

Sept. 11, 1945.

H. T. STENHAMMER

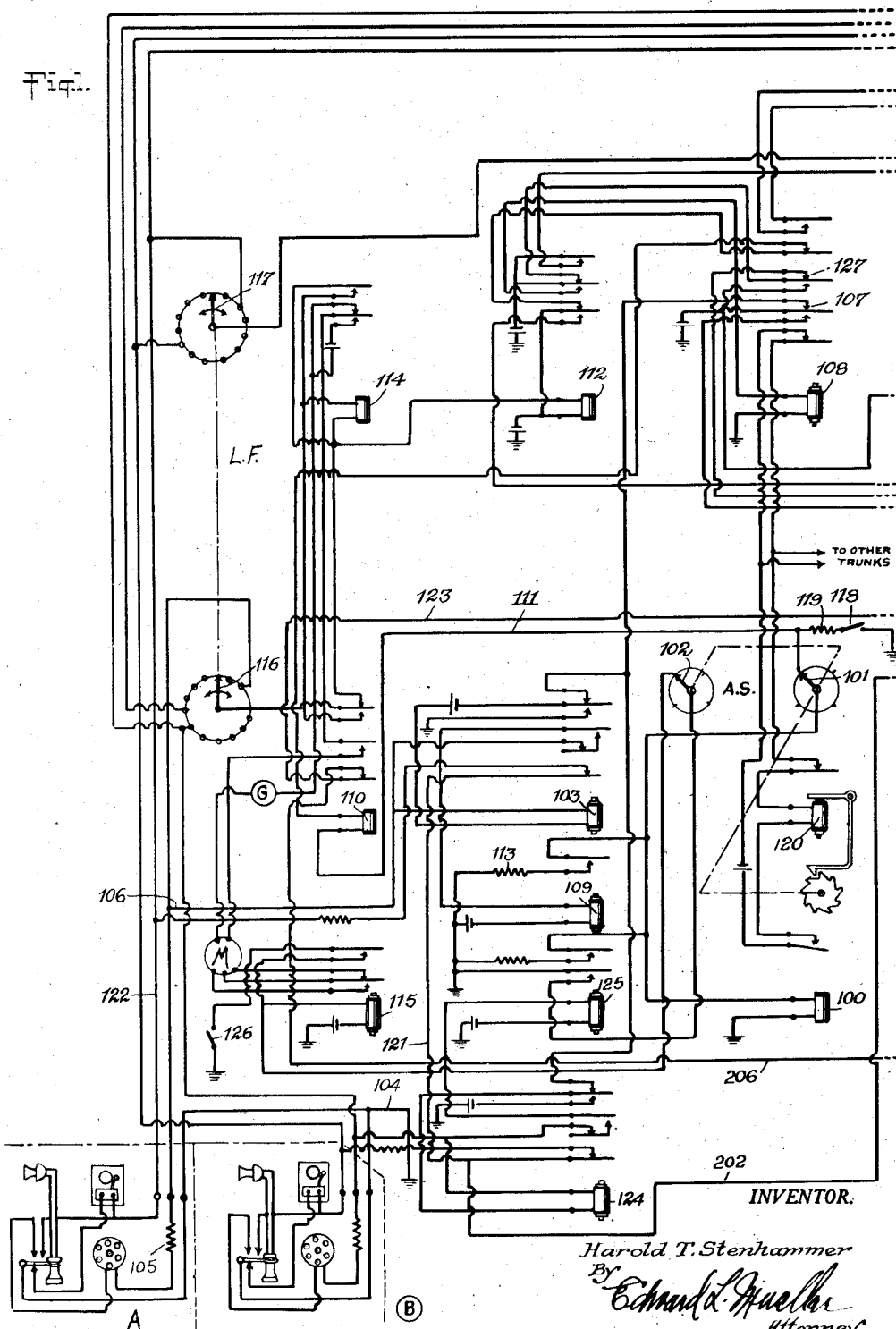
2,384,775

TELEPHONE SYSTEM

Filed May 19, 1944

2 Sheets-Sheet 1

Fig. 1.



