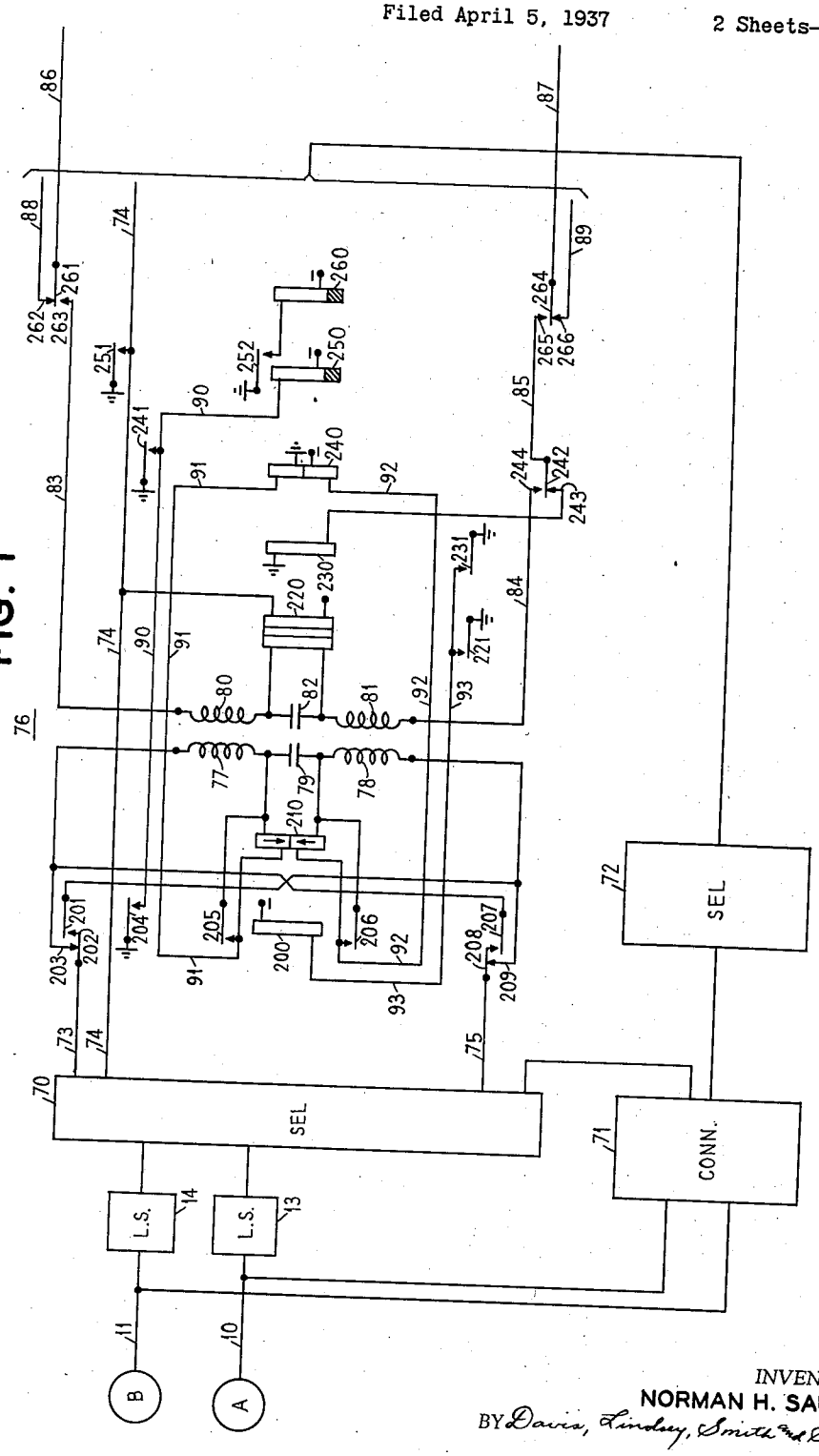
Sept. 27, 1938. N. H. SAUNDERS 2,131,572

TELEPHONE SYSTEM

Filed April 5, 1937 2 Sheets-Sheet 1

FIG. 1



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TELEPHONE SYSTEM

Filed April 5, 1937 2 Sheets-Sheet 2

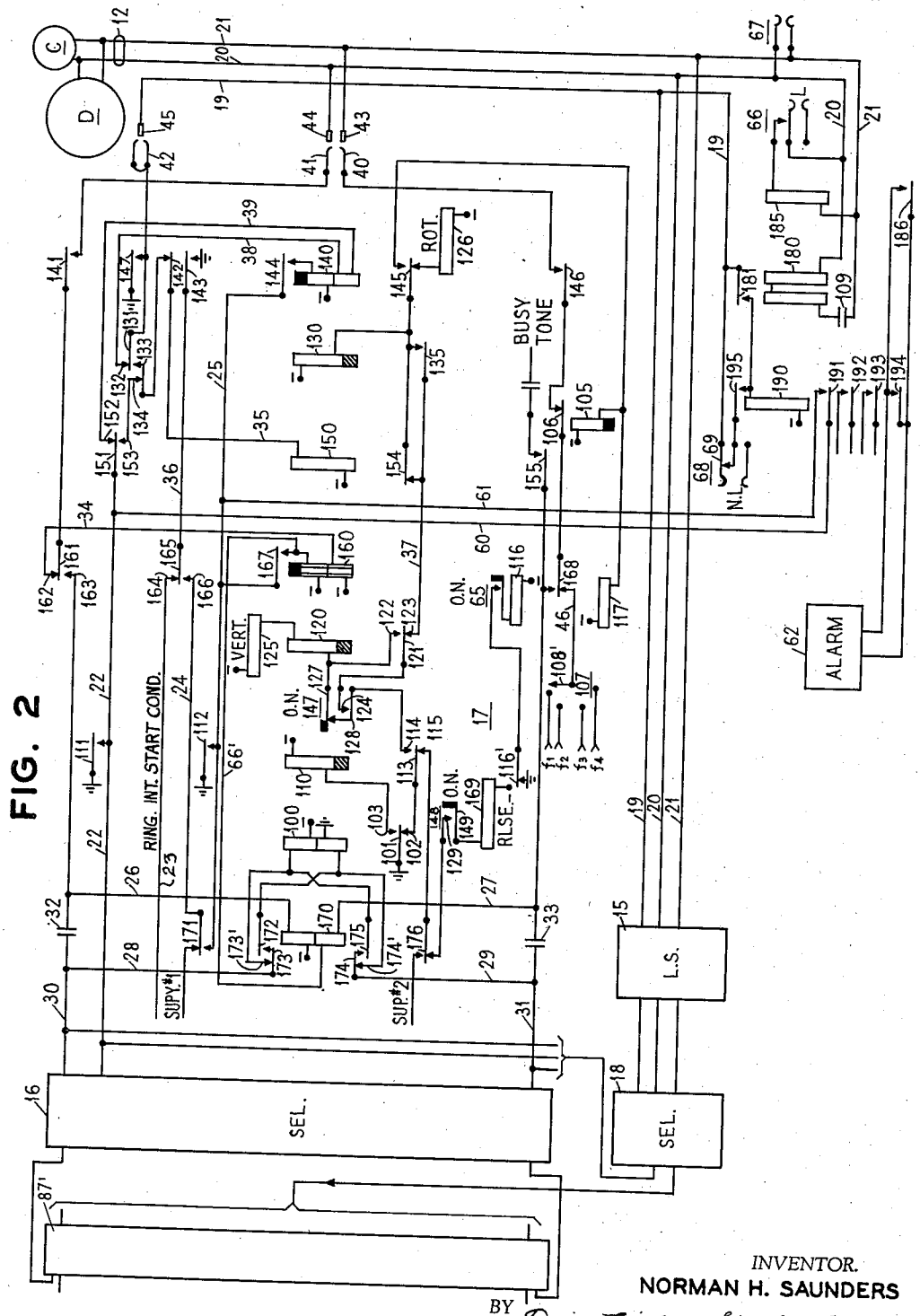


FIG. 2

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Patented Sept. 27, 1938 2,131,572

UNITED STATES PATENT OFFICE

2,131,572

TELEPHONE SYSTEM

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Application April 5, 1937, Serial No. 134,998

20 Claims. (Cl. 179—27)

The present invention relates to telephone systems and more particularly to such systems of the automatic step-by-step type having embodied therein apparatus automatically operable to permit the tracing of incoming calls to any desired predetermined subscriber's telephone.

Systems of the type mentioned conventionally comprise switch trains including step-by-step selector and connector switches for setting up and releasing connections between any pair of telephones in the system. In such systems, as well as in other systems of similar character, the need has long been recognized for means operable to assist an attendant in the tracing of incoming calls to particular telephones. This need arises in connection with repeated annoyance calls to certain telephones, in police work, and in rendering other services ordinarily required of a public exchange system. Various expedients have been resorted to in the past for providing this form of service. These expedients, however, leave something to be desired with respect to the simplicity of the apparatus involved and also with respect to the faithfulness of the operation thereof.

