

Dec. 17, 1940.

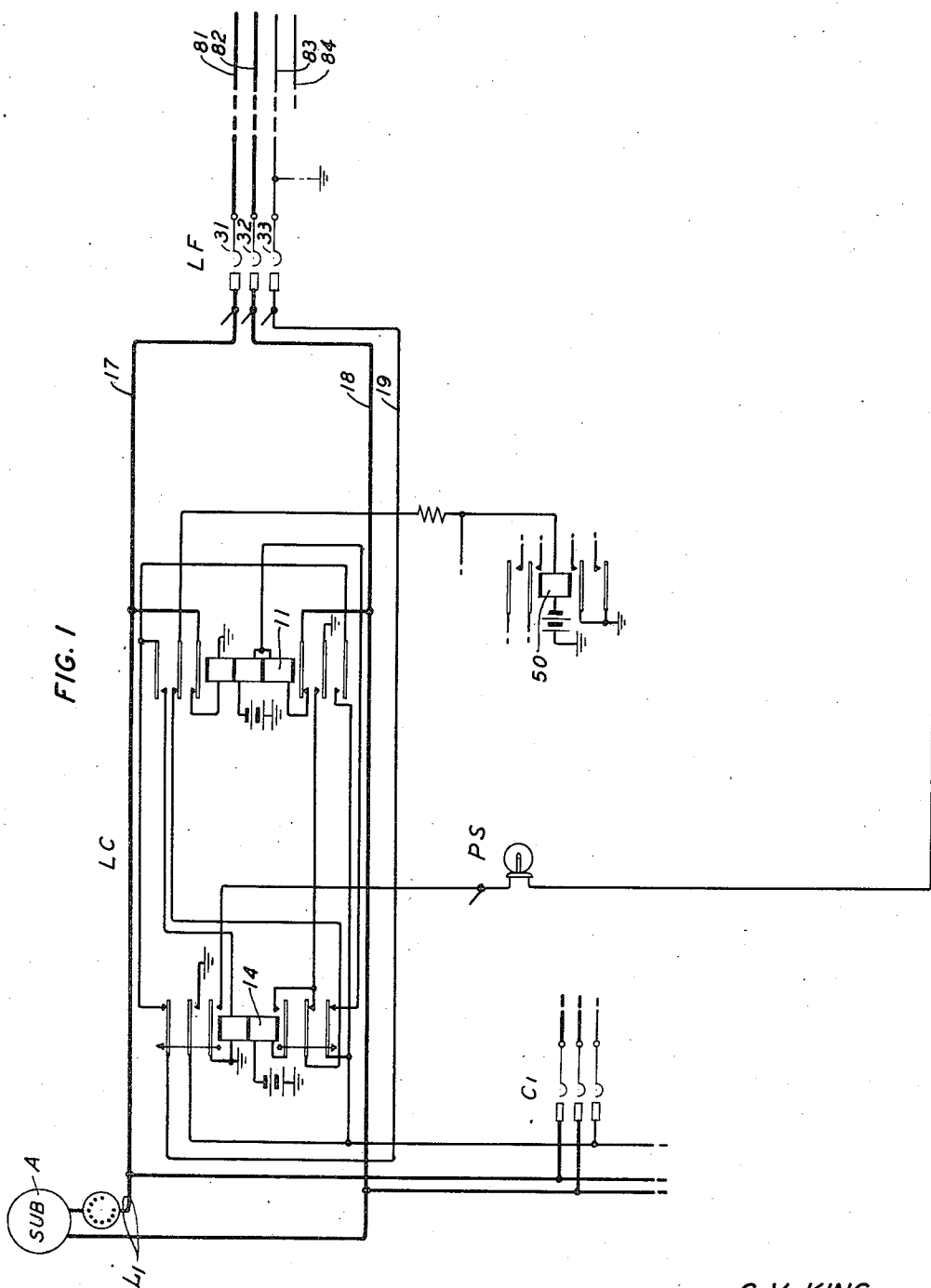
G. V. KING ET AL

2,225,305

TELEPHONE SYSTEM

Filed Aug. 9, 1939

2 Sheets-Sheet 1



INVENTORS: G. V. KING
P. W. SWENSON
BY *W. T. McKenney*
ATTORNEY

Dec. 17, 1940.