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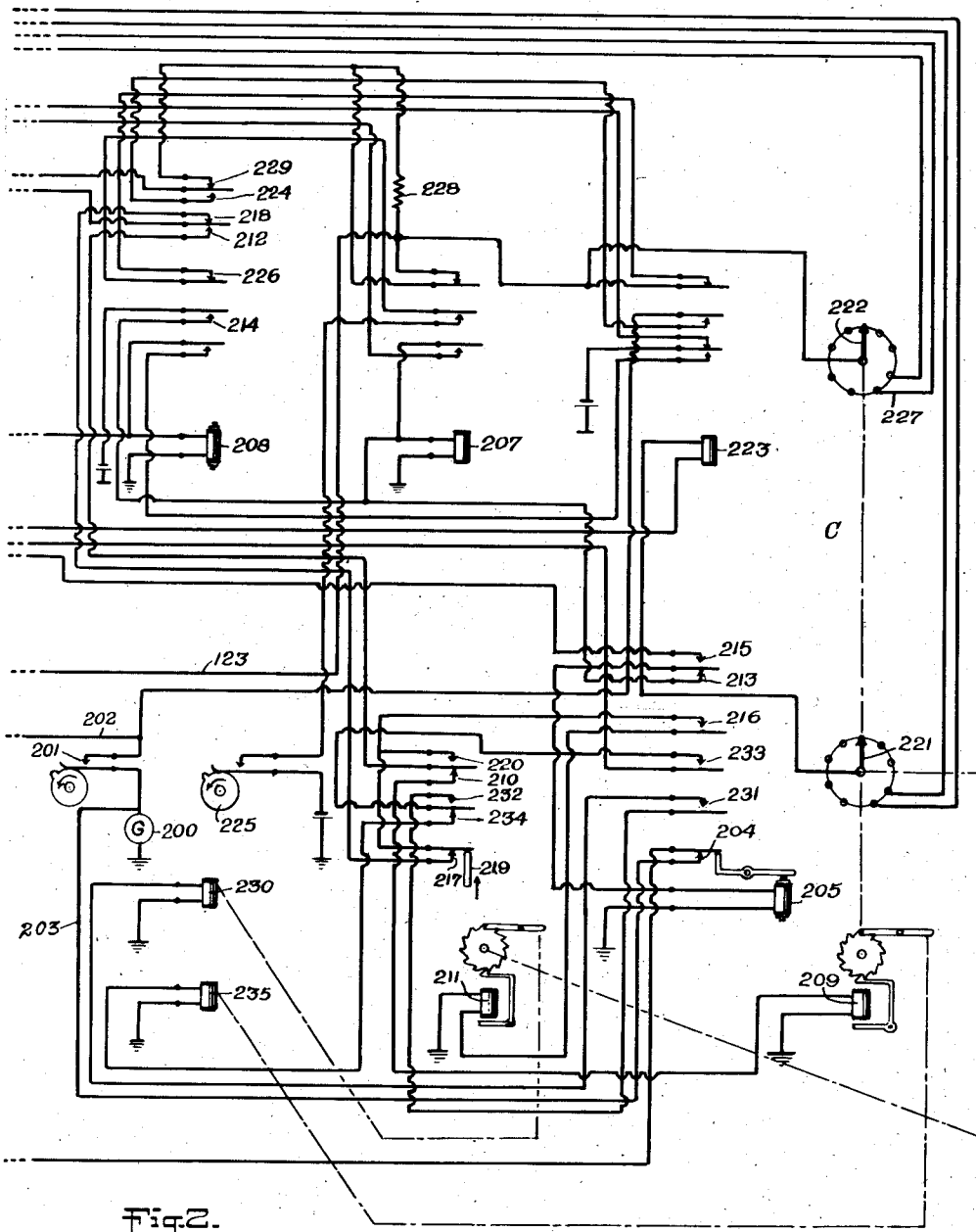
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TELEPHONE SYSTEM

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10 Claims. (Cl. 179—18)

This invention relates to improvements in telephone systems and has particular reference to a system such as may be applicable to a private automatic exchange.

