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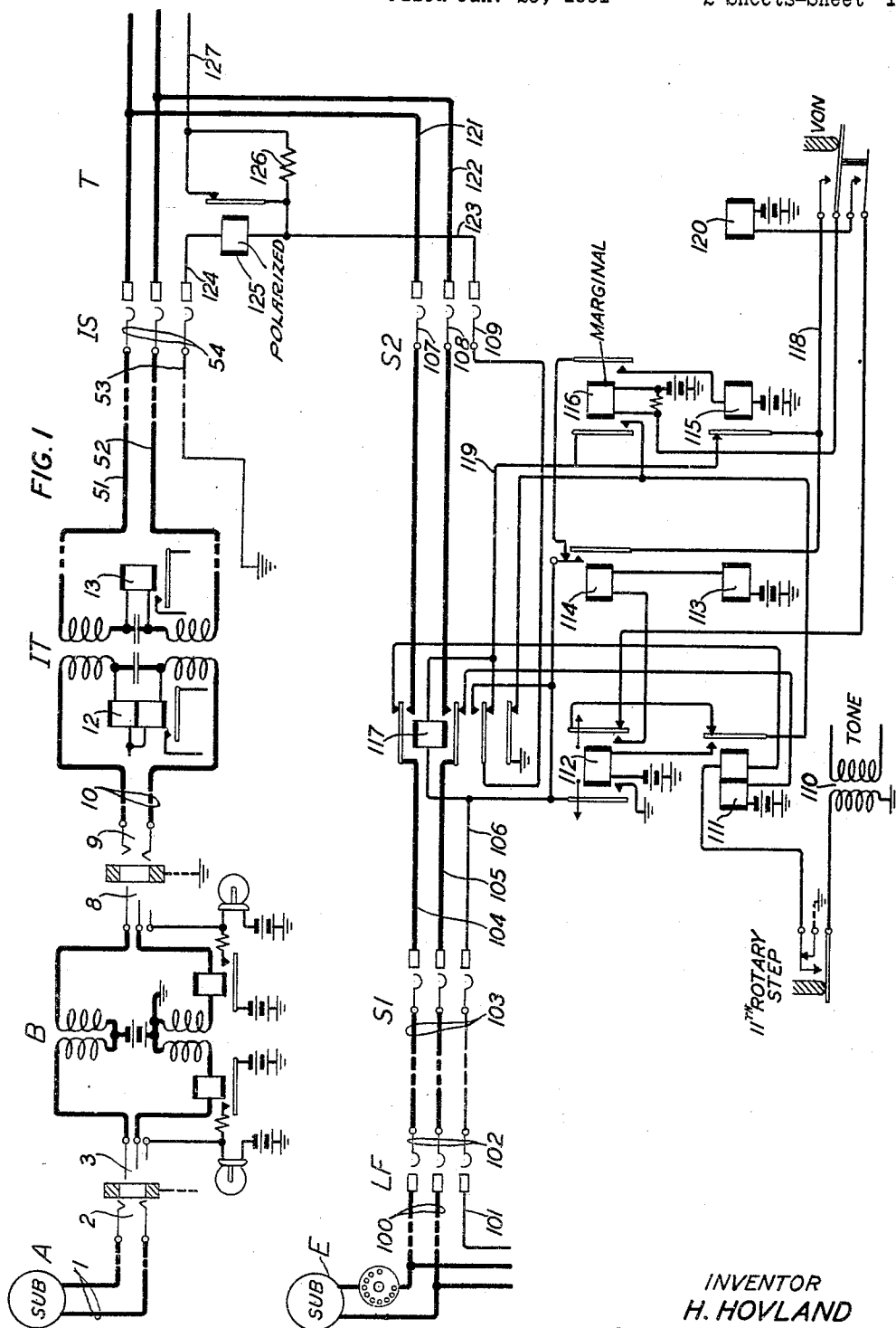
H. HOVLAND