It is an object of the present invention, therefore, to provide an improved and exceedingly simple circuit arrangement, applicable to practically any of the various modifications of the step-by-step automatic telephone system, for assisting an attendant in tracing calls to any desired telephone embodied in the system.

It is another object of the invention to provide an arrangement of the above character which utilizes to the fullest extent the switching equipment normally provided for rendering ordinary telephone service.

More specifically, it is an object of the invention to provide an arrangement of the above character which is operable to assist an attendant in tracing calls to a single telephone on a party line from telephone lines terminating at any one of two or more exchanges included in the system.

The invention as described in detail hereinafter is illustrated as being embodied in an automatic system including two exchanges interconnected by two-way trunk lines and wherein step-by-step line, selector and connector switches, operable in the order named, are provided in each exchange for establishing a connection between a first or calling line to a second or called line. Such a connection may be regarded as comprising a talking loop between the two telephones, the loop being completed when the call is answered at the second or called telephone.

In general, the objects as set forth above are realized in accordance with the present invention by providing means automatically operable as soon as the line associated with the telephone to be observed is seized by a connector switch of the switching equipment for preventing the established connection from being released in response to any possible operation which the calling party may perform at the calling telephone, and more particularly in response to the interruption of the talking loop at the calling telephone. More specifically, this means comprises a plurality of interrelated relays associated with the line leading to the telephone to be observed, one of which operates in response to the application of ringing current to this line, to prevent the selector switch, preceding the operated connector switch, from being released when the calling party interrupts the talking loop at his telephone by hanging up his receiver. By holding this selector switch operated after the calling party hangs up, it is possible for the called party to inform an attendant at the central exchange that a call is to be traced, whereupon the attendant may, by observing the condition of the aforementioned selector switch or switches and the line switch which has caused the operation thereof, determine the line on which the call was initiated. Additional means, comprising certain of the relays of the connector switch in use, are provided which are operable in case a talking loop is not completed at the observed telephone to cause the restoration of the above-mentioned means so that the connection may be released in the conventional manner when the calling party hangs up. As pointed out in detail hereinafter, the aforementioned relays are under the control of the answering party at the observed telephone and function to hold a predetermined potential, namely, ground potential, on the control conductor of the operated selector switch after the party at the calling telephone hangs up, whereby the portion of the switch train preceding the operated connector switch is held operated.

The present arrangement is of particular utility in assisting an attendant to trace calls to a particular telephone on a party line. As is well known, such lines are identified by having thereon a plurality of telephones, each of which has associated therewith a signal device. In those cases where selective harmonic ringing is relied upon for signaling a particular telephone, each of the signal devices on a given party line is responsive to alternating ringing current having a frequency different from the frequency of the current to which each of the other signal devices on the same line is responsive. In accordance with one feature of the present invention, an attendant is assisted in tracing calls to any particular one of the plurality of telephones on a party line by making a portion of the means for holding the switch train operated after a connection is once established to the line, respon-

sive to the application of ringing current to the line of a particular character or frequency. More specifically, the relay associated with the party line to which the telephone under observation is connected and forming a part of the means for holding the switch train operated, is connected and arranged to be responsive only to the application of current to the line of the particular frequency to which the signal device associated with the telephone under observation is responsive.

In certain instances it is desirable that incoming calls to a particular telephone be traced even though the calls originate on lines extending to an exchange different from that to which the line associated with the telephone under observation extends. The switch train or means for establishing this type of connection conventionally comprises a first selector switch, a repeater, a second selector switch and a connector switch, connected in tandem and operable in the order named, the connection itself extending over a trunk line interconnecting the two offices. In accordance with a further feature of this invention, means are provided operable substantially simultaneously with the completion of such a connection for holding the entire switch train operated so that attendants in the respective exchanges may make the necessary observations and exchange the information necessary to a determination of the line on which the call originated. This means, more specifically described hereinafter, comprises means included in the repeater and responsive to the operation of the battery reversing relay of the connector switch for applying a predetermined potential, namely, ground potential to the control conductor of the first selector switch independently of the hold relay of the repeater, it being understood that the last-mentioned relay normally holds ground potential on the control conductor of the first selector and is responsive to an operation, namely, the hanging up of the receiver at the calling telephone, to remove ground therefrom, thereby to release the portion of the switch train preceding the repeater. The portion of the switch train following the selector is held operated by the means briefly referred to above. The elements of the various means referred to above are arranged in an exceptionally simple manner such that the control relays normally provided in the various switches are utilized to the fullest extent in faithfully providing the form of service noted.

The novel features believed to be characteristic of the invention are set forth with particularity in the appended claims. The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the specification taken in connection with the accompanying drawings, in which Figs. 1 and 2 taken together illustrate in partially schematic form a telephone system of the type mentioned, having embodied therein means constructed and arranged in accordance with the present invention for assisting an operator to trace calls to any desired telephone or telephones included in the system.

Referring now to the drawings, there is illustrated, for the purpose of describing the invention, an automatic telephone system of conventional form comprising two exchanges, one of which is shown in Fig. 1 and the other of which is shown in Fig. 2. These two exchanges are interconnected by a plurality of trunk lines such, for example, as the line **86**, **87**, and each thereof has embodied therein impulse responsive step-by-step switches for setting up and releasing connections between any pair of telephone lines included in the system. In general, the system comprises a plurality of telephones or subscribers' substations, four of which are shown at A, B, C, and D, adapted to be interconnected by means including their respective associated subscribers' lines **10**, **11** and **12** and switch trains including the aforementioned step-by-step switches. It will be observed that the line **12** is of the party line variety having a plurality of telephones thereon, two of which are shown at C and D. The switch trains, when established, may individually comprise the usual line switch associated with each subscriber's line, one or more tandem connected intermediate selector switches, the first of which is accessible to the line switch corresponding to the calling subscriber's line, and a connector switch accessible to the finally operated selector switch and having bank contacts in which the called subscriber's line terminates. Thus, in the system shown, the lines **10**, **11** and **12** terminate at line switches **13**, **14** and **15**, respectively, the first two of which have access to a group of selector switches, one of which is shown at **70** included in the first exchange, and the last of which has access to a group of selector switches, one of which is shown at **18** included in the second exchange. These selector switches, in turn, have access to groups of connector switches, each connector switch of each group having its bank contacts multipled to the bank contacts of the other switches in the same group and connected to serve a corresponding group of subscribers' lines in the system. Thus, the selector switch **70** has access to a group of connector switches, one of which is shown at **71**, in the bank contacts of which a group of subscribers' lines of the first exchange terminate. Similarly, the selector switch **18** has access to a group of connector switches, one of which is shown in detail at **17**, in the bank contacts of which a group of subscribers' lines of the second exchange terminate. In order to establish connections between the subscribers' lines of the first exchange and the subscribers' lines of the second exchange, there is provided one or more two-way trunk lines which terminate at either end at a two-way repeater. Thus, the trunk line **86**, **87** terminates at a repeater **76** in the first exchange and a repeater **87'** in the second exchange. The repeaters in the first exchange similar to and including the repeater **76** are accessible to the selector switches, such, for example, as the switch **70**, and, similarly, the repeaters of the second exchange are accessible to the group of selector switches of which only the switch **18** is shown. In the arrangement illustrated individual selector switches **16** and **72** are provided for gaining access to the connector switches included in the respective exchanges on incoming calls thereto, routed by way of the trunk lines such, for example, as the line **86**, **87**. It is well known that by this arrangement, any subscriber may, by proper manipulation of the impulsing device at his substation, establish a connection between his line and any other subscriber's line in the system.

Each of the line switches included in the system, such, for example, as the line switches **13** to **15**, inclusive, may be of any desired commercial construction, although preferably is of the well-known rotary type having three sets of bank contacts, wipers corresponding to the three

contact sets, a ratchet and pawl mechanism for driving the wipers, an operating magnet for actuating the ratchet and pawl mechanism, and control means whereby the operating magnet operates when a call is initiated on the line associated with the corresponding line switch and its operation is arrested when the wipers are rotated into engagement with a set of contacts corresponding to the first idle selector switch available. Similarly, each of the selector switches included in the system may be of any desired form, although preferably is of the well-known Strowger type comprising bank contacts arranged in levels, each level corresponding to a particular group of conector switches, wipers for engaging the bank contacts, ratchet and pawl mechanisms for imparting translatory and rotary movements to the wipers, vertical and rotary magnets for driving the respective ratchet and pawl mechanisms and control means whereby, when a selector switch is first seized, it is automatically conditioned to be responsive to the first digit dialed at the calling substation, the dialing of the first digit causes the vertical magnet to step the wipers upward opposite the level of bank contacts corresponding to the number of impulses in the digit dialed and the wipers are automatically rotated by the rotary magnet and associated ratchet and pawl mechanism into engagement with the set of contacts corresponding to the first idle connector in the group of connectors to which the called line extends.