An object of the invention is to provide an improved system in which the connection between calling and called subscribers' lines is facilitated by the provision of a switch and control means therefor which will selectively operate the switch wipers in either one of two different directions during the establishment of a call.

Another object is to control the operation of a two-directional switch by means of a reversible motor and an alternating current generator in such manner that when said switch has extended a calling line, direct current will be connected to the motor through said generator to dynamically brake said motor.

The above and other objects will appear more clearly from the following description when taken in connection with the accompanying drawings which illustrate a preferred embodiment of the inventive idea.

Figs. 1 and 2, when arranged side by side in vertical position, illustrate the system of the present invention, the dotted lines extending between various parts of the apparatus indicating mechanical drive connections therefor.

The circuit of the invention is designed for use in private automatic exchanges and embodies, generally, a plurality of trunk or link circuits each adapted to be preselected by an allotter switch common thereto, and each having a line finder operable from a normal position to seek the terminals of a calling line. The subscribers' stations are arranged in two groups having terminals in different sectors of the finder bank, and the arrangement is such that initiation of calls in the different groups will cause the finder wipers to rotate from normal in opposite directions in seeking the terminals of the calling lines, thereby materially reducing the time required for hunting. Upon seizure of a calling line, the preselected trunk circuit is then in condition to receive impulses transmitted from a calling station to directionally control the operation of a connector switch which completes the connection to the called line.

The substation equipment conventionally illustrated herein embodies what is known as a sound powered telephone transmitter-receiver. Such equipment, in contrast to the well-known battery telephone, employs no battery for the audio lines since the sound waves impressed upon the diaphragm of the transmitter inductively set up a voltage in its coil. This is accomplished by a

relative motion between said coil and the diaphragm, the coil being placed in the field of a permanent magnet in the transmitter unit. The electrical impulses thus generated are carried over the audio lines to the receiver unit which is also of the well-known magnetic type.

As shown, the trunk circuit and its associated line finder L. F. and connector switch C are in the condition existing at the moment of their preselection by the allotter switch A. S. and before a call is initiated at one of the subscribers' stations in the different groups of lines A or B. Relay 100 of the allotter is at this time energized to maintain the wipers 101 and 102 of said switch on the terminals of the preselected idle trunk, as will be more fully understood from the following description. It will be first assumed that a call is initiated from the station shown in group A. All lines in said group terminate in the right half or sector of the finder bank and hence, as will be seen, the wipers of the finder will rotate clockwise in seeking the terminals of a calling line in said group.

Removal of the receiver from the switch hook at the A station closes a circuit for energizing the slow-operating line relay 103 individual to the calling line, which circuit extends from ground over the conductor 104, the switch hook and impulse sender at said station, resistor 105, conductor 106, winding and upper back contact of relay 103, and from thence to battery through the back contact 107 of the slow-release relay 108. Relay 103 energizes and establishes a locking circuit for itself through its upper front contact to battery. Energization of relay 103 momentarily establishes an energizing circuit for the slow-release relay 109 which is common to the lines in group A, said circuit extending from battery through the winding of relay 109, the make-before-break contacts of relay 103 and from thence to ground over the conductor 106. Energization of the relay 109 is designed to initiate the hunting operation of the finder L. F. by effecting the energization of the control relay 110 for said switch. At the time of the preselection of the trunk by the allotter A. S. and prior to the energization of relay 109, a circuit for relay 100 of the allotter is established which extends from ground through the winding of relay 100, wiper 101 of the allotter, conductor 111, winding of relay 110, the upper back contact of relay 108, and lower back contact of relay 112 to battery. The energizing voltage of relay 100 being considerably less than that of relay 110 causes said relay 100 to energize but the control relay

