July 19, 1932. R. L. STOKELY 1,868,296

AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 25, 1931 3 Sheets-Sheet 1

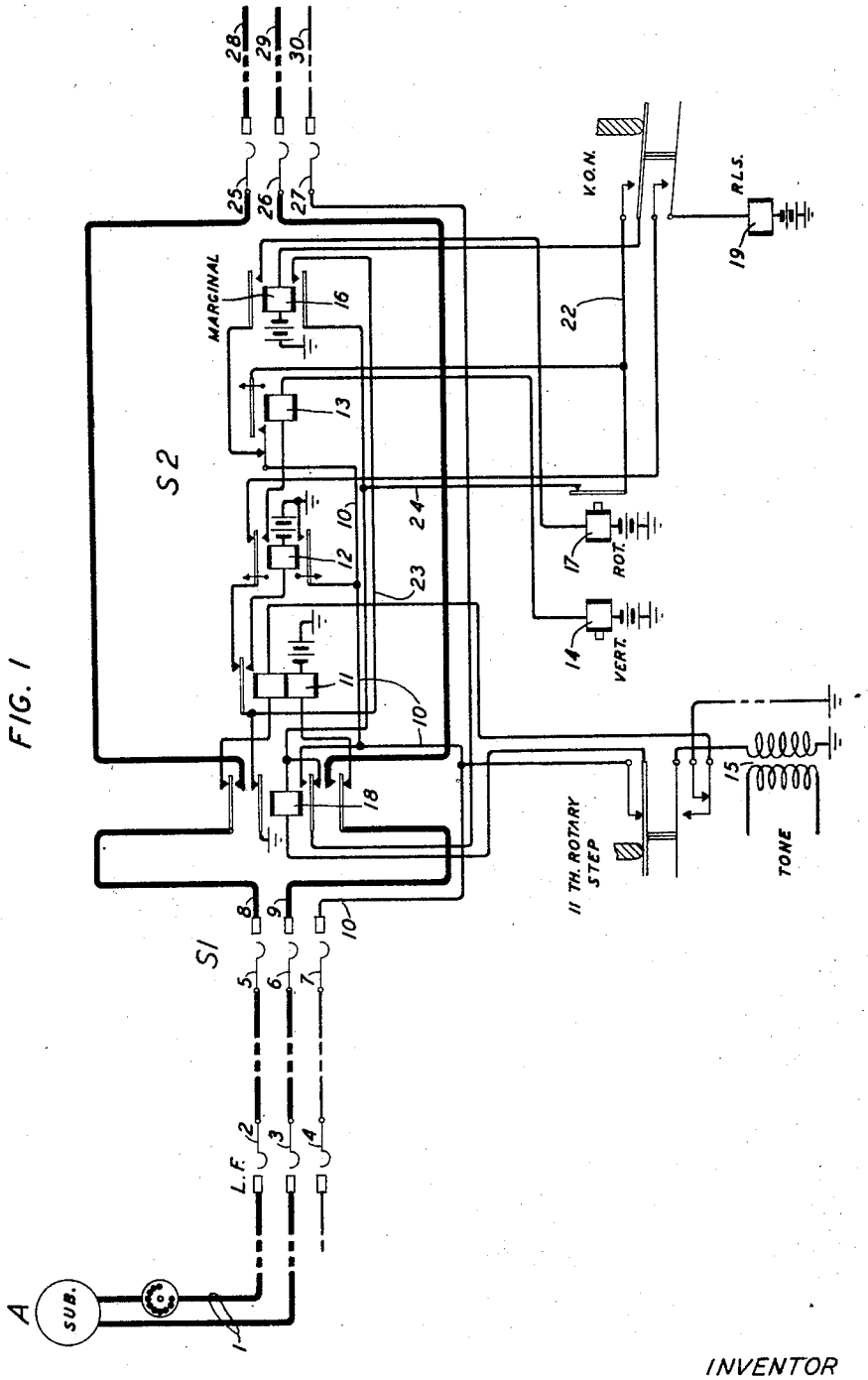

FIG. 1

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Filed Sept. 25, 1931 3 Sheets-Sheet 2