The various connector switches, like the selector switches, are preferably of the Strowger type and may be identical with that illustrated at 17. In brief, the switch 17 comprises two banks of contacts arranged in levels, the individual contact sets connected to the various subscribers' lines being multipled to the corresponding contact sets of other similar connector switches included in the same group. Thus, the switch 17 comprises a contact 45 in the control contact bank, which contact is connected to the control or C conductor 19 leading to the line switch 15 associated with the party line 12. The corresponding line contacts 43 and 44 for the line conductors 20 and 21 of the line 12 are included in the line contact bank. The connector switch 17 also includes wipers 40, 41 and 42 for engaging the various contact sets in the two contact banks, such, for example, as the contacts 43, 44 and 45, a ratchet and pawl mechanism, not shown, for translating these wipers vertically opposite any desired contact level, a vertical magnet 125 for actuating this ratchet and pawl mechanism, a second ratchet and pawl mechanism, not shown for thereafter actuating the enumerated wipers into engagement with the particular contact set corresponding to the called subscriber's line and a rotary magnet 126 for driving this second ratchet and pawl mechanism. The switch also includes a release magnet 169 for actuating the two ratchet mechanisms to permit the wipers to be restored to normal, a minor switch 107 for selectively applying ringing current of a particular frequency to a line seized by the switch 17, and control means comprising a plurality of inter-related relays 100, 110, 120, 130, 140, 150, 160 and 170, their control and controlled circuits and off-normal springs 147 and 148, for controlling the operation of the vertical, rotary and release magnets and for performing the various other functions normally required in this type of switch. The switch 107 comprises a ratchet and pawl mechanism, not shown, a motor magnet 117 for actuating the ratchet and pawl mechanism, a release magnet 116 for permitting the switch 107 to restore to normal, and off-normal springs 65. More specifically, the last-mentioned control means comprises the relays 100 and 110, operative in the order named to condition the vertical magnet 125 for operation; the relay 120 for preventing the impulses of the second digit, dialed at the calling substation, from being transmitted to the rotary magnet 126; the line relay 100 for interrupting the circuit of the vertical magnet 125 in accordance with the impulses of the second digit; the relays 110 and 120 for conditioning, at the end of the second digit, the rotary magnet 126 to be responsive to the impulses comprising the third digit dialed at the calling substation; the relay 100 for interrupting the circuit of the rotary magnet in accordance with the impulses of the third digit; the relay 140 for partially completing the connection to the called line, for applying ringing current thereto and for applying, in case the called line is found idle, ring back current to the incompleted talking loop extending back to the calling subscriber's substation; the relay 150 for applying busy tone to this loop, for interrupting the circuit of the motor magnet 117 and for preventing the calling line from being connected to the called line, all in the event the called line is found busy; the relay 160 for completing the connection between the calling and called lines, for interrupting the application of ringing current to the called subscriber's line and the application of ring back current to the calling subscriber's line; and the relay 170 for reversing battery back over the loop extending to the calling subscriber's line when the called party answers.

As pointed out in detail hereinafter, the relay 110, when operated to one of its two positions, includes closed contacts associated with its armature 111 for applying a predetermined potential, namely, ground potential, to the control conductor 22 extending to the preceding selector switch to hold the latter switch operated when a connection is once established by way of the switch 17 between two subscribers' lines. This relay is also operable to the other of its two positions to remove, at the contacts noted, ground potential from the same control conductor, thereby to release, under certain conditions, the selector switch 16 when the talking loop is interrupted at the calling party's telephone.

Each of the two-way repeaters included in the system may be identical with that shown generally at 76 as comprising primary windings 77 and 78 normally connected across the line conductors 73 and 75 by a condenser 79 and secondary coils 80 and 81 connected in series across the line conductors 83 and 84 by a condenser 82. The control means for this repeater comprises the relays 200, 210, 220, 230, 240, 250 and 260 and their respective control and controlled circuits.

Neglecting for the present the details of the connector switch 17 and the means associated therewith for assisting an attendant to trace calls to a predetermined subscriber's telephone or telephones, the system as described above is entirely conventional in form and its operation is well understood in the art. In brief, when a subscriber such, for example, as the subscriber at the telephone A initiates a call over the line 10 to a second subscriber's telephone in the same exchange such, for example, as the telephone B, by lifting his receiver from its hook, the line

switch 13 associated with the calling subscriber's line operates to select an idle selector switch and to condition the same to be responsive to impulses transmitted from the impulsing device at the telephone A. As noted above, each of the selector switches has access to one or more connector switches in which any subscriber's line of the system terminates. Thus, if the selector switch 10, for example, is seized by the line switch 13, it operates in response to the dialing of the first digit at the substation A to translate its wipers vertically to a contact level corresponding to the group of connector switches at which the called line 11 terminates, following which it automatically rotates its wipers into engagement with a set of contacts corresponding to the first idle connector switch in this group. Thereafter, and assuming the connector switch 17 is seized by the selector switch 10, the connector switch, in response to the dialing of the second digit, and through the operation of its vertical magnet and the associated pawl and ratchet mechanism, translates its wipers vertically to positions opposite the contact levels in which the conductors of the called subscriber's line 11 terminate. With the switch train in this condition and when the third digit is dialed, the rotary magnet of the connector switch, in cooperation with its associated ratchet and pawl mechanism, operates to drive its wipers into engagement with the contacts corresponding to the called line 11.

The system conventionally includes means whereby ringing current and ring back tone are automatically transmitted, respectively, to the substations of called and calling parties in case the called line is idle and upon the connector wipers coming into engagement with the bank contacts at which the called subscriber's line terminates. Also, in accordance with conventional practice, means are provided whereby, in the event the called line is found busy, the calling line is not connected thereto and busy tone is transmitted back over the established loop to the calling party to indicate the busy condition of the called line.

In the event the called line is found idle and the called party answers, battery is reversed back over the loop when the called party lifts his receiver from its hook to connect a bridge across the conductors of the called line. With the system in this condition, a talking connection is established between the calling and called parties which obtains until the conversation is terminated and one of the parties hangs up.

The arrangement is such that, when the calling party is the first to interrupt the talking loop by hanging up, the switch train leading to the connector switch 17 and including the selector switch 10 and the line switch 13 is normally released. The connector switch is, however, held in its operated position until the called party hangs up to remove the bridge from across the conductors of his line. In the event the called party is the first to interrupt the talking loop, the entire switch train is maintained operated until the calling party hangs up.

The method by which the apparatus included in the second exchange, shown in Fig. 2, operates to establish and release a connection between two telephones, both of which are on subscribers' lines extending to this exchange, is exactly the same as that described above and is, therefore, omitted in the interests of simplifying the description.

In the operation of the system on a call from the telephone A connected to a line of the first exchange, to the telephone C, connected to a line of the second exchange, the line switch 13 operates to seize an idle selector switch, such, for example, as the switch 10, in the exact manner described above. In response to the dialing of the first digit, this selector switch seizes an idle trunk line, which will be assumed to be the line 86, 87, extending to the second exchange. When the second digit is dialed the selector switch 16 seized by the line 86, 87 steps its wipers to a level corresponding to the contact level in which the conductors of the group of connector switches serving the called line terminate and automatically seizes an idle connector switch in this group. Assuming the connector switch 17 is seized, this switch, in response to the dialing of the third and fourth digits, actuates its wipers into engagement with the bank contacts at which the called line 12 terminates. When the fifth digit is dialed, ringing current of the proper frequency to cause operation of only the signal device at the desired telephone is applied to the line 12. When the called telephone is answered battery is reversed back over the trunk line conductors, causing the relays 220 and 200 to operate and complete the connection. It will be seen that the switch train or means employed in establishing this connection includes the selector switch 10, the repeater 76, the selector switch 16, and the connector switch 17, connected in tandem and operable in the order named. As pointed out in detail hereinafter, the arrangement is such that, when the calling party hangs up first, the entire switch train excluding the connector switch 17 is normally released, this latter switch being held operated until the called party hangs up. Alternatively, if the called party hangs up first, the entire switch train is held operated until the connection is cleared out at the telephone A.

The mode of operation of the system on a call from a telephone connected to a subscriber's line of the second exchange to a telephone connected to a subscriber's line of the first exchange is deemed to be obvious in view of the description in the preceding paragraph and for that reason is omitted.