1,912,453

TELEPHONE EXCHANGE SYSTEM

Filed Jan. 29, 1931

2 Sheets-Sheet 1



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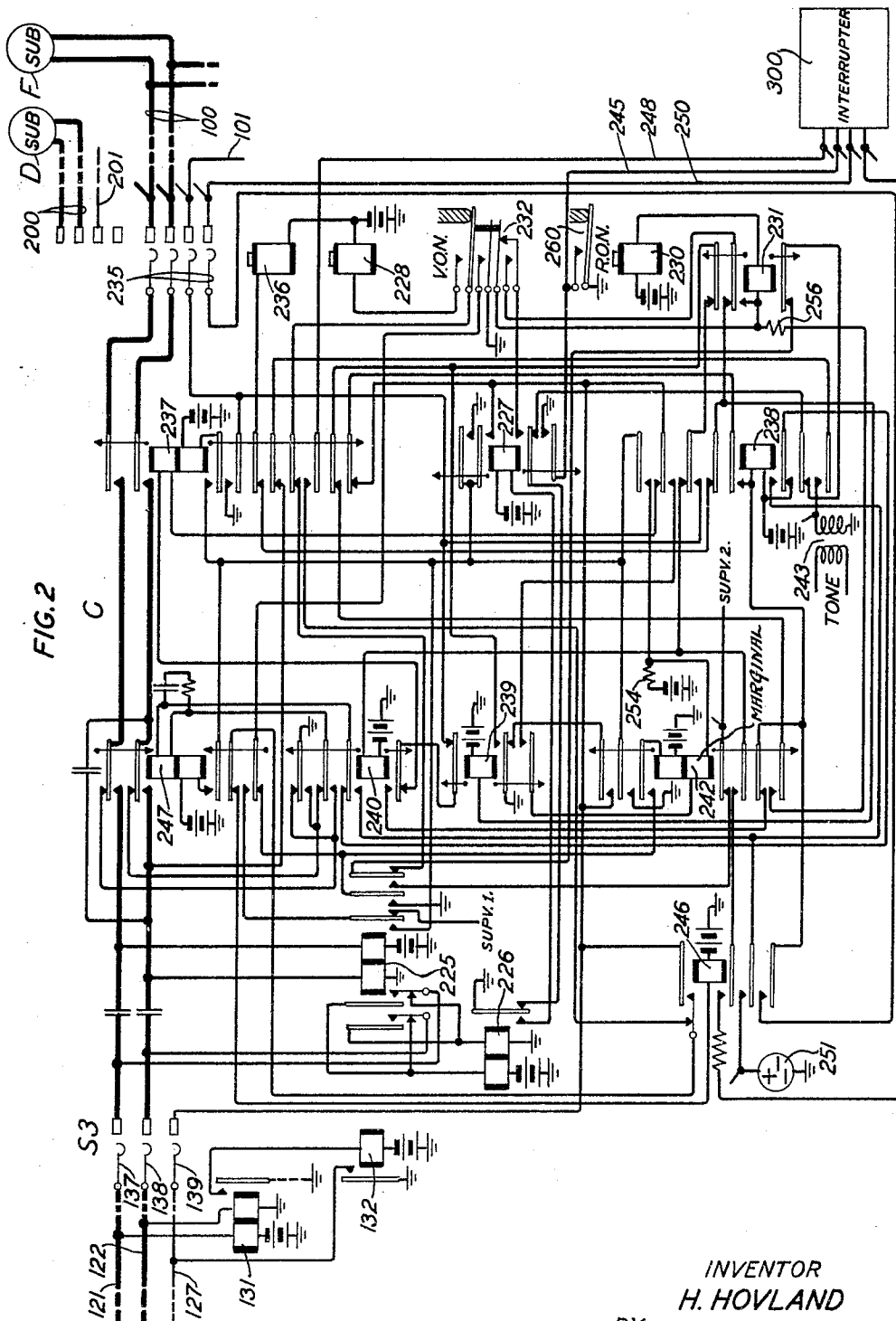
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TELEPHONE EXCHANGE SYSTEM

Application filed January 29, 1931. Serial No. 511,941.

This invention relates to telephone exchange systems and more particularly to improvements in automatic systems arranged for party line service.

5 The object of this invention is to minimize the equipment required for completing calls to party line subscribers and to insure the availability of this equipment for use in completing connections.

10 In automatic telephone systems which give service to rural or party line subscribers, the code ringing connectors provided for completing connections to these lines are arranged to make a test, known as a reverting-call test, whenever the called line is found
15 busy to determine whether the called and calling stations are on the same line. When the receiver is replaced at the calling station, the winding of the reverting-call test relay is
20 connected over the sleeve conductor of the preceding selector switches to the sleeve terminal of the calling line; and, if the calling and called stations are on the same line, the make-busy ground connected through the
25 test brush of the connector switch to the test terminal of the called line is effective to operate the reverting-call test relay and thereby prevent the release of the connector switch. Such a connector switch is disclosed
30 and fully described in the copending application of H. Hovland, Serial No. 452,155, filed May 14, 1930, which matured into Patent No. 1,849,087, March 15, 1932. These connectors cannot be used for completing toll or other
35 interoffice calls if the preceding selector switches are arranged to connect a ground to the sleeve conductor during the release of the connection in consequence of the called line being found busy; for this ground would
40 cause the operation of the reverting-call test relay and thereby falsely indicate that the call was a reverting call and prevent the release of the connector switch.

A feature of this invention is a circuit arrangement in which a high resistance is in series with a conductor which is multiplied to a plurality of points, the resistance being normally short-circuited by the contacts of a polarized relay whose low resistance winding
50 is in series with one of the branches of

the conductor. When thus arranged the relay and resistance do not affect normal circuit operation over any of the branches except that in which the relay winding is inserted, and then only when the current is
55 flowing in the operative direction.