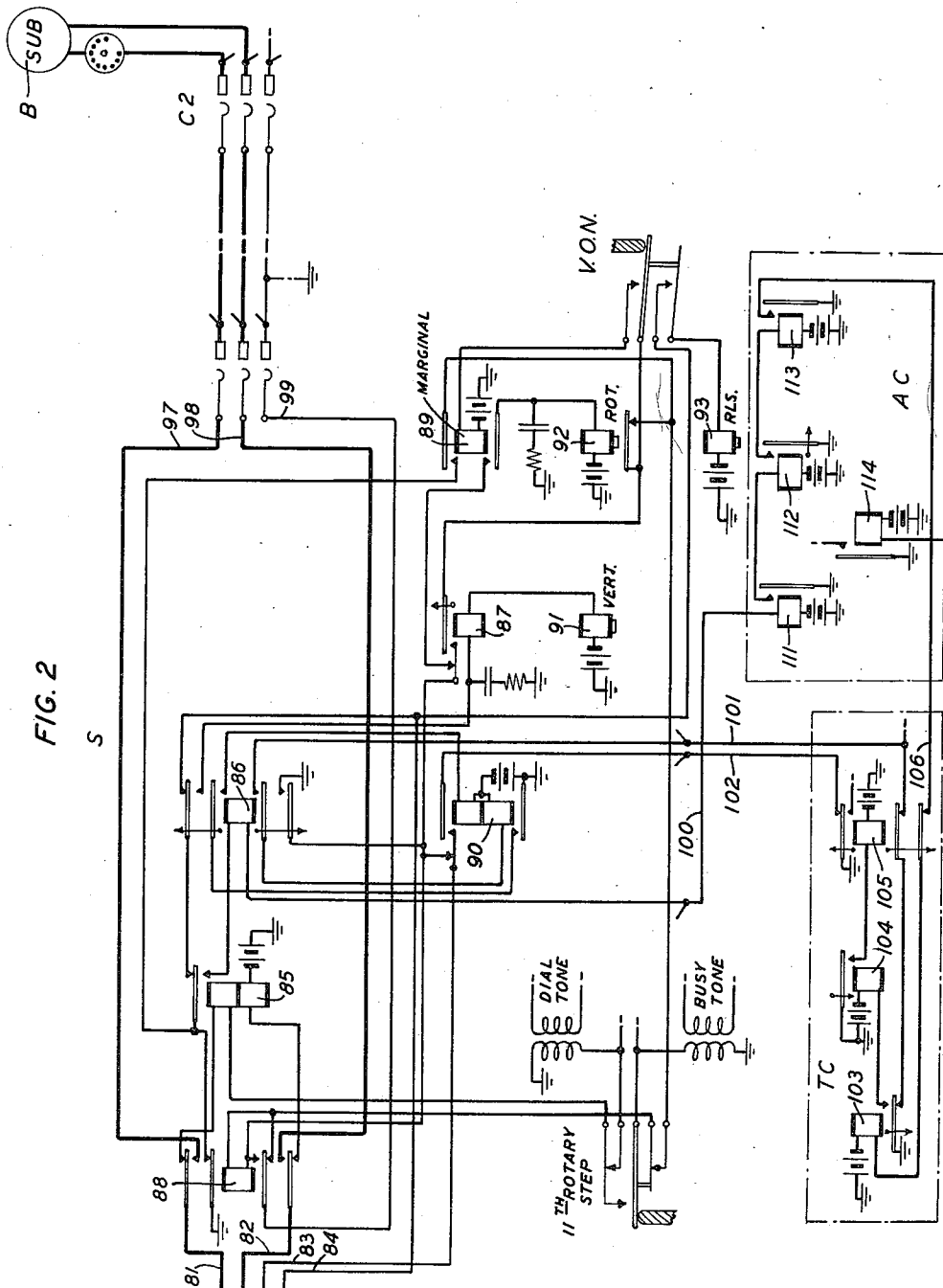
G. V. KING ET AL

2,225,305

TELEPHONE SYSTEM

Filed Aug. 9, 1939

2 Sheets-Sheet 2



INVENTORS: G. V. KING
P.W. SWENSON
BY *W.T. McKenney*
ATTORNEY

UNITED STATES PATENT OFFICE

2,225,305

TELEPHONE SYSTEM

Gerald V. King, Chatham, N. J., and Paul W. Swenson, Jackson Heights, N. Y., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application August 9, 1939, Serial No. 289,148

9 Claims. (Cl. 179—20)

This invention relates to telephone systems and particularly to systems in which automatic switches are employed in establishing connections between subscribers' lines.

5 Objects of the invention are a more efficient use of automatic switching equipment and the provision of circuit arrangements for increasing the reliability of operation of automatic telephone systems.

10 The invention is an automatic telephone system in which a subscriber's line is connected to an idle first selector upon closing of the line loop and in which a novel and improved circuit arrangement is provided for disconnecting a subscriber's line from a selector in case directive impulses are not received by the selector within a predetermined interval of time after the line is connected to the selector.

15 According to a feature of the invention, each subscriber's line circuit comprises a combined line and cut-off relay and a lock-out relay, the winding of the lock-out relay being short-circuited by the holding ground potential connected to the sleeve or test conductor of the line upon connection of the line to a first selector.

20 According to another feature of the invention, a common timing means is provided in an automatic telephone office for supplying the holding ground potential which each of the first selectors connects to the sleeve or test conductor to hold the connection between a calling line and the selector until the selector has been directly operated by impulses transmitted from the calling station to select a desired trunk group and has operated to select an idle trunk in the selected group. After selection of an idle trunk, the ground potential for maintaining the connection between a calling line and a first selector is supplied from the test conductor of the selected trunk. The common timing means operates to measure predetermined intervals of time as long as there is a selector which is connected to a