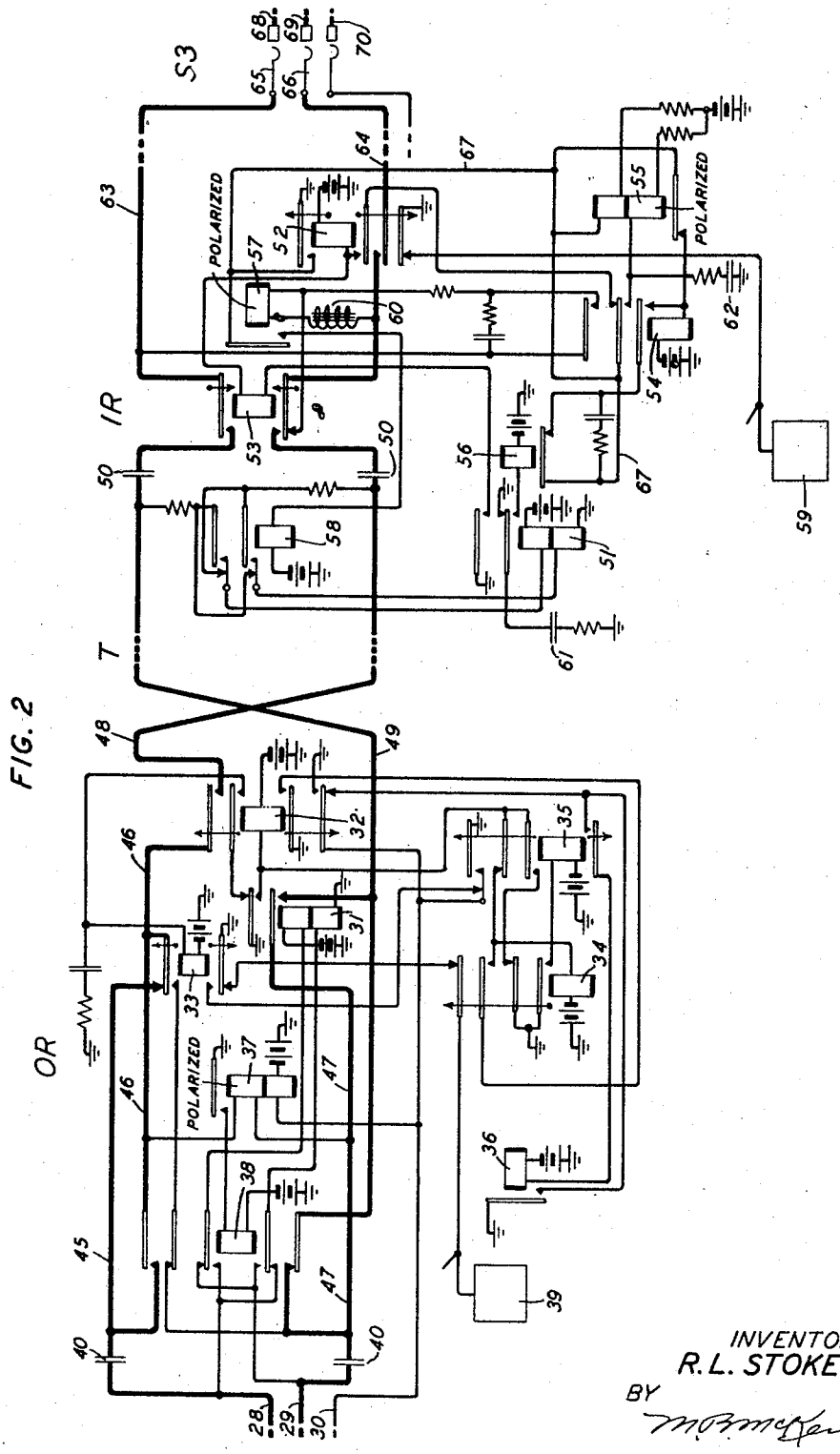

FIG. 2

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AUTOMATIC TELEPHONE SYSTEM

Filed Sept. 25, 1931 3 Sheets-Sheet 3

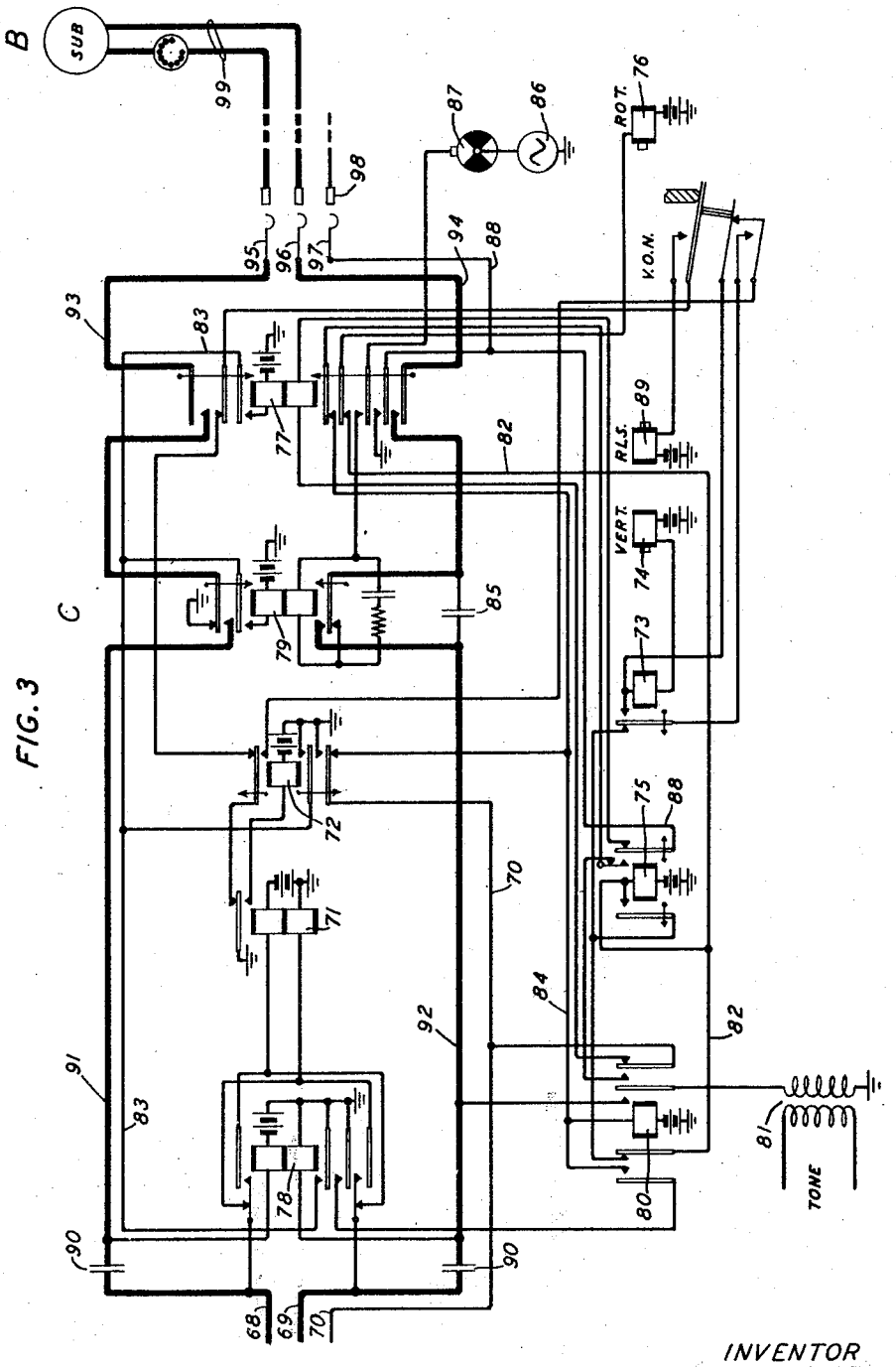

FIG. 3

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UNITED STATES PATENT OFFICE

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AUTOMATIC TELEPHONE SYSTEM

Application filed September 25, 1931. Serial No. 565,066.