Referring now more particularly to the operation of the repeater 76 in the sequence of operations just described, when the selector switch 10 extends the calling loop to the line conductors 73 and 75 a circuit is completed for energizing the line relay 240. This circuit extends from ground at the upper winding of the relay 240, through this winding, over the conductor 91, through the upper winding of the relay 210, the repeater winding 77, the armatures 203 and 202, over the side of the calling loop including the line conductor 73, through the bridge at the telephone A back over the other side of the calling loop including the conductor 75, through the armatures 208 and 209, the repeater winding 78, the lower winding of the relay 210, over the conductor 92 and through the lower winding of the relay 240 to battery. The relay 240 thereupon operates to complete, at its armature 241, an obvious energizing circuit for the hold relay 250 and to prepare, at its armature 242 and associated contact 244, a loop extending by way of the trunk line conductors 86 and 87 to the second exchange. When the slow-to-release hold relay 250 operates it applies ground at its armature 251 to the control or C conductor 74, thereby to hold, in a well-known manner, the switch train preceding

the repeater 76 operated. The relay 250, upon operating, completes an obvious circuit for energizing the relay 260, which latter relay, in turn, operates to complete, at its armatures 261 and 264 and their respective associated contacts 263 and 265, the loop extending to the second exchange. Completion of this loop causes the line relay in the selector switch 16 to operate and initiate the conditioning of this switch to be responsive to the impulses comprising the second digit dialed at the calling telephone A. During impulsing the loop is alternately interrupted and completed by the operation and restoration of the armature 242 of the line relay 240.

When ground is applied to the control conductor 74, the right-hand winding of the relay 220 is energized. This relay is of the polarized type such that it will not operate when only its right-hand or polarizing winding is energized when the current through the left-hand winding is normal. When, however, the called party answers and the current is reversed over the loop including the windings 80 and 81, the left-hand winding of the relay 220 is properly energized to cause the operation thereof. At its armature 221, the relay 220, upon operating, completes a circuit including the conductor 93, for energizing the relay 200. The last-mentioned relay, in turn, operates to short-circuit, at its armatures 205 and 206, the windings of the relay 210 and, at its armatures 201, 202 and 207, 208, to reverse battery back over the loop extending to the calling telephone.

The release of the repeater 76 is primarily under the control of the calling party in so far as the apparatus just described is concerned. Thus, when the called party hangs up and battery is reversed back over the loop to the repeater 76, only the relays 220 and 200 restore, ground being retained on the control conductor 74 by virtue of the operated condition of the relays 240 and 250. When the calling party hangs up, however, to interrupt the previously traced operating circuit for the line relay 240, this relay restores and causes the relays 250 and 260 to restore. The relay 250, upon falling back, removes ground potential from the control conductor 74 at its armature 251, thereby initiating the release of the selector switch 70 and the line switch 13 in the usual manner. Thereafter, the relays 220 and 200 restore and the repeater is in its idle or normal condition.

Fom the foregoing description it will be apparent that the selector switch 70 is normally releasable in response to an operation performed at the calling telephone, namely, the operation of hanging up the receiver to cause the sequential restoration of the relays 240, 250 and 260. More particularly, it will be apparent that so long as a predetermined potential, namely, ground potential is maintained on the control conductor 74 which extends to the control conductor of the selector switch, the switch is held operated, and that when the control means comprising the hold relay 250 restores in response to the calling party's hanging up, this potential is removed from the control conductor and the switch is released.

Referring now more particularly to the operation of the connector switch 17, when the selector switch 16 seizes this connector switch a bridge is connected across the line conductors 30 and 31 at the repeater 76, this bridge comprising the repeater windings 80 and 81 and the left-hand winding of the polarized relay 220. When this bridge is closed, a circuit is completed for energizing the relay 100. This circuit extends from ground at the lower winding of the relay noted, through this winding, by way of the armatures 174 and 174' of the relay 170, the conductor 29, the conductor 31, through the bridge across the conductors 30 and 31, over the conductors 30 and 28, and through the armatures 173 and 173' and the upper winding of the relay 100 to battery. When energized over the above-traced circuit, the relay 100 operates to complete, at its armature 101 and associated contact 103, a circuit for energizing the slow-to-release hold relay 110. The last-mentioned relay in turn operates to connect, at its armature 111, ground to the control or C conductor 22, to prepare, at its armature 112, holding circuits for the relays 140 and 160 and to prepare, at its armature 113 and associated contact 114, a circuit for the series connected vertical magnet 125 and the relay 120. With the hold relay 110 in its operated position, the ground applied to the control conductor 22 at the armature 111 holds the selector switch 16 preceding the connector switch in its operated position. With the control means of the connector switch 17 in this condition, the vertical magnet 125 is conditioned to be responsive to impulses transmitted from the impulsing device at the calling subscriber's telephone A. At the beginning of the first impulse of the third digit, the bridge across the line conductors 30 and 31 is interrupted, thereby to open the previously traced operating circuit for the line relay 100, permitting this relay to restore and complete, at its armature 101, the previously prepared circuit for energizing the relay 120 and the vertical magnet 125 in series. The last-mentioned circuit extends from ground at the armature 101 and its associated contact 102, through the armature 113 and associated contact 114, the contacts 128 and 127 of the off-normal springs 147, the winding of the relay 120, and through the winding of the vertical magnet 125 to battery. When the slow-to-release relay 120 operates, it prepares, at its armature 121 and associated contact 122, an obvious multiple energizing circuit for itself and the vertical magnet 125. At the beginning of the first impulse when the line relay 100 operates to complete the operating circuit of the vertical magnet 125, the ratchet and pawl mechanism associated with the vertical magnet causes the wipers 40, 41 and 42 to be translated one step vertically. This first step of the switch also causes the off-normal contacts 147 and 148 to be operated so that the contacts 128 and 127 are opened, the contacts 124 and 128 are closed and the contacts 129 and 149 are closed. Closure of the last-mentioned contacts prepares an obvious circuit for energizing the release magnet 169, and closure of the off-normal contacts 124 and 128 completes the previously prepared multiple circuit for energizing the relay 120 and the vertical magnet 125. The completion of the last-mentioned multiple circuit permits the vertical magnet alternately to be energized and de-energized in accordance with the operation and restoration of the line relay 100 corresponding to succeeding impulses of the digit being dialed. Thus, the wipers 40 to 42, inclusive, are stepped vertically to a position opposite the level in which the called line terminates and corresponding to the impulses of the dialed digit.

At the end of the digit dialed, the circuit for energizing the line relay 100 is closed, so that the previously traced circuit for the relay 120 and the vertical magnet 125 is interrupted at

the armature 101. Accordingly, the relay 120 restores after an interval, opening, at its armature 121 and associated contact 122, the previously mentioned multiple circuit for itself and preparing, at the same armature and its associated contact 123, a circuit extending by way of the conductor 37, the armature 154 and the armature 145 for energizing the rotary magnet 126 and the slow-to-release relay 130 in parallel. At the beginning of the first impulse of the next digit, the line relay 100 again restores, to complete, at its armature 101, the prepared circuit for energizing the rotary magnet 126 and the relay 130. In response to such energization, the relay 130 operates to interrupt, at its armature 131, a point in the circuit for energizing the lower winding of the relay 140 and to connect, at this same armature, the directing or control wiper 42 to the upper terminal of the winding of the relay 150 over a path extending by way of the armatures 131 and 133, the armature 142 and the conductor 35. At its armature 135, the relay 130 closes a shunt around the armature 154 of the relay 150. During succeeding impulses of the digit being dialed, the operating circuit for the relay 130 and the rotary magnet 126 is alternately interrupted and completed at the armature 101 of the line relay 100, in accordance with the impulses of this digit, whereby the rotary magnet causes its associated ratchet and pawl mechanism to step the wipers 40 to 42, inclusive, into engagement with the bank contacts 43 to 45, inclusive, to which the line conductors of the called line 12 are connected. During these impulses, the relay 130, due to its slow-to-release characteristic, remains operated. In the course of this stepping operation and each time the directing wiper 42 engages a contact corresponding to a busy line, the relay 150 operates, but without effect at this time since its armature 154 is shunted by the operated armature 135. At the conclusion of the series of impulses comprising the dialed digit, the relay 100 remains in its operated position so that the circuit for energizing the relay 130 and the rotary magnet 126 is interrupted. As a consequence, and providing the called line 12 is idle, the relay 130 falls back after an interval to again prepare, at its armature 131 and associated contact 132, a circuit for energizing the lower winding of the relay 140.

If the called line is idle and when the relay 130 restores, a circuit is completed for partially energizing the relay 140, this circuit extending from battery at the cut-off relay in the line switch associated with the called line 12 over the control conductor 19, through the contact 45, the wiper 42, the armature 131 and associated contact 132, over the conductor 38, through the lower winding of the relay 140, over the conductor 39, through the contact 152 and associated armature 151 of the relay 150, and over the release or trunk control conductor 22 to ground at the armature 111. The relay 140 partially operates in response to its partial energization, as described above, to complete, at its armature 144, its previously prepared locking circuit extending by way of the conductor 25 to ground at the armature 112, thereby to cause the full operation thereof. When this occurs, the line circuit to the called line is partially completed at the armatures 141 and 146, direct ground is connected to the control conductor 19 at the armature 147, ground is connected to the ringing interrupter start conductor 23 at the armature 143, the circuit for energizing the relay 150 is interrupted at the armature 142, the circuit for energizing the rotary magnet 126 is interrupted at the armature 145, and a circuit is prepared for energizing the motor magnet 117 of the minor switch 107 at the armature 145 and its associated upper contact.