calling line but which has not completed its directive and automatic operation to select an idle trunk in a desired group. At the end of each measured interval, the timing means disconnects the holding ground potential from each of the selectors which has not completed its trunk hunting operation, thereby effecting the operation of a lock-out relay in each of the lines connected to the selectors in question to permit release of the selector and prevent the connection of the line to another selector.

25 A clear and complete understanding of the invention will be facilitated by considering a tele-

phone system arranged in accordance with the above-mentioned features. One such system is represented schematically in the drawings which form a part of this specification. The invention is, however, not limited in its application to the particular system disclosed but is generally applicable to all automatic telephone systems.

Referring to the drawings:

Fig. 1 shows a calling subscriber's station A, a line circuit LC, a line finder LF, and a connector C1; and

Fig. 2 shows a first selector S permanently associated with the line finder LF of Fig. 1, a connector C2, a called subscriber's station B, a timing circuit TC and an alarm circuit AC.

15 The subscribers' stations are of the usual type employed in common-battery, automatic telephone systems and each includes a dial or other impulse sending device for controlling the numerical switches through which connections with other subscribers' lines are established. The line finder switch LF, selector switch S and connector switches C1 and C2 are each of the well-known two-motion step-by-step type. A clear and complete description of the structure of such switches is found in "Automatic Telephony" by Smith and Campbell, second edition, pages 53 to 55, inclusive. The bank of each of these switches is represented in the drawings by a single set of terminals. The selector circuit S is shown in detail but the line finder and connector circuits are represented by the brushes and a single set of terminals. Reference may be had to a patent application Ser. No. 288,289, filed by T. L. Dimond Aug. 4, 1939, for a complete description of the operation of such a line finder. Reference may be had to "Automatic Telephony," above mentioned, pages 55 to 59, for a complete description of the operation of a connector.

