarily removing the battery connection and permanently removing the ground connection for the preceding switches and means in a preceding switch responsive to said removal and subsequent restoration of the battery connection and removal of the ground connection for applying a busy tone to the calling line.

17. In a telephone system, calling lines, called lines, trains of switches for connecting a calling line and a called line, means in the last switch used in the establishing of a connection for normally connecting battery and ground to the tip and ring conductors for the preceding switches, a relay in said last switch, means for operating said relay during the operation of said last switch in search of the called line, means for releasing said relay if the called line when found is idle and for maintaining it operated if the called line is busy, means responsive to the release of said relay at this time for extending connection to the called line over the tip and ring conductors thereof and for removing the battery and ground connection from the preceding switches, means in a preceding switch responsive to the removal of battery and ground connection for applying ringing signals to the called lines, means responsive to the maintenance of said relay operated for momentarily removing the battery connection and permanently removing the ground connection for the preceding switches, and means in a preceding switch responsive to said momentary removal of the battery connection and the permanent removal of the ground connection for applying a busy tone to the calling line.

18. In a telephone system, calling lines, called lines, trains of switches for connecting a calling line and a called line, means in the last switch used in the establishing of a connection for normally connecting battery and ground to the tip and ring conductors for the preceding switches, a relay in said last switch, means for operating said relay

during the operation of said last switch in search of the called line, means for releasing said relay if the called line when found is idle and for maintaining it operated if the called line is busy, means responsive to the maintaining of said relay operated at this time for momentarily removing the battery connection and for permanently removing the ground connection to the preceding switches, and means including a relay in a preceding switch responsive to said momentary removal of the battery connection and the permanent removal of the ground connection for applying busy tone to the called line.

19. In a telephone system, calling lines, called lines, trains of switches for connecting a calling line with a called line, means in the last switch used in establishing a connection including two relays responsive to the called line being already engaged in a previous connection for applying battery to the tip conductor of the preceding switches, and means including a relay in a preceding switch responsive to this battery connection for applying busy tone to the calling line.

20. In a telephone system, calling lines, called lines, trains of switches for connecting a calling line with a called line, means in the last switch used in establishing a connection for normally applying battery and ground to the tip and ring conductors of preceding switches and for momentarily removing said battery connection and for permanently removing the ground connection in response to the called line being already engaged in a previous connection, two relays in a preceding switch normally maintained actuated by said battery and ground connections applied from the last switch, means for releasing said relays in response to the momentary removal of the battery connection and for permanently removing the ground connection from said preceding switch, another relay, and means for actuating said last mentioned relay in response to the second application of the battery connection applied to said switch operation after the release of one of said previous mentioned relays and before the release of the other, and means for applying busy tone to the calling subscriber in response to the operation of said last mentioned relay.

In witness whereof I hereunto subscribe my name this 24th day of July, 1930.

RAY L. STOKELY.