This invention relates to telephone systems and particularly to systems employing automatic switches for establishing connections between subscribers' lines.

The objects are to safeguard the system against false connections, to enable the economical use of equipment without impairing the quality of the service, and to otherwise improve the operation of systems of this character.

It has been the practice heretofore to effect the release of a train of automatic switches by means controlled partly by the calling subscriber and partly by the called subscriber. Where switches of the step-by-step type are employed, the holding ground potential for maintaining the connection is usually applied at the connector switch. To permit the release of all switches except the connector when the calling party replaces his receiver, it is necessary to temporarily remove the holding condition from the connector switch; and to prevent some other selector from seizing this connector, while it is thereafter held by the called subscriber, it is necessary that the holding or busy condition be reapplied at the end of a short interval. Although the interval during which the busy condition is removed from the connector is short, there is a possibility that some selector switch searching for an idle connector will seize this unguarded connector and thus bring about a false connection. When the connection includes one or more impulse repeaters, the outgoing repeater in the originating office furnishes the holding ground for the switches located in that office. In this case it is also necessary that the holding or busy ground on the sleeve conductor of the outgoing repeater be temporarily disconnected, when the calling subscriber replaces the receiver, to permit the release of the switches in the originating office; and since faulty operation would result if the outgoing repeater were again seized on another connection before the selector switches in the distant office have reached their normal position, it is necessary to reconnect the busy potential to the sleeve conductor of the repeater for a short interval to prevent its seizure on another call before these switches have restored to normal.

According to the present invention, means are provided to prevent the seizure of an outgoing repeater or a connector during the short interval in which their respective sleeve conductors are freed of the holding or busy potential, when the receiver is replaced upon the switchhook at the calling station, to permit the release of the preceding switches. These means include a relay which is connected to the sleeve conductor at the time that the busy potential is removed. If there is no attempt to seize the repeater or connector during these unguarded intervals the aforementioned relays remain inert and the busy potentials are not reconnected to the sleeve conductors until the usual intervals have elapsed; if, however, a hunting selector attempts to seize the repeater or the connector during the unguarded interval, the associated relay is immediately operated to reapply the guarding potential and thus prevent the threatened seizure of the repeater or connector.

The invention will be better understood by considering the operation of a telephone system in which its features have been incorporated, such a system being represented schematically in the drawings which form a part of the following description. It is understood, however, that this embodiment of the invention is given by way of example only, and that various modifications and other applications of the invention will readily occur to those skilled in the art.

The drawings which consist of Figs. 1, 2 and 3 represent schematically a multi-office telephone system in which automatic switches are employed for establishing connections between the subscribers.

Fig. 1 shows a calling subscriber's station A, a line-finder switch LF, a first selector switch S1, and a second selector switch S2.

Fig. 2 shows an outgoing repeater OR, a trunk T, an incoming repeater IR and a selector S3, all three of these circuit units being permanently associated with each other.

Fig. 3 shows a connector circuit C, and a called subscriber's station B.

The subscribers' stations A and B are provided with the usual subscribers' telephone sets and with a dial for controlling the establishment of desired connections. The line-finder LF is of the well known Strowger type and may be similar to that disclosed in Patent 1,711,682 issued May 7, 1929 to H. Hovland. The brushes 2, 3 and 4 correspond to one of the two sets of brushes shown in the Hovland patent. The selector switches S1, S2 and S3 and the connector switch C are also of the well known Strowger type and reference may be had to pages 53 to 67 inclusive, of the second edition of "Automatic Telephony" by Smith and Campbell for a detailed description of the operation of these switches. Only those portions of the circuits of the line-finder LF, selectors S1 and S3 are shown as are required for a clear and complete description of this invention, the omitted portions of these circuits being represented by broken lines. The selector S2, the outgoing repeater OR, the incoming repeater IR and the connector C are shown in detail.

The outgoing repeater OR is arranged to repeat the dial impulses from a calling station over the two wire trunk T to the incoming repeater IR; and the incoming repeater IR is arranged to repeat the impulses received over trunk T to the succeeding selector and connector switches used in establishing the desired connection. The repeater OR is further arranged in accordance with this invention to prevent its seizure on a second connection during the interval in which the holding ground is removed from the test conductor to release the preceding switches. The connector switch C is also arranged in accordance with this invention to prevent its seizure on a second connection during the interval in which the holding ground is removed from the test conductor to release the preceding switches. The invention will be better understood from a description of the operation of these circuits in establishing a connection between the stations A and B.