30 The line circuit LC comprises a combined line and cut-off relay 11 and a permanent signal lock-out relay 14. The relay 11 is partially energized by its three windings in series with the conductors of line L1 when the receiver is removed at station A to originate a call. The partial energization of relay 11 closes a circuit for operating the start relay 53 to start the operation of an idle line finder LF and thereby effect the connection of line L1 to the first selector S in the manner described in detail in the above-mentioned application of T. L. Dimond. When the line finder LF finds the calling line, ground potential is connected from the first selector S through brush 33 and conductor 19 to the middle winding of relay 11 to cause a further energiza-

tion and thereby actuate all of the contacts of this relay. When relay 11 is completely energized, the windings of relay 11 are disconnected from the line and ground is disconnected from the start conductor and relay 50 releases unless there is another calling line awaiting connection to a first selector. With relay 11 completely operated, the upper winding of the permanent-signal lock-out relay 14 is connected in series with the middle winding of relay 11 but is short-circuited by holding ground potential connected to conductor 19 from the first selector. By disconnection of this holding ground, in case a permanent signal condition exists, relay 14 may be operated as hereinafter described in detail to prevent the starting of a second line finder in search for line L1.

The first selector S, which is similar to known two-motion selectors, comprises a line relay 85, release relay 86, change-over relay 87, a vertical stepping magnet 91, a rotary stepping relay 89, a rotary stepping magnet 92, a cut-through relay 88, a release magnet 93, vertical off-normal springs and 11th rotary step springs, all of which have usual and known functions. In addition the selector S is provided with a relay 90 which controls the holding ground potential connected through conductor 83 to the associated line finder LF. After connection of the calling line to the first selector S, the line relay 85 and release relay 86 are actuated to connect the holding ground potential to conductors 83 and 19. When the calling subscriber dials the first digit of a called subscriber's number, the selector S is operated to extend the connection to the next switch used in completing the desired connection as hereinafter described in detail, in which case relay 90 performs no useful function. But, if the calling subscriber fails to dial, or if the extension of a line to selector S is due to a trouble condition, relay 90 is operated to place the holding ground potential under control of the common timing circuit TC. And, if a predetermined interval of time elapses without selector S having been selectively operated by dial impulses, the timing circuit disconnects the holding ground potential to effect the operation of the permanent signal lock-out relay 14 of the calling line.

The permanent signal timing circuit TC comprises two slow-to-release relays, 103 and 105, and a slow-to-operate relay 104. With all three relays normal, ground potential is connected to control conductors 101 and 102, these conductors being common to all of the first selectors in the office. Upon the connection of ground potential to conductor 100, due to the operation of the line relay 85 of any of the local selectors in the office, the operation of a series of relays 111, 112 and 113 in an alarm circuit AC connects ground to the start conductor 106 of timing circuit TC to operate relay 103. The operation of relay 103 closes a circuit for operating relay 104 and disconnects ground potential from conductor 101. When relay 104 operates, it closes a circuit for operating relay 105. The operation of relay 105 disconnects ground potential from conductor 102 and causes the release of relay 103. The release of relay 103 causes the release of relay 104; and the release of relay 104 causes the release of relay 105. The release of relay 105 reconnects ground potential to conductors 101 and 102 and reconnects the winding of relay 103 to conductor 106. If conductor 106 is then connected to ground, the described cycle of operations is repeated. The three relays 103,

104 and 105 are designed to measure a desired interval of time, such, for instance, as two minutes, within which a selector connected to a calling line should receive dial impulses or be released. When relays 103 and 105 are both normal, the control relays 90 of all first selectors which have been connected to subscribers' lines, and which have not as yet been selectively operated by dial impulses, will be operated by the ground potential connected to conductor 101. During the measuring of an interval, the line finders associated with these selectors are held by the ground potential connected to conductor 102. When relay 105 operates at the end of a measured interval, the disconnection of ground from conductor 102 causes the release of the line finders associated with all selectors which have not completed the selection of an idle trunk in a selected level and causes the operation of the permanent signal lock-out relay 14 of each of the lines to which these last-mentioned selectors are connected.