Another feature of this invention is a circuit arrangement in which the sleeve conductor of a local selector having direct access to connectors arranged for use on reverting
60 calls is serially connected through a high resistance and the winding of a polarized relay to test terminals in the banks of toll and other interoffice incoming selectors and is also connected, through the high resistance
65 only, to test terminals in the banks of local selectors, the high resistance being normally short-circuited by the contacts of the polarized relay. On toll and other interoffice
70 calls, the winding of the polarized relay is included in the test circuit whenever a hunting selector tests over the terminals to which the relay is connected and also when the reverting-call test is made in consequence of
75 the called line having been found busy. When a busy test is made while the associated selector is busy, the current which flows through the winding of the relay is in the non-operative direction; and, since the winding
80 is low in resistance, this arrangement does not interfere with normal circuit operation during a busy test. But when a reverting-call test is made in consequence of the called line being found busy, the current through the winding of the polarized relay
85 is in the opposite direction and the operation of this relay opens the short-circuit around the aforementioned high resistance to prevent the operation of the reverting-call test relay and thus prevent interference with the
90 release of the connector switch.

The invention will be better understood by considering a telephone system in which its features have been embodied, such a system being shown schematically in the drawings. The use of the invention is not limited, however, to the particular system illustrated, and other applications of the invention will readily occur to one skilled in
100 the art.

Referring to the drawings,—

Fig. 1 shows a subscriber's station A and line 1 terminating in a manual office, a cord circuit B at the "A" switchboard of the manual office, a jack-ended trunk extending from the manual office to an incoming trunk circuit IT and the associated incoming selector IS in the automatic office; Fig. 1 also shows a subscriber's station E and line 100 in the automatic office, a line-finder switch LF and associated first selector S1, a local second selector S2, and a trunk circuit T which is connected to terminals in the bank of the local selector S2 and is also connected to terminals in the bank of the incoming selector IS.

Fig. 2 shows a third selector S3 which is permanently associated with the trunk T of Fig. 1, a connector C, a called subscriber's line 200 and station D, and another subscriber's station F on the line 100, the line 100 being a party line.

The subscribers' stations E and F are of the usual type employed in automatic telephone systems, each being equipped with a dial for use in establishing connections. The line-finder, selector and connector switches are all of the well known two-motion step-by-step type. The line-finder LF and first selector S1 are represented schematically by the brushes 102 and 103 respectively. For a complete description of such a line-finder and its operation reference may be had to Patent 1,711,682 issued May 7, 1929, to H. Hovland. The first selector S1 is similar to the second selector S2, the selector S2 being completely shown in the drawings. The operation of the line-finder and first selector switches will be omitted as far as possible but the operation of the second selector S2 will be described in detail.

The equipment at station A and the cord circuit B are of the usual type employed in a manual office. The incoming trunk circuit IT and the associated cord, dial and telephone circuits of an intermediate dialing operator's position, which is represented by the broken lines leading to conductors 51 and 52, are similar to those disclosed in the co-pending application of M. B. McDavitt, Serial No. 503,601 filed December 19, 1930, to which application reference may be had for a complete description of these circuits and their operation. The incoming selector IS is represented schematically by the brushes 54; it is similar to the local second selector S2 and a detailed description of the operation of the selector IS is, therefore, unnecessary.

The third selector S3 is represented by the line relay 131, the holding (or release) relay 132 and by the brushes 137, 138 and 139; the operation of the selector S3 is also similar to that of the second selector S2. The connector C is similar to the connector shown and fully described in my co-pending ap-

plication Serial No. 452,155 filed May 14, 1930; the various relays and other pieces of apparatus are designated by reference characters having the same tens and units digits used in the co-pending application but are preceded by the hundreds digit 2. The connector C is arranged for use in completing calls from one subscriber on a party line to another subscriber on the same line, as well as for use in completing calls between stations which are not on the same line. The connector switch and the associated apparatus are completely shown in the drawings but the description of its operation will be limited since reference may be had to the aforementioned co-pending application for a detailed description.

The trunk circuit T comprises the line conductors 121 and 122 which are multipled to terminals in the banks of local selectors such as S2 and incoming selectors such as IS, the sleeve conductor 123 which is multipled to terminals in the banks of the local selectors only, the sleeve conductor 124 which is multipled to the banks of the incoming selectors only, the polarized relay 125, the resistance 126, and the sleeve conductor 127 leading to the third selector S3. Further explanation of this trunk and its operation will be made by describing calls from stations A and E to stations D and F.

When the receiver is removed from the receiver hook at station E to originate a call, the line 100 is extended through the brushes 102 of the line-finder LF to the first selector S1 in the usual manner. When the calling subscriber dials the first digit of the called subscriber's number, the brushes 103 of the selector switch S1 are advanced to a corresponding group of terminals. The selector S1 then automatically hunts for and seizes an idle set of terminals in the selected group. Assuming that the selected set of terminals are connected to the second selector S2, the line relay 111 is energized in a circuit which is traced from battery, through the left-hand winding of relay 111, the inner lower back contact of relay 117, conductor 105, the middle brushes of selector S1 and line-finder LF, over the calling line 100, through the upper brushes of the line-finder LF and selector S1, conductor 104, the upper back contact of relay 117, the right-hand winding of relay 111, through the normally closed contacts of the eleventh rotary-step springs to ground. Relay 111 operates, closing a circuit from battery through the winding of relay 112, and the front contact of relay 111, to ground at the outer lower back contact of relay 117. Relay 112 operates thereby connecting ground through its left-hand front contact over conductor 106 to the sleeve brush of selector S1 to prevent the release of the line-finder LF and first selector S1.

