Sept. 17, 1940. J. H. VOSS 2,214,914

TELEPHONE SYSTEM

Filed June 24, 1938 6 Sheets-Sheet 1

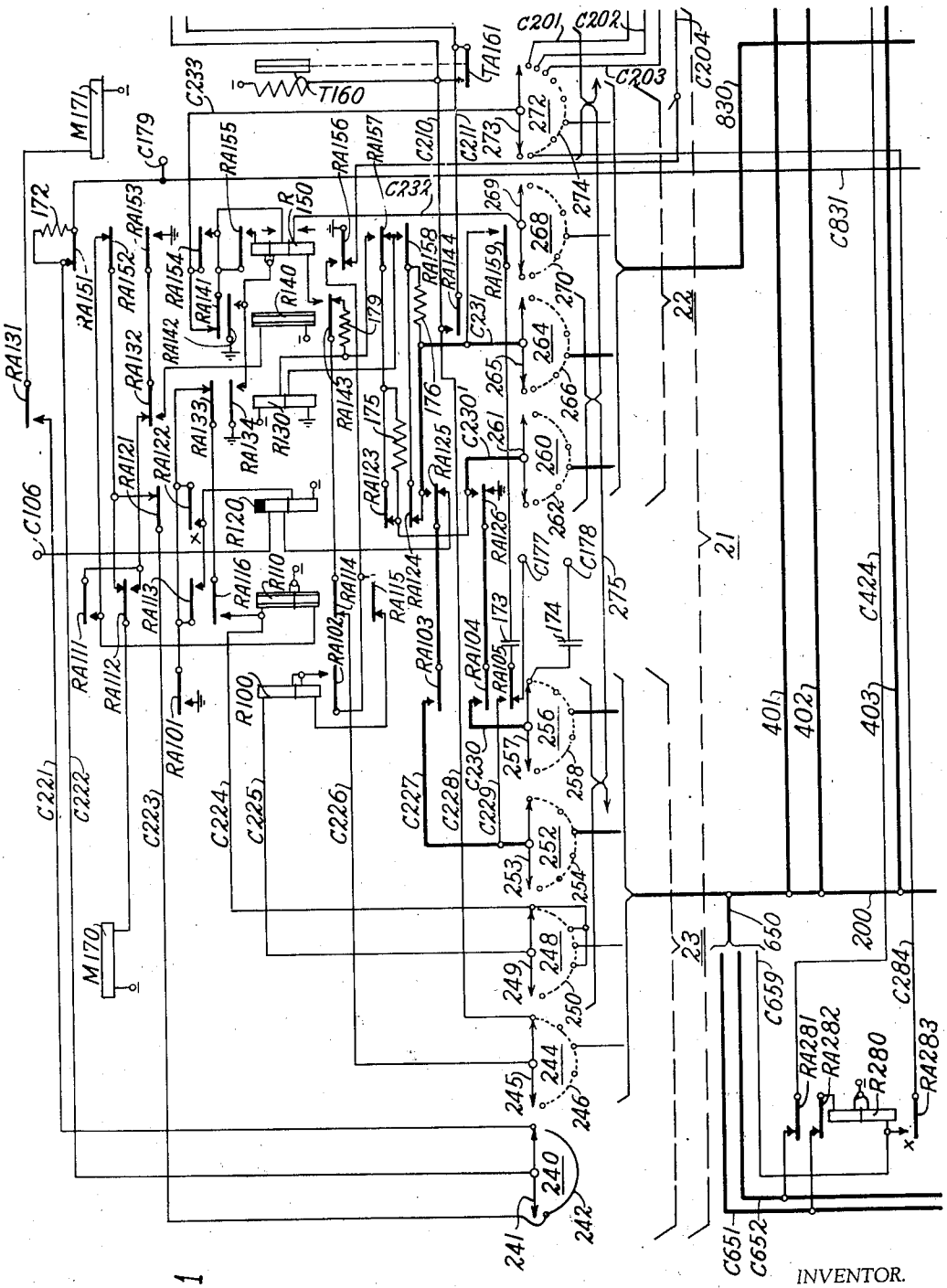


Fig. 1

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Sept. 17, 1940. J. H. VOSS 2,214,914