Assume now that combined line and cut-off relay 11 is partially operated, indicating that the subscriber at station A has removed the receiver to originate a call or that a trouble condition exists on the line L1. The partial operation of relay 11 closes its lower front contacts without actuating its other contacts, thereby effecting the operation of start relay 50 associated with the group of line finders having access to the group of lines which includes line L1. The operation of relay 50 starts a preassigned line finder LF in search for the terminals of the line L1.

When the brushes 31, 32 and 33 of line finder LF engage the terminals of the line L1, a circuit is closed for completing the operation of relay 11 and a circuit is closed for operating line relay 85 of selector S. The circuit for completing the operation of relay 11 is traced, from ground in the line finder and line finder control circuits as described in the aforementioned application of T. L. Dimond, through wiper 33, conductor 19, uppermost back contact of relay 14, lowermost front contact of relay 11, lowermost back contact of relay 14, and middle winding of relay 11 to battery. The ground potential connected to conductor 19 also marks the line busy in the banks of the other line finders and in the banks of the connectors such as C1 having access to the line L1. The circuit for operating relay 85 is traced from battery through the lower winding of relay 85, a back contact of relay 88, conductor 82, brush 32, conductor 18, line L1 and station A, conductor 17, brush 31, conductor 81, a back contact of relay 88, upper winding of relay 85, upper back contact of the 11th rotary step springs, and the left winding of the dial tone transformer, to ground. The complete operation of relay 11 disconnects the outer windings of relay 11 from conductors 17 and 18 and connects the upper winding of the permanent signal lock-out relay 14 to conductor 19 and to the middle winding of relay 11; but as long as there is a holding ground potential connected to conductor 19, the upper winding of relay 14 is short-circuited and relay 14 does not operate. The operation of relay 85 closes a circuit for operating the slow-to-release relay 85. Relay 86 connects ground to conductor 83 to hold relay 11 operated after the ground for operating relay 11 is disconnected in the line finder circuit. Relay 86 also connects the lower winding of relay 90, through supervisory conductor 101, to the timing circuit TC. As soon thereafter as

timing relays 103 and 105 are both normal, conductor 101 is connected to ground to operate relay 90 of selector S and the corresponding relay of all other first selectors which are then connected to calling lines and which have not yet been directly operated by dial impulses. Relay 90 closes a locking circuit through its upper winding and transfers the test conductor 83 from ground at the front contact of relay 86 to the timing conductor 102 and thence to ground at the back contact of timing relay 105.

Assume first that the calling subscriber dials the first digit of the called subscriber's number before the timing relay 105 operates. In this case relay 85 releases and reoperates in response to each impulse of the series created by the dialing of this digit. Being slow in releasing, relay 86 remains operated while these impulses are being received. The release of relay 85 in response to the first impulse closes a circuit for operating the vertical stepping magnet 91 and the change-over relay 87 in series. The operation of magnet 91 steps the brushes 97, 98 and 99 up to the first level of the terminal bank. As soon as the shaft moves out of its normal position, the vertical off-normal contacts VON are actuated, thereby closing a circuit including the front contact of relay 87 for operating relay 89. Relay 89 locks under the control of the rotary stepping magnet 92 to ground at a back contact of relay 88. When relay 85 reoperates at the end of the first impulse, magnet 91 releases but relay 87 is slow in releasing and remains operated until all of the impulses in the series have been received by relay 85. Each succeeding release and reoperation of relay 85 causes the reoperation and release of magnet 91, thereby advancing the brushes of the switch to the level corresponding to the digit dialed. When relay 87 releases after the last impulse of the series has been received, the rotary stepping magnet 92 is operated to advance the brushes into engagement with the first set of terminals in the selected level. The operation of magnet 92 also causes the release of relay 89; and the release of relay 89 causes the release of magnet 92. The release of magnet 92 closes a busy test circuit from battery through the winding of relay 89, contact of the VON springs, back contact of magnet 92, lower contact of the 11th rotary step springs, a back contact of relay 88 and the test wiper 99 to determine whether the trunk or switch connected to the first set of terminals in the selected level is busy or idle. If this trunk or switch is busy, ground potential on the terminal engaged by test wiper 99 causes the reoperation of relay 89; and in this case relay 89 again closes the circuit for operating magnet 92 to cause the advance of the brushes to the next set of terminals in the level. Relay 89 and magnet 92 repeat their cycle of operations to cause advance of the brushes from one set of terminals to the next until an unguarded set of terminals is encountered. If the brushes reach the 11th rotary position, the 11th rotary step springs are actuated to prevent further operation of relay 89 and magnet 92 and to connect the busy tone source to one of the talking conductors and thereby transmit an all-trunks-busy tone to the calling subscriber. When test brush 99 engages the test terminal of an idle trunk or switch, there is no guarding ground connected thereto to cause the reoperation of relay 89, whereupon relay 88 is operated by the current in a circuit from battery through the winding of relay 89, contact of the VON springs, back