When the calling subscriber dials the second digit of the called subscriber's number, relay 111 alternately releases and reoperates in response to the impulses thus created. The first release of relay 111 closes a circuit from battery through the winding of the vertical-stepping magnet 113, the winding of change-over relay 114, the right-hand front contact of relay 112, the back contact of relay 111, to ground at the outer lower back contact of relay 117. The operation of magnet 113 in this circuit advances the brushes 107, 108 and 109 up to the first level of terminals in the associated bank. As soon as the shaft of the switch moves out of its normal position the vertical off-normal springs VON are actuated thereby closing a circuit from battery through the winding of relay 116, the upper contacts of the VON springs, conductor 118, the front contact of relay 114, to ground at the left-hand front contact of relay 112. Relay 116 closes a locking circuit from battery through its winding, the upper contacts of the VON springs, conductor 118, the back contact of the rotary magnet 115, the left-hand front contact of relay 116, to ground at the outer lower back contact of relay 117. When relay 111 reoperates, the vertical-stepping magnet 113 releases, but the change-over relay 114 is a slow-to-release relay and remains operated until all of the impulses in the train corresponding to the second digit of the called number have been received. The magnet 113 is thus alternately operated and released by each release and reoperation of relay 111 to advance the brushes of the selector S2 up to the level corresponding to the second digit of the called number. Relay 112 is also a slow-to-release relay and remains operated during the receipt of the dial impulses.

When all of the impulses corresponding to the second digit of the called subscriber's number have been received, the change-over relay 114 releases thereby closing a circuit from battery through the winding of the rotary-stepping magnet 115, the right-hand front contact of relay 116, the back contact of relay 114, to ground at the left-hand front contact of relay 112. The operation of the magnet 115 advances the brushes 107, 108 and 109 into contact with the first set of terminals in the previously selected level of the associated bank. The operation of magnet 115 causes the release of relay 116; and the release of relay 116 opens the circuit for operating magnet 115. When magnet 115 releases and with the sleeve brush 109 in contact with the sleeve terminal of the first set of terminals, a circuit is closed from battery, through the winding of relay 116, the upper contacts of the VON springs, conductor 118, the back contact of magnet 115, conductor 119, winding of relay 117, to ground at the left-hand front contact of relay 112. If the trunk and

selector to which this set of terminals connect, are idle, relay 117 operates in the aforementioned circuit, but if the associated trunk and selector are busy, there is a ground on the sleeve conductor corresponding to conductor 127 which is extended through the back contact of the polarized sleeve relay corresponding to relay 125, over the conductor corresponding to conductor 123, through brush 109 and the middle lower back contact of relay 117 to conductor 119 thereby short-circuiting the winding of relay 117 to prevent its operation, and to cause the operation of the marginal relay 116. It is to be noted that the closing of the busy-test circuit does not affect the polarized sleeve relay of a busy trunk, since the winding of this relay is not included in this circuit. If relay 116 reoperates, it again closes the circuit for operating the rotary-stepping magnet 115 thereby advancing the brushes 107, 108 and 109 to the next set of terminals in selected level. The step-by-step advance of the brushes continues until an idle set of terminals is reached, at which time relay 117 operates; relay 116 remains normal since the current through its winding, when in series with the winding of relay 117, is not sufficient to cause its operation. When relay 117 operates, the ground at the left-hand front contact of relay 112 is extended through the middle lower front contact of relay 117 and brush 109 to the sleeve terminal of the selected set as a test-busy condition.

The aforementioned operation of relay 117 is also effective to extend the connection from line 100 over conductors 104 and 105 through brushes 107 and 108, to conductors 121 and 122 of the trunk circuit T, thereby causing the release of relays 111 and 112 of selector S2 and causing the operation of line relay 131 of the third selector S3. Relay 131 closes an obvious circuit for operating relay 132. Relay 132 is the release (holding) relay of the selector switch S3 and it connects ground through its front contact to the sleeve conductor 127, this ground being further extended through the back contact of relay 125, conductor 123, brush 109 of selector S2, the middle lower front contact of relay 117, to sleeve conductor 106 to prevent the release of the line-finder and selector switches LF and S1. The ground thus connected to conductor 106 is also extended through the winding of relay 117, conductor 119, the back contact of magnet 115, conductor 118, the upper contacts of the VON springs, to battery through the winding of relay 116 thereby holding relay 117 operated after relay 112 is released.