TELEPHONE SYSTEM

Filed June 24, 1938 6 Sheets-Sheet 2

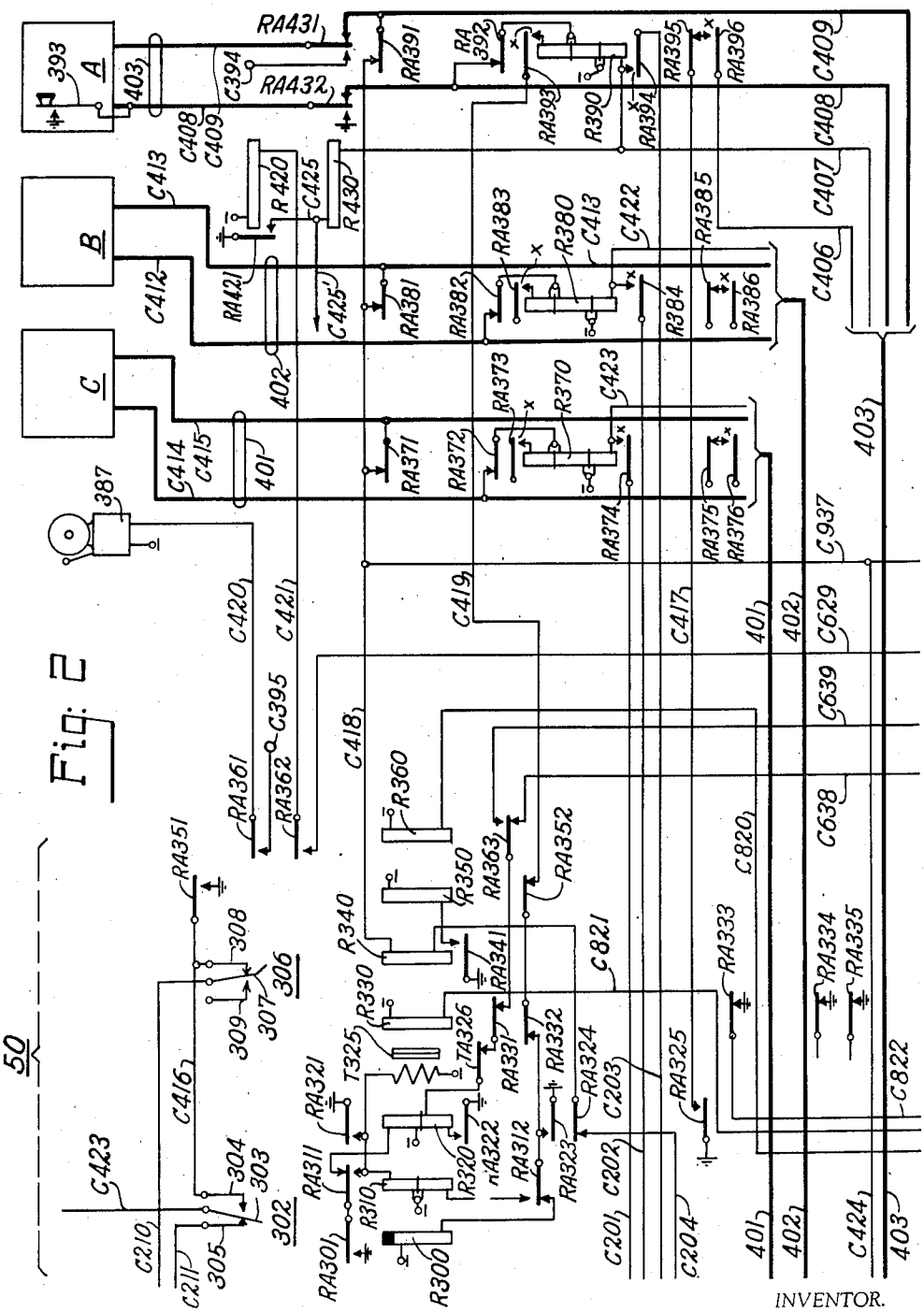


Fig. 2

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