Assuming that the subscriber at station A removes the receiver from the receiver-hook to originate the call, the line-finder LF hunts for and extends the line 1 through its multiple brushes 2, 3 and 4 to the first selector S1. When the calling subscriber dials the first digit of the calling subscriber's number, the brushes 5, 6 and 7 of 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 is connected to the selector S2, the line relay 11 is energized in a circuit which may be traced from battery through the lower winding of relay 11, outer lower back contact of relay 18, conductor 9, brushes 6 and 3 of the selector S1 and line-finder LF, over one side of the calling line 1, through the subscriber's set at station A, back over the other side of line 1, through brushes 2 and 5 of the line-finder LF and selector S1, over conductor 8, through the outer upper back contact of relay 18, upper winding of relay 11, and through the normally closed contacts of the "11th rotary-step" springs to ground. Relay 11 closes an obvious circuit for operating relay 12. Relay 12 connects ground through its lower front contact, over test conductor 10, through brush 7 of selector S1 to hold the line-finder and first selector switches in their operated positions. When the calling subscriber dials the second digit of the called subscriber's number, relay 11 is alternately released and reoperated in accordance with the impulses thus created. The release of relay 11 upon the receipt of the first impulse closes a circuit for operating the vertical stepping magnet 14 and relay 13. This circuit is traced from battery through winding of magnet 14, winding of relay 13, upper front contact of relay 12, back contact of relay 11, and through the inner upper back contact of relay 18 to ground. The operation of magnet 14 steps the shaft and brushes of the selector S2 up to the first level. When relay 11 reoperates, magnet 14 releases. Each succeeding release and reoperation of relay 11 causes a corresponding operation and release of magnet 14 to advance the brushes 25, 26 and 27 to the level corresponding to the digit dialed. Being slow in releasing, relay 13 remains operated until all of the impulses created by the dialing of the second digit have been received. Relay 12 does not release during the receipt of dial impulses since this relay is also slow in releasing.

When the shaft of switch S2 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 16, the upper contacts of the VON springs, conductor 22, front contact of relay 13, over conductor 10 to ground at relay 12. Relay 16 operates in this circuit and closes a locking circuit, independent of relay 13, from conductor 22 through the back contact of the rotary stepping magnet 17, over conductor 24, through the lower front contact of relay 16, over conductor 23, to ground at the inner upper back contact of relay 18. When relay 13 releases after all of the impulses corresponding to the second digit have been received, the rotary stepping magnet 17 operates in a circuit which may be traced from battery through the winding of magnet 17, upper front contact of relay 16, back contact of relay 13, over conductor 10 to ground at relay 12. The operation of magnet 17 rotates brushes 25, 26 and 27 into

contact with the first set of terminals in the selected level. Relay 16 releases when magnet 17 operates, and the release of relay 16 causes the release of magnet 17. If the first set of terminals is idle, relay 18 operates in a circuit which may be traced from battery through the winding of relay 16, upper contacts of the VON springs, conductor 22, back contact of magnet 17, conductor 24, winding of relay 18, upper contacts of the "11th rotary-step" springs, over conductor 10 to ground at relay 12. If the first set of terminals is busy, the winding of relay 18 is short-circuited by the busy ground on the test terminal, this short-circuit being traced through brush 27 of selector S2 and the inner lower back contact of relay 18. Relay 16 reoperates over this short-circuit to the busy ground, and again closes the circuit for operating the rotary stepping magnet 17. The operation of magnet 17 opens the circuit for operating relay 16, and the release of relay 16 again causes the release of magnet 17. In this manner relay 16 and magnet 17 are alternately operated and released to step the brushes from one set of terminals to the next until an idle set of terminals is reached, at which time relay 18 is operated in the circuit hereinbefore traced. Relay 16 is marginal and does not operate in series with relay 18. With relay 18 operated, a busy ground is connected from conductor 10, through the inner lower front contact of relay 18, and through brush 27 to the test terminal of the selected set so as to prevent seizure of a corresponding set of terminals by any other hunting selector.

If all of the trunks in the selected level are busy, the eleventh operation of magnet 17 advances the brushes beyond the tenth set of terminals to cause the operation of the "11th rotary-step" springs and thereby connect the secondary winding of the busy-tone transformer 15, through the front contact of the "11th rotary-step" springs, to the upper winding of relay 11, and thus transmit a busy tone to the calling subscriber.

Assuming the selected set of terminals to be connected to the outgoing repeater OR, the operation of relay 18 of the selector S2 extends the connection from the calling line over conductors 8 and 9, through brushes 25 and 26, and over conductors 28 and 29 to the repeater OR, operating the line relay 31. The circuit for relay 31 may be traced from battery through its upper winding, the inner upper back contact of relay 38, conductor 29, brush 26 of selector S2, the outer lower front contact of relay 18, conductor 9, through the brushes of selector S1 and line-finder LF and over the calling line, back through conductor 8, the outer upper front contact of relay 18, brush 25 of selector S2, conductor 28, the inner lower back contact of relay 38, and through the lower winding of relay 31 to ground. Relay 31 closes an obvious circuit for operating the holding relay 32. Relay 31 also closes a circuit for operating relay 34, this circuit being traced from battery through the winding of relay 34, the inner upper back contact of relay 35, to ground at the outer upper front contact of relay 31. Relay 32 connects ground through its outer lower front contact, over conductor 30, to the sleeve terminal and brush 27 of selector S2 to hold the preceding switches operated until the connection is released by the calling subscriber. Relay 32 also closes a bridge across the conductors of the outgoing trunk T, thereby operating the line relay 51 of the incoming repeater IR. This bridge may be traced from the upper conductor of trunk T, over conductor 49, through the inner front contact of relay 31, conductor 47, upper winding of relay 37, conductor 46, the outer upper front contact of relay 32, over conductor 48, to the lower conductor of trunk T. Relay 37 is polarized and does not operate by the current in this circuit at this time. With relay 34 operated, an obvious circuit is closed for operating relay 35 and ground is disconnected from the conductor which leads to the all-trunk-busy register circuit 39. Relay 35 opens the operating circuit for relay 34, but relay 34 is held operated through its upper outer front contact to ground at the inner lower front contact of relay 32.