When the subscriber at station E dials the next digit of the called subscriber's number, relay 131 responds to the impulses thus created so as to cause the advance of the brushes of selector S3 to the corresponding level of

the associated bank of terminals in the usual manner. Each of the terminals in the selected level are connected to connector circuits such as C and the brushes are automatically advanced to select and seize an idle set of terminals in this level in the usual manner. Assuming that the selected set of terminals are connected to the connector C, conductors 121 and 122 of trunk T are disconnected from the winding of relay 131 and extended through brushes 137 and 138 to operate the line relay 226 of connector C. Relay 226 closes a circuit for operating the release relay 227; and relay 227 connects ground through its upper front contacts, over the incoming sleeve conductor to the sleeve brush 139 of selector S3, this ground being effective to prevent the release of the selector S3, the selector S2, the first selector S1 and the line-finder LF. When the calling subscriber dials the last two digits of the called subscriber's number, the brushes 235 of the connector C are advanced to the corresponding set of terminals which connect to the called line. The busy-test relay 238 is then connected to the sleeve brush to test the sleeve terminal of the selected line to determine whether this line is idle or busy. If station D is the called station and line 200 is idle, relay 238 does not operate and ringing current is transmitted over line 200 to signal the called subscriber. When the call is answered the ringing circuit is opened and the talking circuit closed, talking current being supplied to the called station through the windings of the reversing relay 225; and relay 225 reverses the talking current supplied through the windings of relay 226 to the calling station, in the usual manner. When the calling and called subscribers replace their receivers, relays 226 and 225 release thereby causing the line-finder, selector and connector switches to be restored to normal in the usual manner.

If station D is the called station and line 200 is busy, relay 238 operates. Relay 238 locks through its inner upper front contact and the outer lower back contact of relay 237 to ground at relay 227. Relay 238 connects the secondary winding of tone transformer 243 through the outer lower front contact of relay 238 and the next-to-the-inner lower back contact of relay 237, to the ring conductor of connector C to transmit a busy-tone to the calling station. When the calling subscriber hangs up the receiver, relay 226 releases and the connector C makes a reverting-busy test to determine whether the calling subscriber replaced the receiver because the called line is busy or whether he replaced the receiver, knowing that the calling and called stations are on the same line, in order that ringing current can be transmitted over the line to signal the called subscriber. Since relay 227 is slow in releasing, the release of relay 226 causes the operation

of relay 239 before relay 227 restores to normal, in a circuit from battery through the winding of relay 239, upper inner back contact of relay 231, lowermost front contact of the VON springs 232, inner lower front contact of relay 227, to ground at the back contact of relay 226. With relay 239 operated, the lower winding of the reverting-test relay 242 is connected through the outer lower front contact of relay 239, and the next-to-the-outer upper front contact of relay 238 to the incoming sleeve conductor, and ground is connected through the inner lower front contact of relay 239, the outer upper back contact of relay 231, middle upper armature and front contact of relay 238, sleeve brush of connector C, to the sleeve conductor 201 of the line 200. Since the sleeve conductor 201 of the called line has no connection with the sleeve conductor 101 of the calling line, the reverting-busy test relay 242 does not operate and the entire connection is released and the switches are returned to normal in the usual manner.

If station F is the called station, the operation of relays 238 and 239 connects the lower winding of the reverting-busy test relay 242 to the incoming sleeve conductor and connects ground to the sleeve terminal of the called line as described in the preceding paragraph. Since the called and calling stations are on the same line, this ground is extended over sleeve conductor 101 through the sleeve brush of line-finder LF to the sleeve conductor of the line-finder and first selector circuits, through the sleeve brush of selector S1 to the sleeve conductor 106 of local second selector S2, through sleeve brush 109 of selector S2 over conductor 123 to sleeve conductor 127 of the third selector S3, through the sleeve brush 139 of selector S3 to the sleeve conductor of connector C, thence through the next-to-the-outer upper armature and front contact of relay 238, the outer lower front contact of relay 239, lower winding of the reverting-busy test relay 242, and through resistance 254 to battery. The ground thus connected to conductor 101 holds the cut-off relay (not shown) of line 100, holds the line-finder LF and first selector S1, holds the second and third selectors S2 and S3, and operates the reverting-busy test relay 242 sufficiently to close a locking circuit for completing the operation of this relay; this locking circuit is traced from battery through the upper winding and inner upper front contact of relay 242, the outer lower back contact of relay 247, to ground at the middle contacts of the VON springs 232. It is to be noted that the circuit for operating the reverting-busy test relay 242 passes from conductor 123 of trunk T, through the back contact of the polarized relay 125 to conductor 127 without affecting relay 125. With relay 242 fully operated, a circuit is closed from battery