contact of magnet 92, lower contact of the 11th rotary step springs, winding of relay 88 to ground at a front contact of relay 86. Relay 89 is marginal and does not reoperate in series with relay 88. Relay 88 disconnects the calling line from the windings of relay 85 and extends the connection from the calling line to the selected trunk or switch by connecting conductors 81 and 82 to the brushes 97 and 98. Relay 88 also connects ground to the test wiper 99 to guard the selected trunk against seizure by another selector prior to the connection of busy ground to the test terminal by the seized trunk in usual manner. When relay 85 releases, it opens the circuit energizing relay 86 but relay 86 does not release until a busy and holding ground potential has been connected to the test conductor of the selected trunk to hold relay 88 operated. When relay 86 releases, it causes the release of relay 90. Relay 90 disconnects conductor 83 from the timing conductor 102 and connects conductor 83 through a front contact of relay 88 to the test wiper 99 so that the busy ground potential on the test conductor of the selected trunk or switch is also effective to hold the line finder LF and to hold the combined line and cut-off relay 11.

When the calling subscriber dials the succeeding digits of the called subscriber's number, the connection is extended by the operation of additional selectors, if any, and a connector C2 to establish connection with the called line in usual and well-known manner. If the called line is idle, a ringing circuit is closed and when the call is answered, the ringing circuit is opened, the talking circuit is established and the connection is maintained under the control of the calling subscriber in usual manner. When the calling subscriber restores the receiver to normal, the holding ground potential is disconnected in usual manner to cause the release of relay 88 of selector S, to cause the release of the line finder LF and to cause the release of the combined line and cut-off relay 11. When relay 88 releases, it closes a circuit for operating release magnet 93. When magnet 93 operates, the shaft and brushes are restored to normal, the return of the VON springs to normal being effective to deenergize magnet 93.

Assume next that the selector S has not been selectively operated by dial impulses to select a group of trunks by the time that relay 103 operates following the operation of relay 90. In this case the disconnection of ground from conductors 102 and 83, a measured interval of time after the selector S was seized, effects the return of line finder LF to normal causing the release of relays 85, 86 and 90. The disconnection of ground from conductors 102 and 83 also effects the operative energization of the upper winding of the permanent signal lock-out relay 14 in series with the middle winding of relay 11. Relay 14 is energized sufficiently to close an energizing circuit through its lower winding to ground at a front contact of relay 11, thereby completing the actuation of the contacts of relay 14. Relay 11 is not held operated by its middle winding in series with the upper winding of relay 14 but is slow in releasing, so as to insure the operative energization of the lower winding of relay 14. When relay 11 releases, it opens the holding circuit of relay 14 and again closes the circuit through its three windings in series with the line LF. If the permanent signal condition has not been cleared, relay 11 immediately reoperates partially so as to again close the holding circuit of slow-to-re-

lease relay 14 before relay 14 releases. With relay 14 operated, the partial energization of relay 11 is ineffective to cause the operation of start relay 50 and no line finder is started in search of the line. While relay 14 is operated, ground potential is connected through a lamp PS to operate relay 114 in the alarm circuit AC. The lighting of lamp PS indicates the group of lines in which one of the lines is in a permanent signal condition. The operation of relay 114 in the alarm circuit operates an alarm or, if the office is an unattended office, causes the transmission of an alarm to the master office. When the receiver is replaced at station A or the trouble is cleared, relay 11 releases; and the release of relay 11 causes the release of relay 14.