When the calling subscriber dials the third digit of the called subscriber's number, relay 31 is alternately released and reoperated in accordance with the impulses thus created. The first release of relay 31 in addition to opening the aforementioned bridge across the conductors of trunk T closes a circuit for operating the slow-to-release relay 33. This circuit may be traced from battery through the winding of relay 33, upper inner front contact of relay 32, to ground at the back contact of relay 31. Relay 33 disconnects the upper one of the talking condensers 40 from trunk T and closes a short-circuit around the upper winding of relay 37; this short-circuit may be traced from conductor 46, through the upper front contact of relay 33 and the outer upper back contact of relay 38, to conductor 47. When relay 31 reoperates at the end of the first impulse, the bridge is again closed across trunk T. Each release and reoperation of relay 31 is thus effective to open and close the bridge across the outgoing trunk, to repeat the incoming impulses to the line relay 51 of the incoming repeater IR. Being slow in releasing, relay 32 does not release during the receipt of dial impulses. Relay 33 is also slow to release and remains operated during the receipt of each train of impulses. When relay 33 releases, the short-circuit across the upper winding of relay 37 is opened.

The operation of relay 51 of the incoming

repeater IR, due to the closure of the bridge across the conductors of trunk T, connects the winding of relay 56 to one side of condenser 61. Since this condenser is normally short-circuited by the back contact of relay 51, the operation of relay 51 causes a current to flow through the winding of relay 56 to charge condenser 61 and cause the operation of relay 56. The charging current is temporary and relay 56 remains operated for only a short interval of time. The operation of relay 51 also closes a circuit from battery through the winding of relay 52 and the winding of relay 53, to ground at the outer front contact of relay 51. Relay 52 operates in this circuit but relay 53 is slow to operate and, before it is sufficiently energized to actuate its contacts, its winding becomes short-circuited by the contacts of relay 52. This short-circuit is traced from ground at the upper front contact of relay 52, over conductor 67, the back contact of relay 54, and through the inner lower front contact of relay 52 to the conductor which connects the windings of relays 52 and 53. This connection not only short-circuits the winding of relay 53 but also constitutes a temporary locking circuit for relay 52. With relay 52 operated, a circuit is closed from battery through the upper winding of relay 55, over conductor 67, to ground at the upper front contact of relay 52; being polarized relay 55 is not operated since the current in this circuit is not in the operating direction. The ground thus connected to conductor 67 is also extended through the back contact of relay 55 to the winding of relay 54 causing the operation of relay 54. Relay 54 opens the aforementioned locking path for relay 52 and short-circuit for relay 53, so that relay 53 is now operated and relay 52 is held in series with the winding of relay 53 to the ground at the outer front contact of relay 51. With relay 52 operated, the ground at its outer lower back contact is disconnected from the conductor which leads to the all-trunks-busy register circuit 59. With relay 53 operated, the talking condensers 50 are connected to conductors 63 and 64, and the lower contacts of relay 53 are ineffective to short-circuit the winding of coil 60. With relay 54 operated, a circuit is closed from battery through the lower winding of relay 55, the upper outer front contact of relay 54, to the ground on conductor 67. The current flowing through the lower winding of relay 55 is effective to cause the operation of this relay and thereby open the circuit for operating relay 54. Relay 54 does not release since it is held operated through its inner front contact and the back contact of relay 56 to the ground on conductor 67. The aforementioned operation of relay 54 is also effective to close a bridge across conductors 63 and 64 which lead to the selector S3, thus causing the operation of the line relay (not shown) of this selector. This bridge may be traced from conductor 63, through the outer front contact of relay 54, winding of polarized relay 57, winding of retard coil 60, outer lower front contact of relay 52, to conductor 64. Relay 57 is not operated since the current in this circuit is not in the operating direction.

In response to the impulses created by the dialing of the third digit of the called number and repeated by the outgoing repeater OR over trunk T, relay 51 is alternately released and reoperated. The first release of relay 51 opens the circuit through the windings of relays 52 and 53 thereby causing the release of relay 53; but relay 52 remains operated during the receipt of impulses due to its being slow to release. Relay 53 does not reoperate until all of the impulses have been received due to its being slow to operate. Relay 53 is thereby effective to short-circuit the windings of polarized relay 57 and retard coil 60 during the transmission of each set of impulses, and is also effective to disconnect the talking condensers 50 from the outgoing impulse circuit. Each release and reoperation of relay 51 disconnects and again connects the winding of relay 56 to condenser 61, so that relay 56 is temporarily operated each time relay 51 operates. The operation of relay 56, in response to the receipt of the first impulse, opens the locking circuit for relay 54 thereby causing its release. When relay 54 releases, the bridge across conductors 63 and 64 is opened to cause the release of the line relay of selector S3. The release of relay 54 also opens the circuit through the lower winding of relay 55; but relay 55 is slow in releasing due to current continuing to flow through this winding to charge condenser 62. When relay 55 releases, the winding of relay 54 is again connected to ground on conductor 67 thereby causing the reoperation of relay 54. The release of relay 56 after receipt of the first impulse again closes the locking circuit for relay 54. With relay 54 reoperated, the bridge is again closed across conductors 63 and 64; and the circuit through the lower winding of relay 55 is again closed to cause the operation of relay 55. Relays 51, 53, 54, 55 and 56 repeat this cycle of operations in response to each impulse received over trunk T so as to transmit a corresponding impulse over conductors 63 and 64 to selector S3. Succeeding trains of impulses created by the dialing of the remaining digits of the called number are in like manner received over trunk T and repeated over conductors 63 and 64 to control the operation of the succeeding switches required for the establishment of the desired connection. The resistances and condenseres associated with relay 55 control the releasing time of relay 55 so as to insure the proper open period for each outgoing impulse repeated to the selector S3

and the other succeeding switches. At the end of each series of impulses relay 53 reoperates to connect conductors 63 and 64 through condensers 50 to the conductors of trunk T.