through the winding of magnet 230, winding of relay 231, resistance 256, lowermost front contact of relay 242, back contact of relay 237, to ground at the inner front contact of relay 239. Relay 231 operates in this circuit there-
 5 by disconnecting the ground at the inner front contact of relay 239 from the sleeve conductor 101 so as to cause the release of the line-finder LF and all of the selectors S1, S2 and S3. Relay 238 is also released when
 10 the ground is disconnected from sleeve conductor 101 but relay 242 remains operated since it is locked through its upper winding to ground at the VON springs. The afore-
 15 mentioned operation of relay 231 also opens the circuit through the winding of relay 239, the latter relay being slow in releasing. When relay 239 releases, a busy ground is
 20 connected from the lower back contact of relay 239 through the uppermost front contact of relay 242 to the incoming sleeve conductor to guard against seizure of the con-
 25 nector C on another call. This ground is also extended through the uppermost back contact of relay 238, the upper winding of relay 237, the lower back contact of relay 240, the upper
 30 back contact of relay 239, and through the sleeve brush of the connector, to sleeve conductor 101 to hold the cut-off relay (not shown) of the line 100. Relay 237 is operated suf-
 35 ficiently in this circuit to close a locking circuit from battery through its lower winding and inner lower front contact, to ground at the middle upper front contact of relay 242. The release of relay 239 also opens the circuit
 40 through the winding of relay 231; but relay 231 is slow in releasing so that relay 237 operates before relay 231 releases. If relay 237 fails to operate, the release of relay 231 closes
 45 the circuit for operating the release magnet 228 causing the connector to be restored to normal. With relay 237 operated, ground is also connected through the middle lower
 50 front contact of relay 237 to conductor 101 and the winding of relay 246 is connected to pick-up conductor 248 leading to the ringing interrupter 300. When relay 246 operates, ringing current is transmitted over the line
 55 100 to signal the called and calling stations as described in my aforementioned co-pending application. When the receiver is removed at one of these stations relay 247 operates thereby opening the ringing circuit
 60 and extending the conductors of line 1 to battery and ground through the winding of relay 225. Relay 225 remains operated until both subscribers hang up their receivers. When relay 225 releases relays 237 and 242
 65 release, the release magnet 228 operates and the connector C is restored to normal.

The next call to be considered is one in which the sleeve circuit includes the winding of the polarized relay 125 of trunk T. Assume that the subscriber at station A is
 65 calling the subscriber at station F or the sub-

scriber at station D, that an operator in the manual office answers the call by inserting the plug 3 of cord B in the jack 2, and that the plug 8 of the cord B is inserted in jack 9, thereby extending the connection over trunk
 70 10 to the incoming trunk circuit IT and associated incoming selector IS in the automatic office serving the called station. An intermediate dialing operator at a position of the
 75 special "A" switchboard in the automatic office answers the call by inserting the plug of an answering cord in an answering jack and the plug of the corresponding calling
 80 cord in a dialing jack associated with the incoming trunk IT. Upon receiving the number of the called station from the operator in the manual office, the intermediate
 85 operator dials the called number. After dialing the called number, the intermediate operator disconnects both plugs of the cord from the trunk circuit IT, the connection be-
 90 ing supervised by the operator in the manual office. At the time of the insertion of the plug of the calling cord in the dialing jack of trunk circuit IT, a holding ground is con-
 95 nected to the sleeve conductor 53 which leads to the sleeve conductor of the associated incoming selector IS; this ground is effective to hold the switch IS and all succeeding
 100 switches used in establishing the desired connection until the operator in the manual office disconnects cord B from the jack 9 of trunk 10.

When the intermediate operator dials the first digit of the called station's number, the
 100 brushes 54 of the selector switch IS are advanced to the corresponding level of the associated bank of terminals, the operation of switch IS being similar to the operation
 105 of the local second selector S2. The brushes of switch IS are then automatically advanced to an idle set of terminals in the selected level, the busy-test circuit being similar to that of the selector S2 hereinbefore described. We
 110 will assume that the terminals of the selected set are connected to trunk T and selector S3. When the second digit of the called number is dialed by the intermediate operator, the
 115 brushes 137, 138 and 139 of selector S3 are advanced to the corresponding level of the associated bank of terminals; the brushes of selector S3 are then automatically advanced
 120 to an idle set of terminals in the selected level. We will assume that these terminals are connected to the connector C and the dialing of the last two digits of the called number
 125 advances the brushes 235 to the terminals of the called line. If the called line is idle, the ringing circuit is closed and when the called subscriber answers the talking con-
 130 nection is established through the brushes of connector C as hereinbefore described. When the subscriber at station A replaces the receiver on the receiver hook, the operator in the manual office withdraws the plugs

of cord B from jacks 2 and 9, thereby causing the release of the supervisory relay 12 of trunk circuit IT. When relay 12 releases, the trunk circuit IT restores to normal there-
 5 by disconnecting the holding ground in this circuit from the sleeve conductor 53 to cause the release of selectors IS and S3 and connector C.