110 is not energized in this circuit. However, when relay 109 is energized, as above described, resistor 113 is connected in parallel with relay 100, causing this relay to release and relay 110 to energize. When relay 110 closes its lower front contact, an energizing circuit is established for the line finder motor M through the generator G and the back contact of relay 114. With the back contact of the slow-release, motor-reversing relay 115 closed, the motor will rotate the line finder wipers 116 and 117 in a clockwise direction to seek the terminals individual to the calling line. The energization of relay 109 being only momentary, because of the make-before-break contacts of relay 103, ground through the resistor 113 and contact of relay 109 will be removed from the winding of relay 110 when said relay 109 deenergizes. But before this occurs, the wipers of the switch L. F. will have been moved from their normal positions, causing the closure of switch 118, thus connecting ground through the resistor 119 to the conductor 111 and the winding of relay 119 so as to maintain this relay energized until the wipers 116, 117 engage the terminals of the calling line.

Before proceeding further with the operation of the line finder, it will be noted that upon deenergization of the allotter relay 100 by the short circuit established therefor through the contact of relay 109, a circuit will be established for the slow-release stepping magnet 120 of said allotter so that the wipers 101 and 102 will be stepped to the next succeeding set of terminals individual to another trunk. This energizing circuit for the magnet 120 extends from one side of battery through the contact of relay 100, the winding of relay 120, its self-interrupting contact and the lowermost back contact of relay 108 to the other side of battery. If the wiper 101 should engage the terminal of an idle trunk, the previously described energizing circuit for relay 100 extending through the winding of relay 110 of the idle trunk and back contact 107 of relay 108 of said trunk will be established, and relay 100 will again energize to open the circuit for the stepping magnet 120, and switch A. S. will then come to rest upon the terminals of the idle trunk. However, should wiper 101 engage the terminal of a busy trunk, relay 108 of said trunk will be energized and therefore the energizing circuit for relay 100 will be opened at the uppermost back contact of relay 108 of said busy trunk. This results in the magnet 120 stepping the wipers of switch A. S. to the terminals of the next trunk, providing that at least one of the trunks serving the system is idle. From the foregoing, it will be further observed that if all trunks are busy, the lowermost back contacts of all the relays 108 of said trunks will be open and, consequently, no energizing circuit for the magnet 120 will be established and the wipers of the allotter switch will remain stationary until a trunk becomes available. Further, it will be noted that if all trunks are busy at the time a call is initiated, the line relay 103 of the calling line will fail to energize because the back contacts 107 of all the relays 103 will be open. Under this condition, a busy signal will be transmitted to the calling station from the generator 200 through the interrupter 201, conductor 202, conductor 121, the lowermost back contact of relay 103, the conductor 122, the receiver at the calling station, the switch hook thereat and from thence to ground over the conductor 104. The subscriber at said

station, hearing said busy signal, replaces his receiver upon the switch hook.

Returning now to the operation of the line finder whose wipers 116, 117, are rotating in a clockwise direction because of the energization of the control relay 110, when the test wiper 116 engages the terminal individual to the calling line, it finds ground potential through resistor 105 which is now extended through said wiper, the upper front contact of relay 110 and the windings of relays 114 and 112 to battery. Relay 114, which has a low energizing voltage as compared to relay 112, now energizes and the alternating current circuit from the generator G, which controls the motor M of the line finder, is cut off at the back contact of relay 114 and direct current is momentarily supplied to the motor through the lower front contact of said relay thus effecting a dynamic braking of the motor. Motor M may be of the alternating current type so that when such current is disconnected therefrom and direct current voltage is applied to the field of said motor, its rotor will be caused to come to an immediate stop on the terminals of the calling line. The closure of the upper front contact of relay 114 short circuits said relay and it now releases. However, before said relay releases, relay 112, because of the higher voltage now received due to the closure of the upper front contact of relay 114, energizes over a circuit through said upper front contact and the upper front contact of relay 110 to ground at the terminal now engaged by the wiper 116. Energization of relay 112 closes an energizing circuit for slow-release relay 108 extending from battery through the middle front contact of relay 112 and the winding of relay 108 to ground. The opening of the lower back contact of relay 112 and the upper back contact of relay 108 permanently opens the energizing circuit for the finder control relay 110 which now deenergizes to prevent any further operation of motor M so that the finder wipers will now rest on the terminals of the calling line. A dial tone is now transmitted to the calling station from the generator 200 over the conductor 203, the normally closed contact 204 of the slow-release relay 205 of the connector C, conductor 206, the lower back contact of relay 110, conductor 123, the upper back contact of relay 207, the uppermost back contact 229 of relay 208, the audio wiper 117 of the line finder, and from thence through the receiver and switch hook at the calling station to ground over the conductor 104. The subscriber, hearing this dial tone, will now operate the impulse sender at said station to transmit the necessary series of impulses to operate the two-directional connector C.