TELEPHONE SYSTEM

Filed June 24, 1938 6 Sheets-Sheet 3

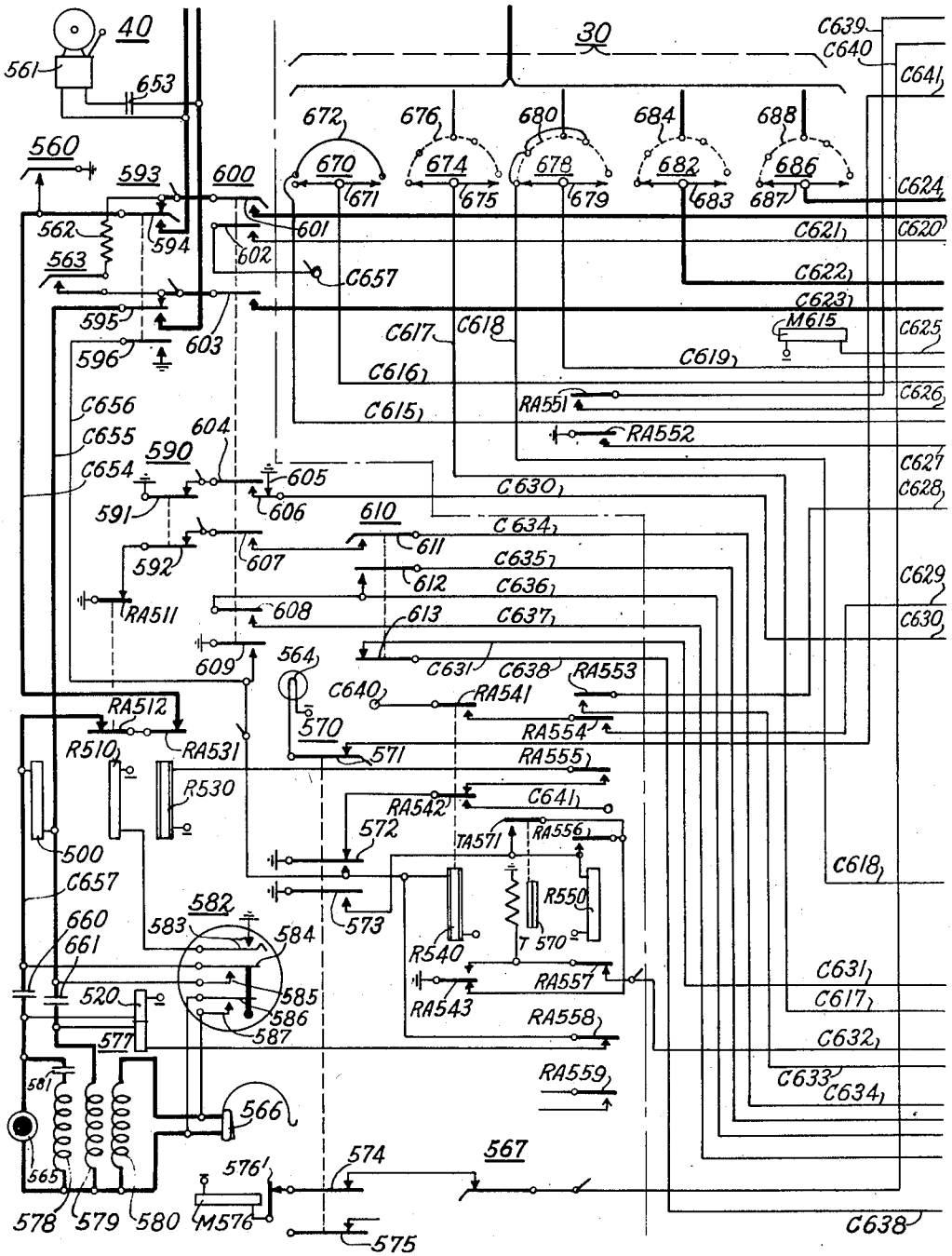


Fig. 3