In response to the impulses created by the dialing of the third digit, and repeated by the outgoing repeater OR over trunk T to the incoming repeater IR and repeated by the incoming repeater IR to the selector S3, the selector S3 is selectively operated in the well known manner to advance its brushes to a corresponding level of terminals. The selector then operates to automatically select an idle set of terminals in the selected group. Assuming that the terminals thus selected are connected to the connector C, the line relay 71 operates in a circuit which may be traced from battery through the upper winding of relay 71, the lower back contact of relay 78, over conductor 69, through brush 66 of selector S3, over conductor 64, through the outer lower front contact of relay 52, winding of retard coil 60, winding of polarized relay 57, outer front contact of relay 54, over conductor 63, and through brush 65 of selector S3, conductor 68, upper back contact of relay 78, and through the lower winding of relay 71, to ground. Relay 71 closes an obvious circuit for operating the slow-to-release relay 72. Relay 72 connects ground through its outer lower front contact over sleeve conductor 70, and through the sleeve brush of selector S3 to hold this switch in its operated position.

The impulses created by the dialing of the last two digits of the called subscriber's number, repeated by the outgoing repeater OR and the incoming repeater IR, now cause the selective operation of the connector switch C. The release of relay 71, in response to the first impulse received from repeater IR, closes a circuit from ground through the back contact of relay 71, the upper front contact of relay 72, the normally closed contacts of the vertical off-normal springs VON, the winding of relay 73 and the winding of the vertical-stepping magnet 74, to battery. The magnet 74 and relay 73 are operated in this circuit, the operation of the magnet stepping up the shaft of this switch one step, so that the brushes 95, 96 and 97 are opposite the terminals in the first level. The vertical off-normal springs VON are actuated when the shaft is moved out of its normal position and the circuit through the winding of magnet 74 and relay 73 is now traced through the front contact of relay 73 and the lower front contact of the vertical off-normal springs, through the front contact of relay 72, to ground at the back contact of relay 71. When relay 71 reoperates at the end of the first impulse, magnet 74 releases. Each succeeding release and reoperation of relay 71 causes the operation and release of magnet 74, thus advancing the shaft and brushes of connector switch C to the level corresponding to the fourth digit of the called subscriber's number. Relay 73 is slow in releasing and remains operated during receipt of this train of impulses. Relay 72 is also slow in releasing and remains operated during the receipt of this and the succeeding train of impulses.

When relay 71 releases in response to the first impulse of the last series, a circuit is closed from ground at the back contact of relay 71, through the upper front contact of relay 72, the lower front contact of the VON springs, back contact of relay 73, left-hand back contact of relay 80, over conductor 82, through the winding of relay 75 to battery and also from conductor 82 through the outer lower back contact of relay 77 and the winding of the rotary-stepping magnet 76 to battery. Relay 75 and magnet 76 are operated in this circuit, the operation of magnet 76 rotating the brushes 95, 96 and 97 into contact with the first set of terminals in the selected level. Relay 75 connects conductor 82 through its left-hand front contact to the back contact of relay 73 thus making the circuit through the winding of relay 75 and the winding of magnet 76 independent of relay 80. Each succeeding release and reoperation of relay 71 is effective to cause the reoperation and release of magnet 74, thus rotating the brushes 95, 96 and 97 into contact with a set of terminals corresponding to the last digit of the called subscriber's number. Relay 75 is slow to release and remains operated during the receipt of the entire train of impulses. With sleeve brush 97 in contact with the sleeve terminal of the called line, a circuit is closed from battery through the winding of busy test relay 80, over conductor 84, through the inner lower back contact of relay 77, the right front contact of relay 75, over conductor 88, through brush 97, to the test terminal 98. If the called line is idle relay 80 does not operate; but if the called line is busy, the test terminal 98 is connected to ground and relay 80 operates. With relay 80 operated, the secondary winding of the busy transformer 81 is connected through the inner right-hand front contact of relay 80, over conductor 92 to condenser 90, thereby transmitting a busy tone to the calling subscriber.

Assuming that the called line is idle, the release of relay 75 closes a circuit from the holding ground on conductor 70, through the right-hand back contact of relay 80, lower winding of relay 77, outer back contact of relay 75, over conductor 88, through brush 97 and terminal 98, through the winding of the cut-off relay (not shown) of the called line 99 to battery. Relay 77 operates in this circuit sufficiently to close its inner upper front contacts and thus lock through its upper wind-

ing, over conductor 83, to ground at the inner lower front contact of relay 72. Relay 77 is thus fully energized to actuate its remaining contacts and thus extend the talking conductors of line 99 through brushes 95 and 96, over conductors 93 and 94 to the ringing relay 79. Relay 77 connects a holding and test-busy ground through its next-to-the-outer lower front contact, over conductor 88 and through brush 97 to terminal 98, to hold the aforementioned cut-off relay and prevent seizure of the line 99 by any other connector having access thereto. Ringing current is now connected to the line 99 to signal the called subscriber. The ringing circuit may be traced from ground through the source of ringing current 86, the interrupter 87, the inner lower front contact of relay 77, the lower winding and lower back contact of relay 79, the lowermost front contact of relay 77, over conductor 94, through brush 96, over line 99 and through the called subscriber's set at station B, back through brush 95, over conductor 93, through the uppermost front contact of relay 77, to ground at the upper outer back contact of relay 79. When the subscriber at station B removes the receiver from the receiver-hook, the current flowing through the lower winding of relay 79 is increased sufficiently to cause the operation of this slow-to-operate relay. Relay 79 locks through its upper winding and inner upper front contacts to the ground on conductor 83. With the relay 79 operated, the talking connection is extended from conductors 68 and 69, through condensers 90, over conductors 91 and 92, through the outer front contacts of relay 79, the outer front contacts of relay 77, over conductors 93 and 94, through brushes 95 and 96 to the called line 99. Talking battery is supplied to the called subscriber's station through the windings of relay 78 in the usual manner. Relays 78 operates thereby reversing the connections between conductors 68 and 69 and the windings of relay 71 thus causing the reversal of current over conductors 68 and 69 to operate the polarized supervisory relay 57 in the repeater IR. Relay 57 closes an obvious circuit for operating relay 58. Relay 58 reverses the connections between the conductors of trunk T and the windings of relay 51 thus reversing the flow of current over the trunk T to cause the operation of polarized supervisory relay 37 in the outgoing repeater OR. Relay 37 in turn closes a circuit for operating relay 38; and relay 38 reverses the connections from conductors 28 and 29 with respect to the windings of relay 31. The current is thus reversed in the circuit over conductors 28 and 29, through the talking conductors of selectors S2 and S1 and line-finder LF, and over the calling line in the usual manner.