In response to the dialing of the final digit at the calling telephone, the motor magnet 117 in cooperation with its associated ratchet and pawl mechanism steps the wiper 108' into engagement with the contact leading to the ringing current generator having an output frequency to which only the signal device at the called telephone C is responsive. At the beginning of the first impulse of the final digit and before the wiper 108' takes its first step, the slow-to-release relay 105 operates to interrupt at its armature 106 the path of the ringing current. This relay, due to its slow-to-release characteristics remains operated during further impulses of the final digit and restores after an interval following the final impulse. When the switch 107 takes its first step at the end of the first impulse, the off-normal contacts 65 are closed to prepare an obvious circuit for energizing the release magnet 116.

Shortly after the conclusion of the final digit, the relay 105 restores, and ringing current is transmitted to the bell at the called substation C over a circuit extending from the ringing generator by way of the wiper 108', the conductor 46, the armatures 168, 106 and 146, the wiper 40 and associated contact 43, the line conductor 21, the bridged bell and condenser at the called party's substation, the conductor 20, the contact 44 and associated wiper 41, the armatures 141 and 161, the conductor 34, and through the lower winding of the relay 160 and battery to ground. Due to the alternating nature of this ringing current, a voltage of the same frequency is induced in the upper winding of the relay 160. This voltage is impressed across the terminals of the receiver at the calling substation over a path which includes the conductor 66', the lower winding of the relay 170 and the line conductor 31. Due to the slow-to-operate characteristic of the relay 160, this relay does not operate during the ringing operation. In this manner, the calling party is notified that the called line is idle, and only the called substation on the party line 12 is signaled.

When the called party at the telephone C answers the call by lifting his telephone receiver from its hook, a direct current circuit is completed for the lower winding of the relay 160, this circuit extending from the grounded terminal of the ringing current source, over the conductor 46, through the armatures 168, 106 and 146, through the wiper 40 and associated contact 43, the conductor 21, through the bridge at the called substation, over the line conductor 20, through the contact 44, the wiper 41, the two armatures 141 and 161, and the lower winding of the relay 160 to battery. The relay 160 now operates to close an obvious locking circuit for itself at its armature 167, to prepare the talking loop between the calling and called substations at its armatures 161 and 168, to interrupt its original energizing circuit at its armature 161 and associated contact 162, to interrupt, at its armature 165 and associated contact 164, the circuit for the ringing interrupter, to interrupt, at its armature 168 and associated lower contact the circuit for applying ringing current to the called line, thereby to discontinue the application of ringing and ringback tone to the loops extending to the called and calling parties, respectively, and to complete,

at its armature 165 and associated contact 166, a circuit for lighting the supervisory lamp No. 1. When the relay 160 operates, a circuit is completed for energizing the battery reversing relay 170, this circuit extending from ground at the armature 112, through the armature 167 and the lower winding of this relay, by way of the conductor 27, over one side of the completed loop to the called telephone, through the bridge across the line conductors at this telephone, back over the other side of the loop and the conductor 26, and through the upper winding of the relay 170 to battery. When the relay 170 operates, it interrupts, at its armature 171, the previously completed circuit for energizing the supervisory lamp No. 1, interrupts, at its armature 176, the previously prepared circuit for the release magnet 169, prepares, at the armature 176, a circuit for energizing the supervisory lamp No. 2 and, at its armatures 172 and 175 and their respective associated contacts 173 and 174, reverses battery back over the completed loop extending to the repeater 76 for the purpose of causing the operation of the polarized relay 220 in the manner previously described. The operation of the armature 171 also completes a multiple locking circuit for the relays 140, 160 and 170, this circuit extending from ground at the armature 143 by way of the conductor 36, the armature 165, the conductor 24 and through the armature 171 to the conductor 25 where the circuit divides into three branches, one for each of the windings of the three enumerated relays.

Before describing the release of the connection as established in the above manner, it will be assumed that, instead of being idle, the called substation C is found busy at the time the wipers 40 to 42, inclusive, are stepped into engagement with the contacts 43 to 45, inclusive, corresponding to the conductors of the called line. When this occurs, ground is present on the release conductor 19 so that, the wiper 42, upon engaging the contact 45, completes an obvious circuit for energizing the relay 150. This relay operates to prepare, at its armature 151, a locking circuit for itself, which circuit is completed when the relay 130 restores after an interval, following the end of the fourth impulse digit. This circuit extends from ground at the armature 111 by way of the control conductor 22, the armature 151 and associated contact 153, the contact 134 and its associated armature 133, the armature 142, the conductor 35, and through the winding of the relay 150 to battery. In its operated position, the relay 150 holds open, at its armature 154, the original circuit for energizing the relay 130 and the rotary magnet 126 and, at its armature 155, applies busy tone to the lower line conductor 31 to notify the calling subscriber A that the called line C is busy. It is to be observed that the circuit for energizing the motor magnet 117 and the relay 105 is held open at the armatures 154 and 145 when the called line is busy, so that the dialing of the final digit has no effect thereon.

Continuing now with the operations which occur during the release of the established connection, when the conversation is concluded and the calling party A replaces his telephone receiver on its hook, the closed loop from the repeater 76 holding the line relay 100 operated, is opened at the armature 242 and associated contact 244 of the relay 240 when the latter relay restores. As a result, the relay 100 restores, opening, at its armature 101 and associated contact 103, the circuit for the relay 110, which latter relay, after an interval, also restores. When the relay 110 falls back, it interrupts, at its armature 112, the original holding circuit for the relay 160, prepares, at its armature 113, a circuit for energizing the release magnet 169, completes at its armature 116' the circuit for energizing the release magnet 116, and at its armature 111, removes ground from the control conductor 22. The release magnet 116, upon operating, permits its wiper 108' to restore to normal, in which position the off-normal springs 65 are opened and the operating circuit of the release magnet 116 is interrupted. The relay 100, upon restoring and before the relay 110 falls back, completes, at its armature 101 and associated contact 102, the previously traced circuit for energizing the relay 130. When the relay 130 operates, it removes, at its armature 132, the multiple ground from the control trunk conductor 22, which ground extends by way of the armature 147, the conductor 38, the lower winding of the relay 140 and the conductor 39. By removing this multiple ground from the conductor 22, the release of the switch train preceding the connector switch 17 is placed under the control of the relay 110. Thus, when the relay 110 restores, following the operation of the slow-to-release relay 130, it completely removes, at its armature 111, ground from the conductor 22 for an interval, thereby permitting the selector switch 16 to be released in a manner well understood in the art.

When the relay 110 restores, shortly after the restoration of the relay 100, it not only effects the release of the selector switch 16, but interrupts, at its armature 113, the circuit for energizing the relay 130, permitting this relay to restore, which it does after an interval, thereby to return ground to the control conductor 22 from the wiper 42 of the connector switch and thus mark the switch 17 as busy in the selector switch contact banks until the connection is cleared out at the called substation. Restoration of the relay 110 also completes an obvious circuit for energizing the supervisory lamp No. 2, which circuit extends from ground at the armature 101 and its associated contact 102, through the armature 113 and associated contact 115, the armature 176, and the supervisory lamp to battery. Although the original locking circuit for the relays 160 and 140 is opened, at the armature 112, these relays are retained operated over the previously traced multiple locking circuit extending from ground at the armature 143. It is to be observed at this point that the connector switch 17 is still held in its operated position by virtue of the fact that the circuit to the release magnet 169 is held open at the armature 176 of the battery reversing relay 170.

When the party at the called substation C hangs up, the circuit to the relay 170 is broken by the removal of the bridge at the called telephone from across the line conductors 20 and 21, permitting this relay to restore and complete, at its armature 176, a circuit for the release magnet 169, this circuit extending from ground at the armature 101 by way of the armatures 113 and 176, the closed off-normal contacts 148, and through the winding of the relay 169 to battery. The release magnet thereupon, in a well-known manner, actuates its associated ratchet to permit the wipers 40 to 42, inclusive, to be restored to normal. When the wipers reach their normal or home positions, the off-normal springs 147 and 148 are restored to normal in a well-known manner. Restoration of the relay 170 also causes the multiple locking cir-

cuit for the relays 140 and 160 to be opened at the armature 171, whereby these relays are permitted to restore. Thus, the control equipment included in the connector switch is restored to normal and the switch is ready for further use.

In the event the talking loop is interrupted at the called substation C before the calling party at the substation A hangs up, the battery reversing relay 170 is the first to fall back. This relay thereupon interrupts, at its armature 171, the multiple locking circuit for the relays 140 and 160 and prepares, at its armature 176, a circuit for energizing the release magnet 169. Under the conditions stated, the entire switch train preceding the connector 17 is held in its operated condition until the talking loop is interrupted at the calling substation A. When this occurs, the relay 190 restores to cause the reoperation of the relay 130 and to interrupt the circuit for the holding relay 110. The relay 130, upon reoperating, removes multiple ground from the control conductor 22 so that, when the relay 110 restores its armature 111, the selector switch 16 is released and automatically restores to normal. The steps which follow the restoration of the relays 190 and 110 are from this point on exactly the same as those described in the preceding paragraphs.