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TELEPHONE SYSTEM

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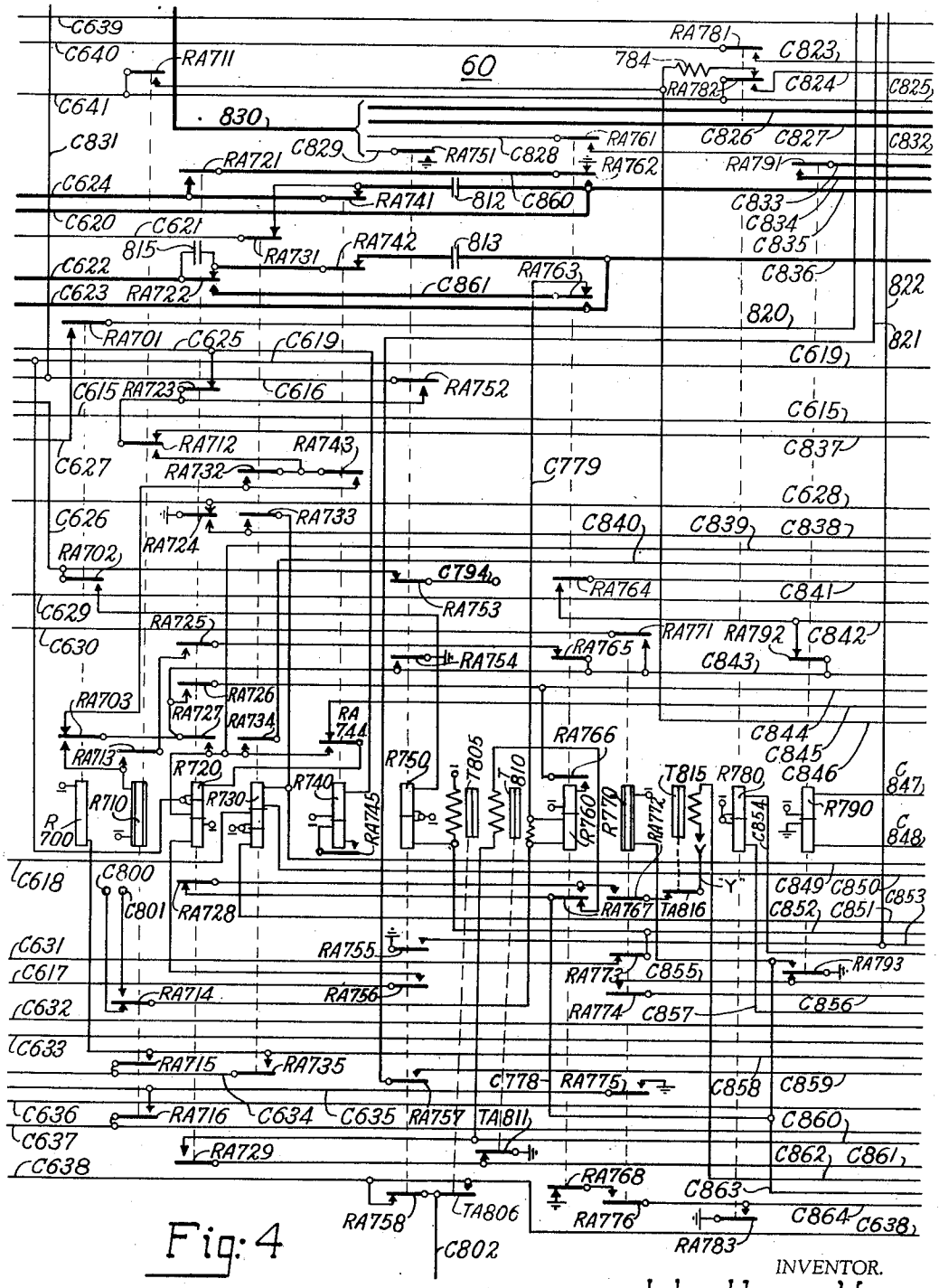