Before proceeding with the description of the completion of the call from the line in group A, the operation of the finder L. F. in response to the initiation of a call in group B will be described. In this instance, the line relay 124 individual to the calling line energizes and locks up when the receiver is removed from its switch hook, in the same manner as described in connection with the line relay 103. Energization of relay 124 closes, through its make-before-break contacts, a momentary energizing circuit for slow-release relay 125 which is the equivalent of relay 109 and which is common to the subscribers' lines in the B group. Closure of the upper front contact of said relay 125 effects the release of relay 100 to cause the allotter A. S. to preselect another idle trunk and energizes the finder control relay

110 to start the line finder on its hunting operation, as previously described, with the exception that in this instance the wipers of the finder are rotated in a counterclockwise direction. This reversal of the movement of the wipers, as distinguished from the clockwise movement thereof when a call is initiated in group A, is brought about by the closure of the lower contact of relay 125 which establishes a circuit for the reversing relay 115 extending from battery through the winding of said relay, the wiper 102 of the allotter switch and from thence to ground through said lower contact of relay 125. Energization of relay 115 reverses the connections to the terminals of the motor M so that when the previously described operating circuit for said motor, which extends through the lower front contact of relay 110, is established by the energization of the latter relay, said motor will then drive the wipers 116, 117 in a counterclockwise direction. As the wipers leave their normal positions, the off-normal switch 126, similar to switch 118 closes, and in so doing, establishes a locking circuit for the relay 115 before relay 125 releases, which circuit extends through the upper front contact of relay 115. Therefore, the latter relay remains energized until the finder is restored to normal at the conclusion of the call. When test wiper 116 finds ground on the terminal of the calling line, relays 114 and 112 are energized, relay 114 thus braking motor M and relay 112 causing relay 110 to release and thus permanently open the energizing circuit for said motor. Thereupon, the dial tone from the source 200 is connected to the receiver at the subscriber's station.

The transmission of impulses from any station in group A or B controls the operation of the connector switch C in the following manner. Relay 112 is responsive to the interruptions in its circuit which extends through the upper back contact of relay 110 and, at the first interruption in said circuit, it opens, at its middle front contact, the holding circuit for relay 108, but the latter being slow to release, will remain energized during the transmission of impulses. Closure of the upper back contact of relay 112 at the first interruption in the pulsing circuit establishes an energizing circuit for the slow-release relay 208 extending from battery through said upper back contact, the middle front contact of relay 108 to ground through the winding of relay 208. The latter relay remains energized during transmission of each series of impulses and, in the event that the called line is busy, a locking circuit will be established for relay 208 through its lowermost contact for a purpose and in a manner which will appear in the course of the description. Energization of relay 208 closes an operating circuit for relay 207 through the closed contact 214 of relay 208, and relay 207 is held energized in a locking circuit extending from ground through its winding and lower front contact, the uppermost front contact of relay 108 and the lower back contact of relay 223 to battery. Relay 207 remains energized at least until the switch C is connected to the terminals of the called line and will continue to be held energized if said line is idle so that ringing current can be applied to the line, as will later appear. Upon reenergization of relay 112 at the termination of the first interruption in its pulsing circuit, an energizing circuit for the vertical stepping magnet 209 of the switch C will be established extending from ground through the winding of said magnet, the normally closed contact 210 of the switch pile