When the receiver is replaced on the receiver-hook at the calling station, the line relay 31 of the outgoing repeater OR releases, thereby causing the release of relay 32. Relay 31 also opens the bridge across the conductors of trunk T to release line relay 51 of the incoming repeater IR. Relay 32 disconnects the test conductor 30 from the ground at its lower front contact and connects this conductor through the lower front contact of relay 35 to the winding of relay 36. Relay 32 also opens the circuit through the winding of the slow-to-release relay 34. When relay 34 releases, it closes a circuit from ground through its inner back contact, the inner upper front contact of relay 35, and through the winding of relay 32 to battery. Relay 32 reoperates in this circuit and thus reconnects the ground at its outer lower front contact to test conductor 30 as a guarding potential. With relay 32 operated and relay 31 released, relay 33 reoperates. The aforementioned release of relay 34 is also effective to cause the release of the slow-to-release relay 35; and when relay 35 releases, ground is also connected from the lower front contact of relay 33 through the outer back contact of relay 35 to test conductor 30. The release of relay 35 also opens the circuit which caused the reoperation of relay 32, so that relay 32 again releases, thereby causing the release of relay 33. With relays 32 and 33 both released, the test conductor 30 is no longer connected to ground and the repeater may now be seized for use on a succeeding call. The interval during which the test conductor 30 is freed of the holding ground is sufficient to insure the release of relay 18 of selector S2 and the corresponding relay in each of the preceding selector switches to cause the return of these switches and the line-finder switch to normal in the usual manner. The circuit for operating the release magnet 19 of selector S2 may be traced from battery through its winding, lower contacts of the VON springs, and upper back contacts of relays 12, 11 and 18 to ground. This circuit is opened by the VON springs when the shaft and brushes of selector S2 reach normal.

In case some selector having access to the repeater OR should test conductor 30 while relay 32 is temporarily released, relay 36 operates; the circuit for operating relay 36 may be traced from battery through its winding, the lower front contact of relay 35, the back contact of relay 32, over conductor 30, through the test terminal and test brush of the selector similar to selector S2 which is hunting for an idle outgoing repeater, through the lower inner back contact and winding of a relay corresponding to relay 18, and through the back contacts of the "11th rotary-step" springs of the hunting selector to ground at the lower front contact of a relay corresponding to relay 12. Relay 36 is a

fast operating relay and ground is connected through its front contact and the back contact of relay 32 to act as a temporary busy potential and thus prevent the operation of the relay in the hunting selector which corresponds to relay 18. Relay 36 locks and remains operated until relay 35 releases. The seizure of the repeater OR by another selector prior to the reoperation of relay 32 is thus prevented to insure that the bridge across trunk T be held open by relays 31 and 32 for an interval sufficient to cause the release of the succeeding selectors and also the release of the connector C if the receiver has also been replaced on the receiver-hook at station B.

The aforementioned opening of the bridge across trunk T causes the release of relay 51 of the incoming repeater IR. With relay 51 normal, relays 52 and 53 release. With relay 52 released, relays 54 and 55 release. The bridge across conductors 63 and 64 is opened when relay 52 releases, thereby causing the release of the line relay 71 of the connector C. The release of relay 71 closes the circuit for operating relay 75 and opens the circuit for relay 72. If the receiver at the called station has not been replaced on the receiver-hook, relay 78 of the connector remains energized to hold relays 77 and 79 and thus to prevent the return of the connector switch to normal. To release the selector S3, the release of relay 72 disconnects the holding ground from test conductor 70 and thus releases the relay (not shown) of selector S3 which corresponds to relay 18 of the selector S2. The selector S3 is thus restored to normal in the usual manner. With relay 72 released, the test conductor 70 is connected through its lower back contact, over conductor 84 to the winding of relay 80 and the circuit through the winding of relay 75 is opened. The release of relay 75 connects ground at the next-to-the-outer lower front contact of relay 77, through the outer right back contact of relay 75, lower winding of relay 77, and through the right back contact of relay 80 to conductor 70 to prevent the seizure of connector C; this ground connection is also extended from conductor 70 through the lower back contact of relay 72 to the winding of relay 80 thereby causing the operation of relay 80. Relay 80 locks through its left front contact to ground at the middle lower front contact of relay 78 and thus extends this ground to test conductor 70. In this manner the resistance of the lower winding of relay 77 is eliminated from the busy potential connection to render the protection against seizure more effective.

In case a hunting selector attempts to seize the connector C during the interval of time between the release of relay 72 and the release of relay 75, relay 80 operates in a circuit which may be traced from battery through its winding, conductor 84, lower back contact of relay 72, conductor 70, test terminal and brush of the hunting selector, through the inner lower back contact and winding of the relay in this selector which corresponds to relay 18 of selector S2, to ground at the front contact of the relay which corresponds to relay 12 of selector S2. Relay 80 is fast in operating and connects ground from the middle lower front contact of relay 78, through the left front contact of relay 80, over conductor 84 to test conductor 70 to prevent the operation of the test relay of the hunting selector and thus cause this selector to advance beyond the terminals of the connector C. Relay 80 is now held operated under the control of relay 78 until the called subscriber replaces the receiver on the switch-hook, at which time relays 78, 80, 77 and 79 release. The release of relay 77 closes the circuit for operating the release magnet 89. The shaft and brushes of connector C are then returned to normal in the usual manner, the circuit for magnet 89 being opened at the contacts of the VON springs when the shaft reaches its normal position.