What is claimed is:

1. In a telephone system, a subscriber's station and line, a selector, means connecting said line to said selector, a line cut-off relay individual to said line, means in said selector for closing a circuit for operatively energizing a winding of said relay, timing means associated with said selector effective to maintain an operating circuit through said winding for a predetermined interval of time and to then open said circuit, a lock-out relay individual to said line, and a circuit including said winding of the line cut-off relay in series with a winding of said lock-out relay closed by the operation of the line cut-off relay, said winding of the lock-out relay being short-circuited until the operating circuit through said winding of the line cut-off relay is opened by said timing means.

2. In a telephone system, subscribers' lines, selectors for use in completing connections between calling and called lines, means responsive to the origination of a call over one of said lines for connecting the calling line to an idle one of said selectors, a first relay and a second relay, both individual to said calling line, means responsive to the interconnection of said line and a selector for closing a circuit for operatively energizing a winding of the first relay, timing means common to said selectors, means in said interconnected selector controlled by said timing means to maintain an operating circuit through said winding of the first relay for a predetermined interval of time and to open said circuit at the end of said interval, a circuit for operating said second relay including said winding of the first relay and a winding of said second relay, said winding of the second relay being short-circuited until the operating circuit through said winding of the first relay is opened by said timing means.

3. In a telephone system, a subscriber's station and line, a selector, means connecting said line to said selector, a line cut-off relay individual to said line, means in said selector for closing a circuit for operatively energizing a winding of said relay, timing means associated with said selector effective to maintain an operating circuit through said winding for a predetermined interval of time and to then open said circuit to release said line cut-off relay, a lock-out relay individual to said line, and a circuit including said winding of the line cut-off relay in series with a winding of said lock-out relay closed by the operation of the line cut-off relay, said winding of the lock-out relay being short-circuited until the operating circuit through said winding of the line cut-off relay is opened by said timing means, the energization of said winding of the line cut-off relay in series with the winding of

said lock-out relay being ineffective to hold said line cut-off relay operated.

4. In a telephone system, a subscriber's line, a selector, means operatively responsive to the origination of a call over said line connecting said line to said selector, a line cut-off relay individual to said line, means in said selector effective upon the interconnection of said line and selector for connecting ground potential to the test conductor of said line to maintain said interconnection and to operate said relay, timing means, means in said selector controlled by said timing means for maintaining the connection of ground potential to said test conductor for a predetermined interval of time and for then disconnecting ground potential from said test conductor to release said line cut-off relay, a lock-out relay individual to said line, and an operating winding of said lock-out relay connected to said conductor by the operation of said line cut-off relay, said winding of the lock-out relay being short-circuited by ground potential connected to said conductor.

5. In a telephone system, a subscriber's line, a combined line and line cut-off relay for said line, a selector circuit, means interconnecting said line and selector circuits, means responsive to the interconnection of said line and selector circuits for connecting ground potential to and through a conductor of said line circuit to an operating winding of said relay, timing means for maintaining the connection of ground potential to said conductor for a predetermined interval of time and for then disconnecting ground potential from said conductor, and a line lock-out relay individual to said line, an operating winding of said lock-out relay being connected to said conductor by contacts of the combined line and line cut-off relay, said winding of the lock-out relay being short-circuited by ground potential connected to said conductor.

6. In a telephone system, a subscriber's line, a line circuit comprising a combined line and line cut-off relay for said line, a selector circuit, means interconnecting said line and selector circuits responsive to the origination of a call over said line, means responsive to the interconnection of said line and selector circuits for connecting ground potential to and through a conductor of said line circuit to an operating winding of said relay, contacts actuated by the energization of said winding for disconnecting said line from the windings of said relay, timing means for maintaining the connection of ground potential to said conductor for a predetermined interval of time and for then disconnecting ground potential from said conductor, and a line lock-out relay individual to said line, an operating winding of said lock-out relay being connected to said conductor by contacts of the combined line and line cut-off relay, said winding of the lock-out relay being short-circuited by ground potential connected to said conductor.