As pointed out above, occasions arise when it is extremely desirable to be able to trace calls to a particular telephone on a party line included in the system. In accordance with the present invention, means are provided, operable in response to the application of ringing current of the frequency to which the signal device is responsive, for preventing the means comprising the relay 110 from initiating the release of an operated selector switch preceding the switch 17 in the above described manner. This means when once operated is maintained operated so long as the established talking loop is not interrupted at the called telephone. More specifically, this means comprises the relay 180 for causing the operation of the relay 190, which latter relay, when operated, prevents the relay 110 from removing ground from the control conductor 22 to release the operated selector switch preceding the seized connector switch. The winding of the relay 180 is connected in series with a condenser 109 across the line conductors 20 and 21 of the subscriber's line 12, to which line is connected the telephone C it is desired to observe. It will be understood that this line is multipled to the bank contacts of each of the group of connector switches at which the line 12 terminates, so that, in the event any of these connector switches is seized on an incoming call to the line 12, the relay 180 is connected thereacross. The relay 130 is an alternating current relay designed to be responsive only to current of the particular frequency to which the signal device at the telephone C is responsive. There are several well-known relays of this type now commercially available, any one of which is adaptable for use in this particular application. When the relay 180 operates, it completes, at its armature 181, a circuit for energizing the relay 190. The last-mentioned relay has a number of armatures, including an armature 195 for closing a locking circuit for itself independently of the relay 180 and an armature for each of the connector switches in which the conductors of the line 12 are multipled. Each of the armatures 191, 192, 193, etc., extends to the control conductor of its associated connector switch, and the respective contacts associated with these armatures are individually connected to the respective hold conductors of the corresponding connector switches. Thus, the armature 191 is connected by means of a conductor 60 to the control conductor 22 and the contact associated with the armature 191 is connected over a conductor 61 to the hold conductor 25. If desired, an additional armature 194 and associated contact may be embodied in the relay 190 for closing a circuit for energizing an alarm such, for example, as a bell. Such an alarm is schematically indicated at 62. In order that an attendant may hold the switch train operated independently of the condition of the telephone C, under observation, there is provided another relay 185 adapted to have its winding bridged across the line conductors 20 and 21 by a key switch 66. It will be understood that the winding of this relay, when connected across the conductors 20 and 21, functions to maintain the battery reversing relay 170 operated independently of the bridge formed by the telephone at the substation C.

With the above arrangement it is to be observed that the relay 110 when in one of its two positions, namely, its operated position, applies a predetermined potential, i. e., ground potential to the control conductor 22 to hold the selector switch 16 operated. In the other of its two positions, or its restored position, this relay removes ground potential from the control conductor 22 to release the selector switch. It will further be apparent that the conductors 60 and 61 comprise a normally uncompleted path for applying this same predetermined potential to the control conductor independently of the relay 110, this path being closed and extending from ground at the armature 143, through the armatures 185 and 171, over the conductors 25 and 61, through the armature 191 and over the conductor 60.

In the operation of the above-described arrangement and assuming that it is desired to observe incoming calls to the telephone C on the line 12, immediately upon the application of ringing current to this line of the frequency to which the signal device at the substation C is responsive, the alternating current relay 180 operates to complete a circuit for energizing the relay 190, this circuit extending from ground at the armature 147 through the wiper 42, the contact 45, the control conductor 19 associated with the called line 12, the armature 181 and through the winding of the relay 190 to battery. The last-mentioned relay operates to complete at its armature 195, a locking circuit for itself and to close all of its armatures 191, 192, 193, 194, etc., to their respective associated contacts. Closure of the armature 194 to its associated contact initiates the operation of the alarm device 62, thereby indicating to an attendant in the exchange wherein the connector switch 17 is located that a call is being made to the telephone under observation. If the called line is answered, the attendant may, by connecting an operator's telephone across the conductors 20 and 21 at the jack 67, converse with the called party and determine whether or not the call is to be traced. If the call is to be traced, the attendant may, by observing the condition of the selector switch 16, determine the line extending to the second exchange on which the call was initiated. By operating the key switch 66 to its locked off-normal position, the attendant may place a bridge across the line conductors 20 and 21 comprising the winding of the relay 185 to hold the battery reversing relay

170 operated. When this is done, the called party at the telephone C may hang up immediately after conversing with the attendant and before the call is traced.

It is the function of the means comprising the relays 170, 180 and 190 to prevent the selector switch 16 from being released in case the calling party interrupts the talking connection immediately after its completion and before the attendant can receive instructions as to whether or not the call should be traced. Thus, let it be assumed that the calling party hangs up shortly after the call is answered at the called substation. When this occurs, multiple ground is removed from the control conductor 22 at the armature 131 of the relay 130, and the relay 110 restores as described above. When the relay 110 restores, it removes ground from the control conductor 22 at its armature 111 and normally this last operation would permit the selector switch 16 to be released. As noted above, however, when the relay 190 is locked operated at the armature 195, the previously traced path including the conductors 60 and 61 is completed so that ground is maintained on the control conductor independently of the relay 110. The operated selector switch, preceding the connector switch 17 is, therefore, held in its operated condition until such time as the call is cleared out at the called substation or the operator removes the bridge across the conductors 20 and 21 by operating the switch 66 to open the contacts thereof. Also, and as described previously, the relays 170, 140 and 160 are held operated by virtue of the multiple locking circuit extending from ground at the armature 143, until such time as the bridge across the loop comprising the line conductors 20 and 21 is removed. With the system in this condition and when the loop is interrupted at the called substation or at the switch 66, the relays 170, 160 and 140 restore, in the order named, and the release magnet 169 operates. The first-mentioned relay upon falling back interrupts, at its armature 171 and the associated lower contact, the previously traced alternative path from ground to the control conductor 22, so that when the relay 140 restores, ground is completely removed from the control conductors 22 and 19. Thereupon, the relay 190 restores to interrupt, at its armature 195, its locking circuit and to open, at its armature 191, a further point in the alternative path including the conductors 60 and 61. Removal of ground from the conductor 22 permits the operated selector switch to release and thus this switch and the connector switch 17 are restored to normal.

It will be evident that, in an instance when the line to a telephone under observation is seized by a connector switch but the call is not answered, the switch train comprising the operated connector switch and the selector switch preceding the same should be subject to release when the connection is interrupted at the telephone of the calling party. That this mode of operation is provided is evident from the fact that the battery reversing relay is only operated when the talking loop is completed to the telephone under observation. Thus, when this condition prevails, the battery reversing relay 170 is not operated and, consequently, the above-traced alternative path for applying ground potential to the control conductor 22 is not completed. Hence, when the relay 110 restores its armature 111, following the interruption of the loop at the calling telephone, ground is completely removed from the control conductor 22 and the operated selector switch is permitted to restore in the usual manner. This relay, upon falling back, also completes the circuit for energizing the release magnet 169 so that the wipers 40 to 42, inclusive, of the connector switch are permitted to return to their respective normal positions and ground is removed from the control conductor 19 associated with the called line 12. Upon removal of ground potential from the conductor 19, the above-traced locking circuit for the relay 190 is interrupted and this relay restores, thereby returning the equipment to its normal condition.

Although the operation described in the preceding paragraph is that which will ordinarily occur in the event the call is not answered at the called telephone, it is pointed out that an attendant may hold up the switch train leading to the called line independently of whether or not the call is answered at the telephone under observation. Thus, when the alarm 62 starts to operate, immediately upon the application of ringing current to the line 12, the attendant may, by actuating the key switch 66, place the bridge comprising the winding of the relay 185 across the line conductors 20 and 21 to cause the operation of the battery reversing relay 170. When this is done, the condition of the connector switch is exactly the same as that which prevails when the called telephone is answered. In other words, the switch train comprising the operated selector switch and the connector switch 17 is held operated following the interuption of the loop at the calling substation.

As pointed out previously, the arrangement of the system is such that, when the line leading to the telephone to be observed is seized by any one of the group of connector switches in the bank contacts to which this line is multipled, ground is present on the control conductor of this line and the relay 190 is operated. Hence, all of the armatures 191, 192, 193, etc., are closed to their respective associated contacts, and the paths for applying ground potential to the respective control conductors of the connector switches included in the group, independently of their respective hold relays, such, for example, as the relay 110, are partially completed. Since, however, these paths are only fully completed when the corresponding battery reversing relays, such, for example, as the relay 170, are operated, a switch train set up in an attempt to establish a connection to the observed telephone when the associated line is busy, is not held operated when the calling party hangs up and until the connection which created the busy condition of the line is cleared out.

Thus, in the sequence of operations just described, and if the line 12 is busy, the calling party receives busy tone and hangs up, whereupon the relays included in the connector switch restore to permit the release of the operated selector switch in the exact manner described above. This is possible because the battery reversing relay 170 is not operated when the line 12 is found busy and, hence, the path for applying ground by way of the conductors 60 and 61 to the control conductor 22, independently of the contacts associated with the armature 111, is held open at the armature 171 and its associated lower contact.