controlled by the horizontal stepping magnet 211, the now closed contact 212 of relay 208 and from thence to battery through the upper front contact of relay 112. The energization of relay 208 in response to the first interruption in the pulsing circuit, energizes slow-release relay 205 in a circuit established from ground through the winding of said relay, the normally closed contact 213 of the switch pile associated with said relay and the closed contact 214 of relay 208 to battery. Energization of relay 205 in this circuit causes its armature to raise the movable elements of the switch pile so that the contacts 204 and 213 will be opened and the remaining contacts of the pile closed. When the uppermost contact 215 of said pile is closed, a holding circuit is established for relay 205 extending to battery through the lowermost front contact of relay 108 so that all contacts of the pile similar to 215 are closed until the connector switch is restored to normal. Subsequent impulses in the first series transmitted from the calling station successively operate stepping magnet 209 so as to vertically move the wipers of the connector switch to the horizontal rows in its bank corresponding to the number of impulses in the tens digit of the called line.

At the termination of the transmission of the first series of impulses, slow-release relay 208 de-energizes and relay 112 remains energized. This condition establishes a temporary circuit for the horizontal stepping relay 211 which causes the wipers of the connector switch to take one step in a rotary direction. This circuit for the stepping magnet extends from ground through the winding thereof, the now closed contact 216 of the switch pile associated with relay 205, the normally closed contact 217 of the pile associated with the stepping magnet 211, the back contact 218 of relay 208, and the upper front contact of relay 112 to battery. Magnet 211 takes one step and in so doing the cam 219 is operated to reverse the positions of its switch pile so that the energizing circuit for magnet 211 will be opened at contact 217. The change over from vertical to horizontal movement of the connector wipers is now completed and the switch is ready to receive the second series of impulses corresponding to the units digit of the called line.

The subscriber now dials the second series of impulses and at the first interruption of relay 112, relay 208 again energizes and remains in this condition through the successive impulses of the series. Energization of relay 208 prepares an energizing circuit for the horizontal stopping magnet 211 which circuit is closed upon reenergization of relay 112 at the termination of the first interruption of its pulsing circuit. Said energizing circuit for magnet 211 extends from ground through its winding, the now closed contacts 216 and 220 of the switch piles, contact 212 of relay 208, and from thence to battery through the upper front contact of relay 112. Stepping magnet 211 thus responds to each interruption of the pulsing circuit to horizontally step the wipers of connector C to the terminals of the called line. If this line is not busy, relay 208 will deenergize upon completion of the train of impulses and the energizing circuit for the stepping magnet 211 will be permanently opened so that the wipers 221 and 222 of the connector will come to rest on the desired terminals. On the other hand, if the called line is busy, ground potential will be applied to the test terminal of said line from the grounded conductor 104 thereof. Consequently,

this ground will be extended through the test wiper 221 of connector C through the winding of relay 223 to battery at the lower front contact of relay 112. Relay 223 energizes in this circuit before slow-release relay 208 can deenergize, and the previously mentioned locking circuit for the latter relay is thus established from battery to ground through the lower front contacts of relays 223 and 208, and the winding of the latter relay. Operation of relay 223 removes battery from the locking circuit of relay 207 which then releases. A busy signal is now transmitted to the calling station from the source 200 through the interrupter contact 201, the upper front contact of relay 223, the upper front contact 224 of relay 208, and from thence through the wiper 117 of the line finder to the receiver at the calling station. The subscriber thereat replaces his receiver and thereby effects the release of the circuit in a manner to presently appear.