7. In a telephone system, a subscriber's line, a line circuit for said line comprising a combined line and cut-off relay and a slow-to-release lock-out relay, a selector circuit, means interconnecting said line and selector circuits, timing means associated with said selector circuit, means in said selector for connecting ground potential to and through a conductor of said line circuit to an operating winding of said line and cut-off relay, a winding of said lock-out relay connected to said conductor and to said winding of the line and cut-off relay, the winding of the lock-out

5 relay being short-circuited by the ground potential connected to said conductor by said timing means, said timing means being effective
 10 a predetermined interval of time after the connection of ground to said conductor to disconnect the ground therefrom to cause the operative energization of said winding of the lock-out relay
 15 and the release of said line and cut-off relay, and a locking winding for said lock-out relay for holding said lock-out relay operated in case said
 20 line and cut-off relay immediately reoperates after its release due to the operation of said lock-out relay.

8. In a telephone system, subscribers' lines, a
 15 combined line and line cut-off relay for each of said lines, selectors for use in connecting calling and called lines, means including a winding and a contact of said relay for effecting the connection
 20 of a calling line to an idle one of said selectors, means in said selector effective upon interconnection of said line and selector for connecting ground potential to and through the test
 25 conductor of said line to another winding of said relay, contacts closed by the energization of said other winding upon the connection of ground
 30 potential to said conductor for disconnecting said line from said windings, a line lock-out relay having an operating winding connected to said conductor and to said other winding of the combined
 35 line and line cut-off relay by contacts of said line and line cut-off relay upon energization of said other winding, said operating winding of the lock-out relay being short-circuited while ground potential
 40 is connected to said conductor, timing means common to said selectors, means in said selector controlled by said timing means for maintaining the connection of ground potential
 45 to said conductor for a predetermined interval of time and for then disconnecting ground potential therefrom, the operating winding of the lock-out relay being operatively energized in series with
 50 said other winding of the line and line cut-off relay upon disconnection of ground potential from said conductor.

9. In a telephone system, subscribers' lines, a
 45 combined line and line cut-off relay for each of

said lines, selectors for use in connecting calling and called lines, means including a winding and a contact of said relay for effecting the connection of a calling line to an idle one of said selectors, means in said selector effective upon inter-
 5 connection of said line and selector for connecting ground potential to and through the test conductor of said line to another winding of said relay, contacts closed by the energization of said
 10 other winding upon the connection of ground potential to said conductor for disconnecting said line from said windings, a slow-to-release line lock-out relay having an operating winding and a locking winding, the operating winding of said
 15 lock-out relay connected to said conductor and to said other winding of the combined line and line cut-off relay by contacts of said line and line cut-off relay upon energization of said other winding, said operating winding of the lock-out relay being
 20 short-circuited while ground potential is connected to said conductor, timing means common to said selectors, means in said selector controlled by said timing means for maintaining the connection of ground potential to said conductor for
 25 a predetermined interval of time and for then disconnecting ground potential therefrom, means effective upon disconnection of ground potential from said conductor for disconnecting said line from said selector, the operating winding of the
 30 lock-out relay being operatively energized in series with said other winding of the line and line cut-off relay upon disconnection of ground potential from said conductor, the energization of said other winding of said line and
 35 line cut-off relay in series with the winding of the lock-out relay being ineffective to maintain the actuation of the contacts of said line and line cut-off relay, the locking winding for said lock-out relay being energized to hold said relay operated in case the line and line cut-off relay re-
 40 operates after its release due to the disconnection of ground potential from said conductor, and contacts on said lock-out relay for preventing the connection of said line to any of said selectors.

GERALD V. KING.

PAUL W. SWENSON.