What is claimed is:

1. In combination, a trunk, means for extending connections to said trunk, means for establishing a busy condition to guard the trunk against seizure, means for removing said condition, and means for reestablishing said condition in response to an attempted seizure of the trunk by said connective means.

2. In combination, a trunk terminating in a selective switch, means for extending connections to said trunk, means for establishing a busy condition to guard the trunk against seizure, means for removing said condition, and means for reestablishing said condition in response to an attempted seizure of the trunk by said connective means.

3. In combination, a selective switch, automatic switches having access to said selective switch for extending connections thereto, means associated with said selective switch for establishing a condition on the extended connection to hold one of said automatic switches in its operated position, means for removing said holding condition to permit the release of the operated automatic switch, and means for reestablishing said condition in response to an attempted seizure of said selector switch by one of said automatic switches.

4. In a telephone system, subscribers' lines, a link for use in connecting a calling and a called line, means for extending a calling one of said lines to said link, means for establishing a busy condition to guard the link against seizure, means for removing said condition, and means for reestablishing said condition in response to an attempted seizure of the link by said connective means.

5. In a telephone system, subscribers' lines, a link for use in connecting a calling and a

called line, preceding links having access to said link, one of said preceding links connecting a calling one of said lines to said link, means responsive to the seizure of said link for establishing a busy condition to guard said link against seizure by another of said preceding links, means for removing said busy condition to cause the release of said link by said one of the preceding links, and means for reestablishing the busy condition in response to an attempted seizure of said link by another one of said preceding links.

6. In a telephone system, a link, switches each having access to said link, means responsive to the seizure of said link by one of said switches for connecting a guarding potential to one of the conductors of said link to prevent seizure of said link by a second one of said switches and to hold said one of said switches, means for removing said guarding potential to cause the release of said one of said switches, means effective after a short interval of time for again connecting said guarding potential to said conductor, and means effective in response to an attempted seizure of said link by another one of said switches during said interval to connect a guarding potential to said conductor to prevent said attempted seizure from being successful.

7. The combination in a telephone system of a connector switch, selector switches for extending connections to said connector switch, means associated with said connector for establishing a holding condition on the connection extending back to one of said selector switches, means for removing said holding condition for an interval of time to permit the release of the preceding selector switch, means effective after the expiration of said interval for reestablishing said condition to guard the connector against seizure, and means effective during said interval to reestablish said condition should another one of said selector switches attempt to seize said connector.

8. The combination in a telephone system of a calling line and a called line, a selective switch and other switches having access to said selective switch, means for operating said switches to establish a connection between the calling line and the called line, means in said selective switch for setting up a condition in the established connection to hold said other switches in operated position, means controlled by the calling subscriber for removing said holding condition to permit the release of said other switches, means effective to restore said condition in response to an attempt by one of said other switches to seize said selective switch, and means controlled by the called subscriber for releasing said selective switch.

9. The combination in a telephone system of a calling line and a called line, selector switches and a connector switch for establishing a connection between said lines, means in the connector switch for applying a given potential to the connection to hold said slector switches operated, means controlled by the calling subscriber for momentarily removing said potential to permit the release of said selector switches, means in said connector switch effective in response to an attempted seizure of said connector switch by one of said selectors to restore said potential to guard said connector switch from seizure, and means controlled by the called subscriber for releasing said connector switch.

10. In combination, an automatic switch, a connective circuit extending to said switch, other switches having access to said connective circuit, means responsive to the operation of said automatic switch for establishing a holding condition on one of the conductors of said connective circuit, means for removing said holding condition to permit the release of one of said other switches, a relay, means for connecting said relay to said conductor when said condition is removed therefrom, means for operating said relay responsive to an attempt by one of said other switches to seize said automatic switch and a circuit completed by said relay for restoring said condition to guard the automatic switch against seizure.

11. In combination, an automatic switch, a circuit including a control conductor extending to said switch, other switches for seizing said circuit to extend connections to said automatic switch, means in said automatic switch for establishing a ground potential on said control conductor to hold preceding switches, means for removing said ground potential for an interval of time to permit the release of preceding switches without restoring said automatic switch, a relay associated with said automatic switch, means for connecting said relay to said holding conductor during said interval of time, means for operating said relay if a preceding switch attempts to seize said automatic switch during said interval, means controlled by said relay for restoring said ground potential to the control conductor to prevent the seizure of said automatic switch, and means for restoring said ground potential to the control conductor after the expiration of said interval of time.

12. In a telephone system, subscribers' lines, a repeater for use in extending a connection from a calling to a called line, switches having access to said repeater, switches for operation in response to impulses transmitted through said repeater from a calling line, means responsive to the seizure of said repeater by one of said preceding switches for connecting a guarding potential to one of the conductors of the repeater,

means for removing said guarding potential, and means responsive to an attempted seizure of said repeater by another one of said preceding switches for reconnecting said guarding potential to prevent said attempted seizure from being successful.

13. In a telephone system, subscribers' lines, a repeater for use in extending a connection from a calling to a called line, switches having access to said repeater, switches for operation in response to impulses transmitted through said repeater from a calling line, means responsive to the seizure of said repeater by one of said preceding switches for connecting a guarding potential to one of the conductors of the repeater, means responsive to the release of the connection by the calling subscriber for causing the release of one of said succeeding switches and for temporarily disconnecting said guarding potential to release said one of said preceding switches, and means effective in response to an attempted seizure of said repeater while said guarding potential is temporarily disconnected for reconnecting a guarding potential to said conductor to prevent said attempted seizure from being successful.

In witness whereof, I hereunto subscribe my name this 22 day of September, 1931.

RAY L. STOKELY.