Assuming now that the called line was idle and further assuming for purposes of illustration that the called station is station B, a ringing signal is connected to the called line from the source 225 through the interrupter thereat, the upper front contact of relay 207 which now remains energized in the previously described locking circuit therefor, the back contact 226 of relay 208 which has now released, the upper back contact of relay 223 and from thence through the wiper 222 of connector switch over the talking conductor 227 to ground through the ringer at station B. Part of this ringing voltage is fed back to the receiver at the calling station through the resistor 228, the upper back contact 229 of relay 208 and the wiper 117 of the line finder to the receiver at the calling station A. The subscriber at the called station, upon removing his receiver from the switch hook, applies ground to the test wiper 221 of the connector and thus establishes the energizing circuit for relay 223 which, at its upper back contact, disconnects the ringing source from the line and, at the same time, breaks the locking circuit for relay 207 which then releases.

The release of the connection is under the control of the calling station and, when the receiver thereat is replaced upon its switch hook, ground over the conductor 104 is disconnected at the switch hook contact from relay 112, and this relay now deenergizes, thus breaking the circuit for relay 108 at the middle front contact of relay 112 and said relay 108, after an interval, releases. Line relay 103 is also released by the removal of said ground and the opening of the lower front contact of relay 112 also releases relay 223. Control relay 119 of the line finder is again energized through the switch 118, the uppermost back contact of relay 108 and the lower back contact of relay 112, whereupon the energizing circuit for the finder motor M is again closed through the lower front contact of relay 110 and the back contact of relay 114. If the called station happened to be in group B, the motor reversing relay 115 will be energized and locked at this time and consequently the motor M will again drive the wipers 116, 117 in a counterclockwise direction until the normal positions of said wipers are reached. At this time, the switches 118 and 126 will open to deenergize, respectively, the control relay 110 and the reversing relay 115, whereupon the wipers of the finder will come to rest in their normal positions.

Release of the connector switch is also accomplished when relays 108 and 112 deenergize. A circuit is then established for the horizontal re-

lease relay 230 extending from ground through the winding of said relay, the now closed contacts 231, 232 and 233 in the two switch piles, the back contact 127 of relay 108 and the upper back contact of relay 112 to battery. Energization of relay 230 will, through its mechanical connection to the horizontal stepping mechanism of magnet 211, effect the restoration of the switch wipers 221, 222 in a horizontal direction and will, at the same time, restore the cam 219 in a manner well understood so that the movable contacts of the pile controlled by said cam will restore to their normal positions and thus again close the contacts 210, 217 and 234 with the result that the energizing circuit of the release magnet 230 will be permanently opened. Closure of the contact 234 establishes an energizing circuit for the vertical release relay 235 through said contact, contact 233 and from thence to battery over the previously described energizing circuit for the release magnet 230. Energization of relay 235 releases the stepping mechanism controlled by the vertical magnet 209, thus permitting the wipers 221, 222 to move downwardly to their normal positions. At the time that relay 108 was released at the conclusion of the call, the holding circuit for the slow-release relay 205 was opened at the lowermost front contact of relay 108, but the release of relay 205 is so timed that the horizontal and vertical restoration of the connector switch wipers is accomplished before the armature of relay 205 restores. Therefore, the last in the sequence of restoring operations of the switch C and associated equipment is the return to normal of the switch pile controlled by the relay 205 and the consequent deenergization of the vertical release relay 235.

What is claimed is:

1. In a telephone system, a plurality of subscribers' lines arranged in groups and each having a line relay individual thereto, a plurality of trunk circuits, an allotter switch for preselecting an idle trunk, means to prevent operation of said switch when all trunks are busy, a second switch having a two-directional rotary movement during establishment of calls over an idle trunk, means to rotate said second switch in one direction or the other depending upon the group in which a calling line is located, means operable upon initiation of a call to prevent energization of said line relay should all trunks be busy, and means thereupon controlled by said line relay for transmitting a busy signal to the calling line.

2. In a telephone system, a plurality of subscribers' lines arranged in groups, a trunk circuit including a line finder having a two-directional movement when hunting for calling lines in said groups, a reversible motor and an alternating current generator therefor for operating said finder, means dependent upon the group of lines in which a call is initiated for controlling the direction of operation of said motor, and means operable upon the finding of a calling line in either group to momentarily connect direct current to said motor through said generator to dynamically brake said motor.