If another selector such as IS should hunt
 10 over the terminals of trunk T during the time it is busy on a local call, the busy ground connected to sleeve conductor 127 of trunk T from the succeeding switches would be extended through the back contact and wind-
 15 ing of polarized relay 125, conductor 124, sleeve brush of the hunting incoming selector, back contact of the relay which corresponds to relay 117 of selector S2, the con-
 20 ductor which corresponds to conductor 119, the back contact of the rotary-stepping magnet, the conductor which corresponds to conductor 118, the upper contact of the VON springs, through the winding of the relay which corresponds to relay 116 to battery.
 25 Relay 125 does not operate since this relay is polarized and the current is not in the operating direction. The resistance 126 continues to be short-circuited by the back contact of relay 125 and, since the resistance of
 30 the winding of relay 125 is low, the current flowing in this busy-test circuit is effective to operate the relay of the hunting incoming selector corresponding to relay 116 of selector S2 and thus cause the brushes of the hunt-
 35 ing selector to be stepped-off from the terminals of trunk T.

If the called station is found busy, when tested by connector C on the call incoming
 40 over trunk 10 from the manual office, the busy-tone circuit it closed in the manner here- before described to transmit a busy tone to the calling subscriber. When the calling
 45 subscriber hangs up the receiver and the operator in the manual office disconnects from trunk 10, the line relay 226 of connector C releases without delay but the ground in
 50 trunk circuit IT is not immediately disconnected from sleeve conductor 53 since the release relay (not shown) of trunk circuit IT is slow in releasing. The reverting-busy test
 55 relay 242 of connector C is connected to the incoming sleeve conductor as hereinbefore described to determine whether the connector should or should not restore to normal; and
 60 if the sleeve cut-off trunk circuit T were not provided, this holding ground from trunk circuit IT would cause the false operation of the reverting-busy test relay 242 of connector C. This trouble is obviated by the operation
 65 of relay 125 in the reverting-busy test circuit which is traced from battery through resistance 254, lower winding of relay 242, lower- most front contact of relay 239, next-to-
 the-outer upper front contact of relay 238, incoming sleeve conductor of connector C,

sleeve brush 139 and conductor 127 of selector S3, back contact and winding of relay 125, conductor 124, sleeve brush and conductor 53 of selector IS, to the holding ground in trunk circuit IT. The operation of relay
 70 125 opens the short circuit around the high resistance 126; and since relay 125 is fast in operating as compared with relay 242, the current through the winding of relay 242 is
 75 reduced sufficiently to prevent the operation of relay 242. Relay 125 remains operated in series with resistance 126 and the winding of relay 242 until the holding ground in trunk
 80 circuit IT is disconnected from conductor 53, at which time relay 125 releases and all of the selector and connector switches are restored to normal.

In the system illustrated in the drawings the trunk circuit IT is only one of a number
 85 of incoming trunk and repeater circuits, provided for use in completing incoming calls, which are arranged to connect a holding
 ground to the sleeve conductors of succeeding switches. By providing a sleeve cut-off trunk
 90 circuit such as T with each preceding selector having access to connectors such as C, these connectors may be used to complete calls in-
 coming from any of these incoming trunk and repeater circuits as well as for completing
 95 local calls.

What is claimed is:

1. In a telephone system, the combination of a conductor, a high resistance in series with said conductor, a plurality of branches
 100 leading to said conductor through said high resistance, and a polarized relay in series with one of said branches, said resistance being normally short-circuited by the contacts of
 said relay.

2. In a telephone system, a connector
 105 switch, a selector for use in extending calls incoming from distant offices, another selector for use in extending local calls, a selector for further extending calls from either of
 110 said first mentioned selectors to said connector, a sleeve conductor of said last-mentioned selector multiplied to a terminal in the bank of each of said first-mentioned selectors, a
 high resistance in series with said conductor, and a polarized relay connected in series with
 115 the branch of said conductor which leads to the terminal in the bank of said incoming selectors, said high resistance being normally short-circuited by the contacts of said relay.

3. In combination, a first switch, a second
 120 switch, a third switch, a trunk for extending connections from said first and second switches to said third switch, a test relay for said third switch, means for connecting said test relay
 125 to a conductor of said trunk, means including said first switch for connecting ground to said conductor of said trunk to operate said
 test relay, means including said second switch for connecting ground to said conductor of
 said trunk, and means for preventing the op-

eration of said test relay on connections from said second switch.

4. In a telephone system, a selector, another selector, a connector, a trunk for extending connections from said selectors to said connector, a test relay for said connector, means for connecting said test relay to a conductor of said trunk, means including said first-mentioned selector for connecting ground to said conductor of said trunk to operate said test relay, means including said other selector for connecting ground to said conductor of said trunk, and means including a polarized relay in said conductor of said trunk for preventing the operation of said test relay on connections from said other selector.

5. In combination, a first switch, a second switch, a third switch, a trunk for extending connections from said first and second switches to said third switch, a test relay for said third switch, means for connecting said test relay to a conductor of said trunk, means including said first switch for connecting ground to said conductor of said trunk to operate said test relay, means including said second switch for connecting ground to said conductor of said trunk, and means including a polarized relay and a high resistance in said conductor for preventing the operation of said test relay on connections from said second switch.