As pointed out in the introductory portion of this specification, means are provided whereby the entire switch train leading to the telephone

C may be held operated even though a call to this line is initiated on a subscriber's line of the first exchange shown in Figure 1. This means comprises, in addition to the apparatus already described for holding the selector switch in the second exchange operated, the relays **230** and **200** in the repeater **76**. The release of this repeater and the portion of the switch train preceding the same is normally under the control of the party at the calling substation. Thus, the calling party may, at any time before or after a connection to the called telephone is established, hang up his receiver and thereby interrupt the previously traced operating circuit for the line relay **240**. This relay, upon restoring, normally opens the circuit holding the hold relay **250** operated, which latter relay in turn, upon restoring, removes, at its armature **251**, ground potential from the control conductor **74** to initiate the release of the selector switch **70** and the line switch leading to this selector switch. Thus, it will be seen that the line relay **240** comprises control means for maintaining ground potential on the control conductor and for normally causing the removal of this potential from the conductor in response to an operation performed at the calling telephone. The relays **230** and **200**, however, operate in response to the operation of the battery reversing relay **170** in the connector switch to maintain ground potential on the control conductor **74** independently of the line relay **240**.

Thus, when the connection is established to the called line **12** and the telephone at the substation C is answered, the battery reversing relay **170** operates as described above to reverse battery back over the line conductors **30** and **31** which are connected, respectively, to the trunk line conductors **86** and **87**. Thereafter, and when the calling party hangs up to cause the restoration of the line relay **240**, a circuit is completed for energizing the relay **230**, this circuit extending from battery at the upper winding of the relay **100**, through the armatures **175** and **174** of the relay **170**, over the conductors **31** and **87**, through the operated armature **264**, the restored armature **242** and the winding of the relay **230** to ground. The relay **230** upon operating completes, at its armature **231**, a multiple circuit for holding the relay **200** operated. The latter relay, in its operated position, retains, at its armature **204**, ground on the conductor **90** and thereby maintains the hold relay **250** in its operated position. The relay **250** in turn maintains, at its armature **251**, ground on the control conductor **74** to hold the portion of the switch train preceding the repeater **76** in its operated condition.

It will be evident in view of the foregoing description that, so long as the battery reversing relay **170** is maintained operated, the switch train leading to and including the repeater **76** is not permitted to release. Consequently, and when the attendant in the second exchange determines that the selector switch **16** is operated, he may, by conversing with an attendant in the first exchange over another trunk line, instruct the latter attendant to trace the connection leading to the trunk line **86**, **87**. The attendant in the first exchange may do this by observing the condition of the operated selector switch **70** and the line switch **13**.

When the connection is finally cleared out at the telephone under observation or at the switch **66**, the battery reversing relay **170** restores to interrupt the previously traced circuit holding the relay **230** operated. This relay upon restoring opens, at its armature **231**, the multiple circuit for the relay **200**, thereby to initiate the sequential restoration of the relays **200**, **250** and **260**. When the relay **250** restores, it removes, at its armature **251**, ground from the control conductor **74** and permits the switch train leading to the repeater **76** to release.

From the foregoing description it will be apparent that, under any conditions following the completion of a talking loop between a calling substation and the telephone under observation, it is possible to trace a call to the latter telephone, and this is true irrespective of whether the call is initiated on a line extending to the same exchange as the line of the telephone under observation, or is initiated on a line extending to an exchange different from that of the line associated with the telephone under observation. It will further be evident that the means provided for this purpose is selectively responsive to the application of ringing current of a particular character to the line of the telephone under observation and that, as a result, calls to a particular telephone connected to a party line may be traced.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and it is contemplated in the appended claims to cover all such modifications as fall within the true spirit and scope of the invention.

I claim:

1. In a telephone system, a first line, a second line, a first telephone on said first line, a second telephone on said second line, means for establishing a connection between said lines on a call from said first telephone to said second telephone, said means normally being releasable in response to an operation performed at said first telephone, means operative during the establishing of said connection for applying ringing current to said second line, and means including means responsive to the application of ringing current to said second line for preventing the release of said first-named means in response to an operation performed at said first telephone, whereby calls to said second telephone may be traced by an attendant.

2. In a telephone system, a first line, a second line, a first telephone on said first line, a second telephone on said second line, means for establishing a connection between said lines on a call from said first telephone to said second telephone, said means normally being releasable in response to an operation performed at said first telephone, means operative during the establishing of said connection for applying ringing current to said second line, a relay associated with said second line and operable in response to the application of ringing current thereto, and means including means responsive to the operation of said relay for preventing the release of said first-named means in response to an operation performed at said first telephone.

3. In a telephone system, a first line, a second line including a control conductor, a first telephone on said first line, a second telephone on said second line, means for establishing a connection between said lines on a call from said first telephone to said second telephone, said means including means for applying a predetermined potential to said control conductor and normally being releasable in response to an oper-

ation performed at said first telephone, means operative during the establishing of said connection for applying ringing current to said second line, a relay associated with said second line and operable in response to the application of ringing current thereto, means including a second relay operable in response to the operation of said first-named relay for preventing the release of said first-named means, and a circuit for maintaining said second relay operated independently of said first-named relay and so long as said predetermined potential is maintained on said control conductor, said circuit being completed upon the operation of said second relay.

4. In a telephone system, a first line, a second line, a first telephone on said first line, a plurality of telephones on said second line, each of said plurality of telephones having associated therewith a signal device, each of said signal devices being responsive to ringing current of a character different than that of the current to which each of the other signal devices is responsive, means for establishing a connection between said lines on a call from said first telephone to one of said plurality of telephones, said means normally being releasable in response to an operation performed at said first telephone, means operative during the establishing of said connection for applying ringing current to said second line, said current being of the character to which only the signal device associated with said one telephone is responsive, and means including means responsive to the application of ringing current to said second line of the character to which only the signal device associated with said one telephone is responsive for preventing the release of said first-named means, whereby calls to said one telephone may be traced by an attendant.

5. In a telephone system, a first line, a second line, a first telephone on said first line, a plurality of telephones on said second line, each of said plurality of telephones having associated therewith a signal device, each of said signal devices being responsive to ringing current of a character different than that of the current to which each of the other signal devices is responsive, means for establishing a connection between said lines on a call from said first telephone to one of said plurality of telephones, said means normally being releasable in response to an operation performed at said first telephone, means operative during the establishing of said connection for applying ringing current to said second line, said current being of the character to which only the signal device associated with said one telephone is responsive, means including means responsive to the application of ringing current to said second line of the character to which only the signal device associated with said one telephone is responsive for preventing the release of said first-named means, whereby calls to said one telephone may be traced by an attendant, and means for preventing said last-named means from operating in the event said second line is busy at the time said call is initiated.

6. In a telephone system, a first line, a second line, a first telephone on said first line, a plurality of telephones on said second line, each of said plurality of telephones having associated therewith a signal device, each of said signal devices being responsive to ringing current of a character different than that of the current to which each of the other signal devices is responsive, means for establishing a connection between said lines on a call from said first telephone to one of said plurality of telephones, said means normally being releasable in response to an operation performed at said first telephone, means operative during the establishing of said connection for applying ringing current to said second line, said current being of the character to which only the signal device associated with said one telephone is responsive, means including means responsive to the application of ringing current to said second line of the character to which only the signal device associated with said one telephone is responsive for preventing the release of said first-named means, whereby calls to said one telephone may be traced by an attendant, and means for preventing the application of ringing current to said second line in the event said second line is busy at the time said call is initiated, whereby said last-named means is prevented from operating.

7. In a telephone system, a first line, a second line, a first telephone on said first line, a plurality of telephones on said second line, each of said plurality of telephones having associated therewith a signal device, each of said signal devices being responsive to ringing current of a character different than that of the current to which each of the other signal devices is responsive, means for establishing a connection between said lines on a call from said first telephone to one of said plurality of telephones, said means normally being releasable in response to an operation performed at said first telephone, means operative during the establishing of said connection for applying ringing current to said second line, said current being of the character to which only the signal device associated with said one telephone is responsive, a relay associated with said second line and operative only in response to the application of ringing current to said second line of the character to which the signal device associated with said one telephone is responsive, and means including means responsive to the operation of said relay for preventing the release of said first-named means.

8. In a telephone system, a first line, a second line, a first telephone on said first line, a plurality of telephones on said second line, each of said plurality of telephones having associated therewith a signal device, each of said signal devices being responsive to ringing current of a character different than that of the current to which each of the other signal devices is responsive, means for establishing a connection between said lines on a call from said first telephone to one of said plurality of telephones, said means normally being releasable in response to an operation performed at said first telephone, means operative during the establishing of said connection for applying ringing current to said second line, said current being of the character to which only the signal device associated with said one telephone is responsive, a relay associated with said second line and operative only in response to the application of ringing current to said second line of the character to which the signal device associated with said one telephone is responsive, and means including means operable in response to the operation of said relay for preventing the release of said first-named means, said last-named means being maintained operated independently of said relay following the operation thereof.