3. In a telephone system, a plurality of subscribers' lines arranged in groups, a trunk circuit including a line finder having a two-directional movement when hunting for calling lines in said groups, a reversible motor and an alternating current generator therefor for operating said finder, means responsive to the initiation of a call in one of said groups for energizing said motor so that it will rotate in one direction, a relay

responsive to the initiation of a call in a different group for reversing the direction of said motor, and means responsive to the seizure of a calling line in either group for dynamically braking said motor.

4. In a telephone system, a plurality of subscribers' lines arranged in groups, a line relay individual to each line, group relays each common to the lines of one of said groups and energizing said line relays, a plurality of trunk circuits, an allotter for preselecting an idle trunk under the control of said group relays, a line finder for the selected trunk having movements in either one of two directions depending upon the group location of a call-initiating line, a reversible motor and connections therefor, for operating said line finder in either direction, a circuit for said motor, a control relay for said circuit energized through said allotter and contacts of said group relays, and another relay controlled through said allotter and by one of said group relays and responsive to the initiation of a call in one of said groups to reverse the connections of said motor and thereby drive said finder in one of said directions.

5. In a telephone system, a plurality of subscribers' lines, a switch operable during establishment of a call for extending a calling line, a reversible motor and an alternating current generator therefor for operating said switch, and means operable, when said switch has extended said line, to connect direct current to said motor through said generator to dynamically brake said motor.

6. In a telephone system, a plurality of subscribers' lines, a switch having a two-directional movement and operable during establishment of a call to extend a calling line, a reversible motor and an alternating current generator therefor for operating said switch, means dependent upon the line on which a call is initiated for controlling the direction of movement of said switch, and means operable, when said line is extended by said switch, to connect direct current to said motor through said generator to dynamically brake said motor.

7. In a telephone system, a plurality of calling and called subscribers' lines, a line finder having a two-directional movement and operable to extend a calling line toward a called line, a reversible motor and an alternating current generator therefor for operating said line finder, means dependent upon the line on which a call is initiated for determining the direction of movement of said finder, and means responsive to the extension of a calling line to said finder to connect direct current to said motor through said generator.

8. In a telephone system, a plurality of subscribers' lines arranged in groups, a relay for each group, a plurality of trunk circuits, an allotter under the control of said relays and responsive to the initiation of a call on a line in any one of said groups for preselecting an idle trunk for a succeeding call in either group, a line finder for each trunk circuit operable to seek a calling line in any one of said groups, a reversible motor and connections therefor for operating said line finder in different directions depending upon the group in which the call is initiated, a circuit for said motor, means under the control of one of said group relays and said allotter for energizing said motor circuit to operate its finder in one direction, and means responsive to the initiation of a second call in a different group and controlled through said allotter and by the relay individual to the latter group for reversing the connections of the motor of said preselected trunk.

9. In a telephone system, a plurality of subscribers' lines arranged in groups, a plurality of trunk circuits, a line finder for each circuit having a two-directional movement, an allotter for preselecting an idle trunk for a succeeding call upon initiation of a first call in one of said groups, means to enable the finder assigned to said idle trunk to start its hunting operation to seek said succeeding call in either of said groups before the first named finder is connected to its calling line, and means to move each of said finders in one or the other of its directions depending upon the group in which the calling line sought by said finder is located.

10. In a telephone system, a plurality of subscribers' lines arranged in groups, a plurality of trunk circuits, a line finder assigned to each circuit, a control relay for each finder, an allotter for preselecting an idle trunk for a succeeding call upon initiation of a first call in one of said groups, a relay for said allotter having an energizing circuit including the winding of the finder control relay of a preselected trunk for stopping said allotter on the terminals of said trunk, a group relay common to the group of lines in which said first call appears and operable upon initiation of said call to release said allotter relay and energize the finder control relay of the finder to which said call is allotted, means responsive to the release of said allotter relay to operate said allotter switch to preselect said idle trunk, and means responsive to the energization of said finder control relay to initiate the operation of the finder switch allotted to first said call.

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