6. In a telephone system, a first switch, a second switch, a third switch, a trunk for extending connections from said first and second switches to said third switch, a polarized relay and a resistance in a conductor of said trunk, said resistance being normally short-circuited by contacts of said relay, a test relay for said third switch, means for connecting said test relay to said conductor of said trunk, a circuit over a conductor of said local selector and said conductor of said trunk for operating said test relay, the current in said circuit being in the opposite direction to that required for operating said polarized relay, and a circuit over a conductor of said second switch and said conductor of said trunk for operating said polarized relay whereby said high resistance is inserted in said circuit to prevent the operation of said test relay.

7. In a telephone system, a first switch, a second switch, a third switch, a trunk for extending connections from said first and second switches to said third switch, a polarized relay and a resistance in the sleeve conductor of said trunk, said resistance being normally short-circuited by contacts of said relay, a test relay for said third switch, said test relay being relatively slow in operating with respect to said polarized relay, a circuit including the sleeve conductors of said first switch and said trunk for operating said test relay, the current in said circuit being

in the opposite direction to that required for operating said polarized relay, and a circuit including the sleeve conductors of said second switch and said trunk for operating said polarized relay whereby said high resistance is inserted in said circuit to prevent the operation of said test relay, said polarized relay remaining operated in series with said resistance.

8. In a telephone system, a first selector, another selector, a connector, a trunk for extending connections from said selectors to said connector, a polarized relay and resistance in the sleeve conductor of said trunk, said resistance being normally short-circuited by contacts of said relay, a test relay for said third switch, means for connecting said test relay to the sleeve conductor of said trunk, a circuit over the sleeve conductors of said trunk and said first-mentioned selector for operating said test relay without operating said polarized relay, and a circuit over the sleeve conductors of said other selector and said trunk effective to operate said polarized relay before said test relay can operate and thereby insert said resistance in said circuit to prevent the operation of said test relay.

9. In a telephone system, subscribers' stations including a calling and a called station, lines each having a plurality of said stations permanently connected thereto, a connector comprising a switch having a set of brushes and an associated bank of terminals, said lines being connected to terminals in the bank of said connector, a local selector for use in completing local calls, an incoming selector for use in completing incoming calls, an intermediate selector for use in extending connections from said local and said incoming selectors through said connector, means for advancing the brushes of said connector into engagement with the terminals of a called line, means including a test relay of said connector for making a reverting-busy test to determine whether said calling and called stations are on the same line, and means individual to said intermediate selector for preventing the false operation of said reverting-busy test relay on incoming calls without interfering with the operation of said reverting-busy test relay on local calls.

10. In a telephone system, lines, a local selector, an incoming selector, means including a connector for extending connections from said local and incoming selectors to one of said lines, a test relay for said connector, means for connecting said test relay to the sleeve conductors of said local and incoming selectors, means for connecting ground to the sleeve conductor of said local selector to operate said test relay, means for connecting ground to the sleeve conductor of said incoming selector, and means for preventing the operation of said test relay when

connected to ground over the sleeve conductor of said incoming selector.

11. In a telephone system, a local selector, an incoming selector, a connector comprising a set of brushes and associated bank of terminals, means for advancing the brushes of said connector to a desired set of terminals, a test relay for said connector, an intermediate selector for extending connections from said local and incoming selectors to said connector, means for connecting ground to the sleeve conductor of said incoming selector to hold said intermediate selector and said connector, means for connecting said test relay to the sleeve conductor of said connector, means for connecting ground over the sleeve conductors of said local and intermediate selectors and the sleeve conductor of said connector to operate said test relay, and means individual to said intermediate selector for rendering the holding ground on the sleeve conductor of said incoming selector ineffective to operate said test relay.

12. In a telephone system, an incoming selector, a local selector, a connector, an intermediate selector for extending connections from said local and incoming selectors to said connector, a connection to ground at said connector for holding said intermediate and local selectors, a connection to ground at said incoming selector for holding said intermediate selector and said connector, means for advancing the brushes of said connector to a desired set of terminals, a test relay for said connector, means for connecting ground over the sleeve conductor of said local and intermediate selectors through the sleeve conductor of said connector to operate said test relay, and means individual to said intermediate selector for rendering said connection to ground at said incoming selector ineffective to cause the operation of said test relay.

13. In a telephone system, the combination of a marginal testing device, a high resistance in series with said device, two test conductors leading to said device through said high resistance, and a polarized relay connected in series with one but not the other of said conductors, the contacts of said relay normally short-circuiting said high resistance.

14. In a telephone system, a marginal testing device, a high resistance, two test conductors both leading to said device through said resistance, a polarized relay connected in series with the first but not the second of said conductors, said high resistance being normally short-circuited by contacts of said relay to permit operation of said device, a circuit over said first conductor ineffective to operate said relay, another circuit over said first conductor for operating said relay to prevent operation of said testing device, and a circuit over said

second conductor for operating said testing device.

In witness whereof, I hereunto subscribe my name this 28th day of January 1931.

HENRY HOVLAND. 70

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