9. In a telephone system, a first line, a second line including a control conductor, a first telephone on said first line, a plurality of telephones on said second line, each of said plurality of tele-

phones having associated therewith a signal device, each of said signal devices being responsive to ringing current of a character different from that of the current to which each of the other signal devices is responsive, means for establishing a connection between said lines on a call from said first telephone to one of said plurality of telephones, said means including means for applying a predetermined potential to said control conductor and normally being releasable in response to an operation performed at said first telephone, means operative during the establishing of said connection for applying ringing current to said second line, said current being of the character to which only the signal device associated with said one telephone is responsive, a relay associated with said second line and operative in response to the application of ringing current to said second line of the character to which the signal device associated with said one telephone is responsive, means including a second relay operative in response to the operation of said first-named relay for preventing the release of said first-named means, and a circuit for maintaining said second relay operated independently of said first-named relay and so long as said predetermined potential is maintained on said control conductor, said circuit being completed upon operation of said second relay.

10. In a telephone system, a first line, a second line, a first telephone on said first line, a plurality of telephones on said second line, each of said plurality of telephones having associated therewith a signal device, each of said signal devices being responsive to alternating ringing current of a frequency different from the frequency of the current to which each of the other signal devices is responsive, means for establishing a connection between said lines on a call from said first telephone to one of said plurality of telephones, said means normally being releasable in response to an operation performed at said first telephone, means operative during the establishing of said connection for applying ringing current to said second line, said current being of the frequency to which only the signal device associated with said one telephone is responsive, and means including means responsive to the application of ringing current to said second line of the frequency to which the signal device associated with said one telephone is responsive for preventing the release of said first-named means, whereby calls to said one telephone may be traced by an attendant.

11. In a telephone system, a first line, a second line, a first telephone on said first line, a plurality of telephones on said second line, each of said plurality of telephones having associated therewith a signal device, each of said signal devices being responsive to alternating ringing current of a frequency different from the frequency of the current to which each of the other signal devices is responsive, means for establishing a connection between said lines on a call from said first telephone to one of said plurality of telephones, said means normally being releasable in response to an operation performed at said first telephone, means operative during the establishing of said connection for applying ringing current to said second line, said current being of the frequency to which only the signal device associated with said one telephone is responsive, a relay associated with said second line and operative only in response to the application of ringing current to said second line of the frequency to which the signal device associated with said one telephone is responsive, and means including means responsive to the operation of said relay for preventing the release of said first-named means.

12. In a telephone system, a first line, a second line including a control conductor, a first telephone on said first line, a plurality of telephones on said second line, each of said plurality of telephones having associated therewith a signal device, each of said signal devices being responsive to alternating ringing current of a frequency different from that of the current to which each of the other signal devices is responsive, means for establishing a connection between said lines on a call from said first telephone to said second telephone, said means including means for applying a predetermined potential to said control conductor and normally being releasable in response to an operation performed at said first telephone, means operative during the establishing of said connection for applying ringing current to said second line, said current being of the frequency to which only the signal device associated with said one telephone is responsive, a relay associated with said second line and operative in response to the application of ringing current to said second line of the frequency to which the signal device associated with said one telephone is responsive, means including a second relay operative in response to the operation of said first-named relay for preventing the release of said first-named means, and a circuit for maintaining said second relay operated independently of said first-named relay and so long as said predetermined potential is maintained on said control conductor, said circuit being completed upon operation of said second relay.

13. In a telephone system, a first line, a second line, a first telephone on said first line, a second telephone on said second line, means including a selector switch and a connector switch, operable in the order named, for establishing a connection between said lines on a call from said first telephone to said second telephone, said selector switch including a control conductor adapted to have a predetermined potential applied thereto during the establishing of said connection, said selector switch being maintained operated so long as said predetermined potential is maintained on said conductor and being released when said potential is removed from said conductor, control means in said connector switch for holding said predetermined potential on said conductor and for normally removing said predetermined potential therefrom in response to an operation performed at said first telephone, means operative during the establishing of said connection for applying ringing current to said second line, a normally incomplete path for applying said predetermined potential to said control conductor independently of said control means, means responsive to the application of ringing current to said second line for partially completing said path, and means responsive to the completion of a talking connection between said telephones for completing said path.

14. In a telephone system, a first line, a second line, a first telephone on said first line, a plurality of telephones on said second line, each of said plurality of telephones having associated therewith a signal device, each of said devices being responsive to ringing current of a character different from that of the current to which each of the other signal devices is responsive, means including a selector switch and a connector switch, operable in the order named, for establishing a

connection between said lines on a call from said first telephone to one of said plurality of telephones, said selector switch including a control conductor adapted to have a predetermined potential applied thereto during the establishing of said connection, said selector switch being maintained operated so long as said predetermined potential is maintained on said control conductor and being released when said potential is removed from said conductor, control means in said connector switch for holding said predetermined potential on said conductor and for normally removing said potential therefrom in response to an operation performed at said first telephone, means operative during the establishing of said connection for applying ringing current to said second line, said current being of the character to which the signal device associated with said one telephone is responsive, and means responsive to the application of ringing current to said second line of the character to which only the signal device associated with said one telephone is responsive for applying said predetermined potential to said control conductor independently of said control means.

15. In a telephone system, a first telephone, a second telephone, means including a first selector switch, a second selector switch and a connector switch, connected in tandem and operable in the order named, for establishing a connection between said telephones on a call from said first telephone to said second telephone, said selector switches normally being releasable in response to an operation performed at said first telephone, means operable during the establishing of said connection for preventing the release of said second selector switch, an alarm device, means included in said connector switch and operable during the establishing of said connection for causing the operation of said alarm device, and means operable substantially simultaneously with the completion of said connection for preventing the release of said first selector switch in response to an operation performed at said first telephone, whereby calls to said second telephone may be traced by an attendant.

16. In a telephone system, a first telephone, a second telephone, means including a first selector switch, a second selector and a connector switch, connected in tandem and operable in the order named, for establishing a connection between said telephones on a call from said first telephone to said second telephone, said first selector switch normally being releasable in response to an operation performed at said first telephone, a relay in said connector switch operated when said call is answered at said second telephone, an alarm device, means included in said connector switch and operable during the establishing of said connection for causing the operation of said alarm device, and means responsive to the operation of said relay for preventing the release of said first selector switch in response to an operation performed at said first telephone, whereby calls to said second telephone may be traced by an attendant.

17. In a telephone system, a first telephone, a second telephone, means including a selector switch, a repeater, and a connector switch, connected in tandem and operable in the order named, for establishing a connection between said telephones on a call from said first telephone to said second telephone, said selector switch normally being releasable in response to an operation performed at said first telephone, and means included in said repeater and operable substantially simultaneously with the completion of said connection for preventing the release of said selector switch in response to an operation performed at said first telephone, whereby calls to said second telephone may be traced by an attendant.

18. In a telephone system, a first telephone, a second telephone, means including a selector switch, a repeater, and a connector switch, connected in tandem and operable in the order named, for establishing a connection between said telephones on a call from said first telephone to said second telephone, said selector switch normally being releasable in response to an operation performed at said first telephone, a relay in said connector switch operated when said call is answered at said second telephone, and means included in said repeater and responsive to the operation of said relay for preventing the release of said selector switch in response to an operation performed at said first telephone, whereby calls to said second telephone may be traced by an attendant.

19. In a telephone system, a first telephone, a second telephone, means including a selector switch, a repeater and a connector switch, connected in tandem and operable in the order named for establishing a connection between said telephones on a call from said first telephone to said second telephone, said selector switch including a control conductor adapted to have a predetermined potential applied thereto during the establishing of said connection, said selector switch being held operated so long as said potential is maintained on said conductor and being released when said potential is removed therefrom, control means included in said repeater for maintaining said potential on said conductor and for normally removing said potential from said conductor in response to an operation performed at said first telephone, a relay in said connector switch operated when said call is answered at said second telephone, and means included in said repeater and responsive to the operation of said relay for maintaining said predetermined potential on said conductor independently of said control means.

20. In a telephone system, a first telephone, a second telephone, means including a selector switch, a repeater and a connector switch, connected in tandem and operable in the order named, for establishing a connection between said telephones on a call from said first telephone to said second telephone, said selector switch including a control conductor adapted to have a predetermined potential applied thereto during the establishing of said connection, said selector switch being held operated so long as said potential is maintained on said conductor and being released when said potential is removed therefrom, control means included in said repeater for maintaining said potential on said conductor and for normally removing said potential from said conductor in response to an operation performed at said first telephone, a battery reversing relay in said connector switch operated when said call is answered at said second telephone, and means including a relay in said repeater operated in response to the operation of said battery reversing relay for maintaining said predetermined potential on said conductor independently of said control conductor.

NORMAN H. SAUNDERS.