Fig. 4

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TELEPHONE SYSTEM

Filed June 24, 1938 6 Sheets-Sheet 5

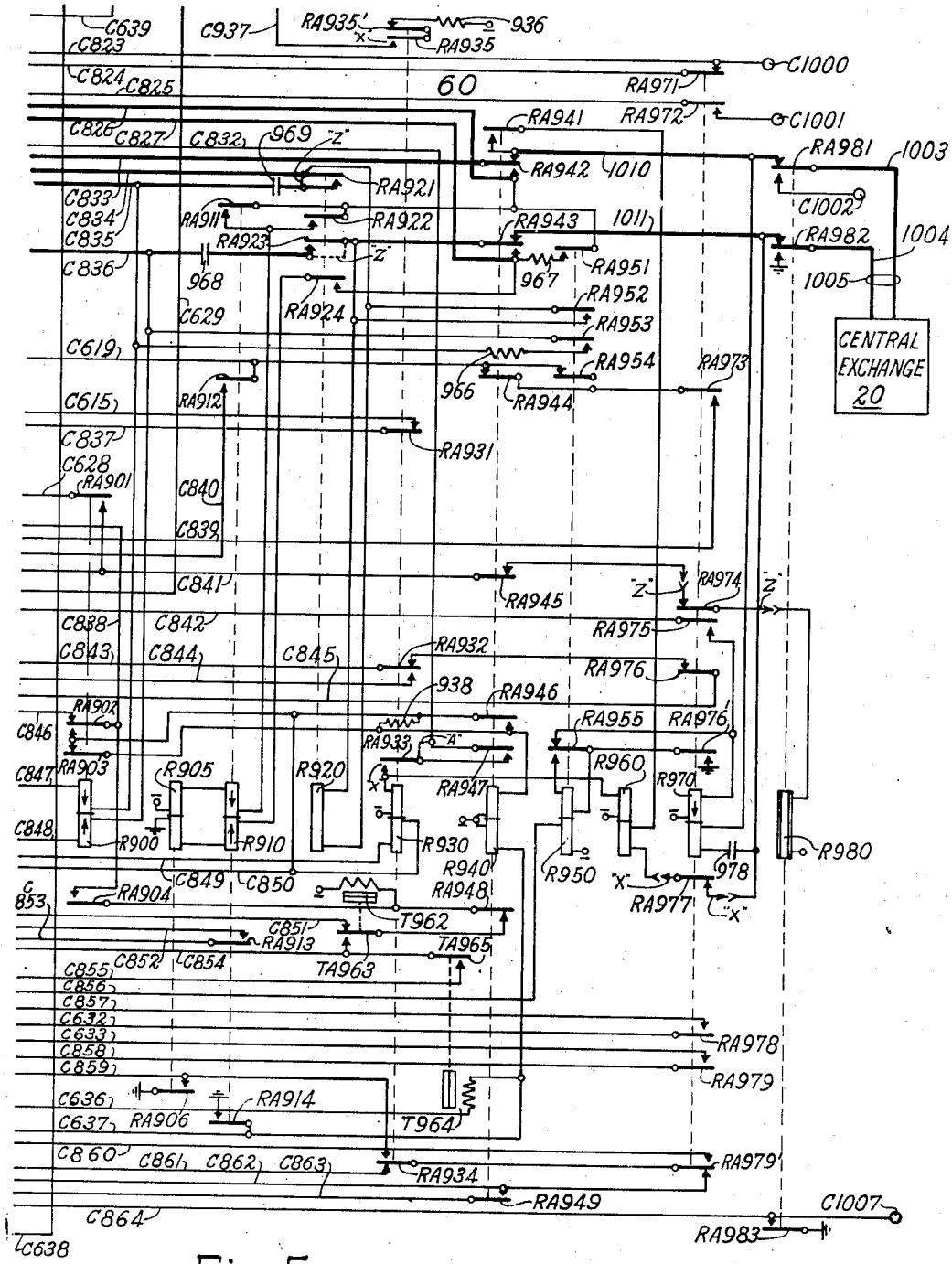


Fig. 5

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TELEPHONE SYSTEM

Filed June 24, 1938 6 Sheets-Sheet 6

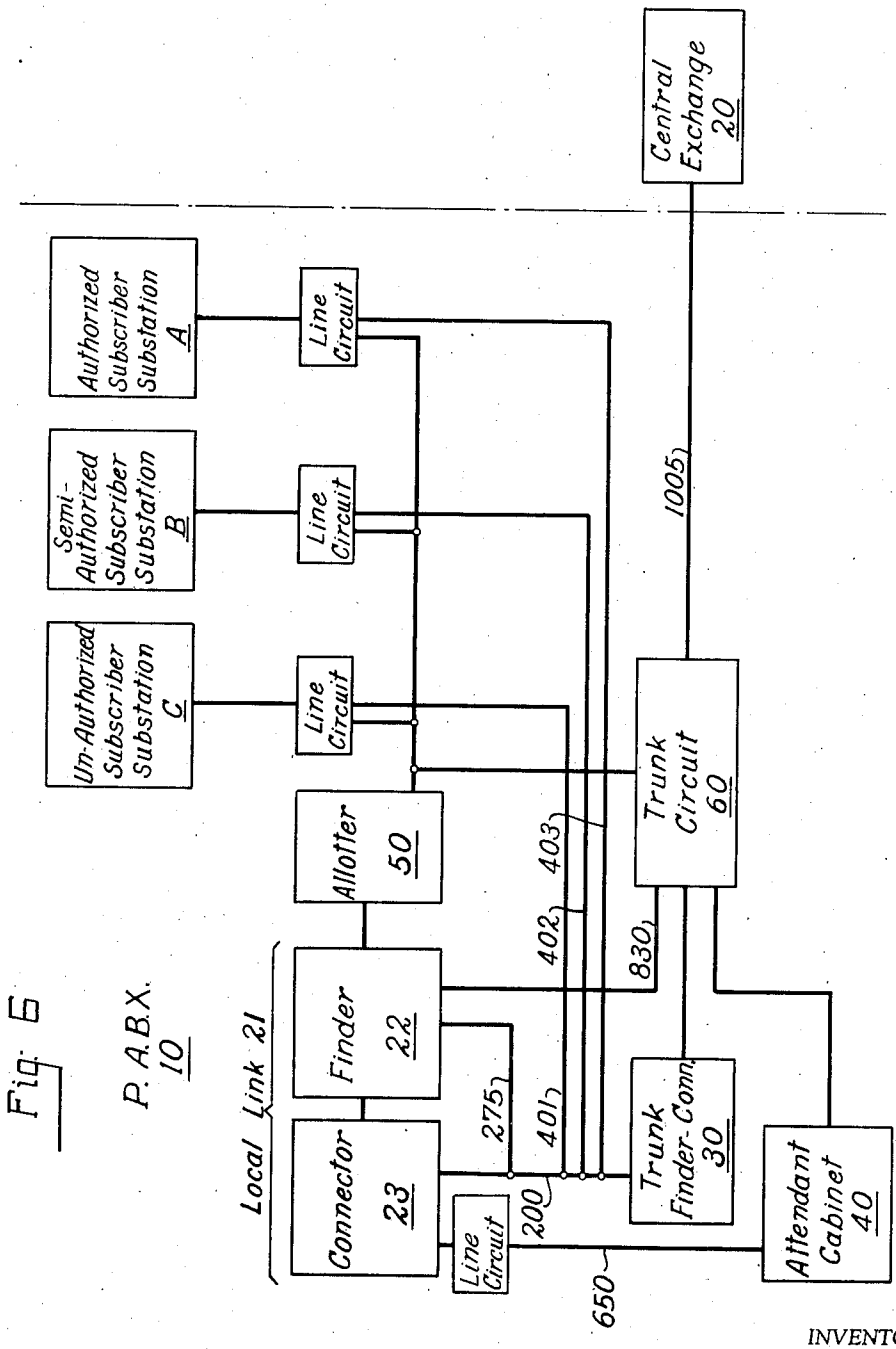


Fig. 6

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Patented Sept. 17, 1940

2,214,914

UNITED STATES PATENT OFFICE

2,214,914

TELEPHONE SYSTEM

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Application June 24, 1938, Serial No. 215,517

34 Claims. (Cl. 179—27)

The present invention relates to telephone systems, and more particularly to improvements in private automatic branch exchange systems associated with central exchanges by way of two-way trunk lines extending therebetween.

A private automatic branch exchange or P. A. B. X. conventionally comprises an attendant cabinet or operator station, a number of subscriber substations, a plurality of two-way-trunk lines extending between the P. A. B. X. and a central exchange associated therewith, a plurality of subscriber lines individually extending to the subscriber substations, and apparatus including a switch train having access to each of the subscriber and trunk lines which is operated to set up connections between the various subscriber and trunk lines. Usually the apparatus in a P. A. B. X. of this type is so connected and arranged that the connections between the various subscriber lines can be set up by the subscribers at the subscriber substations without the assistance of an attendant at the attendant cabinet. Frequently the apparatus is also connected and arranged so that a subscriber at one or more of the subscriber substations can initiate an outgoing central exchange call from the P. A. B. X. on an idle one of the trunk lines without the assistance of the attendant at the attendant cabinet. Universally, when the attendant is on duty, incoming central exchange calls to the P. A. B. X. on the trunk lines are answered by the attendant at the attendant cabinet and then routed to the desired subscriber substations. Usually the attendant cabinet of a P. A. B. X. of this type is provided with a night switch or key which is operated before the attendant leaves the attendant cabinet or goes off duty in order to institute night service. In a conventional P. A. B. X., this operation of the night key at the attendant cabinet sets up connections between the trunk lines extending to the P. A. B. X. and corresponding ones of a selected number of the subscriber lines, whereby incoming central exchange calls to the P. A. B. X. on the trunk lines are automatically routed to the corresponding selected subscriber substations.

While reasonably satisfactory service may be rendered the subscribers in a P. A. B. X. of this type, there are several objectionable features thereto. In the first place, the attendant frequently leaves the attendant cabinet for several minutes at a time without operating the night key, thereby rendering the P. A. B. X. totally without incoming central exchange call service during this time interval. Also, when night service is in force, an incoming central exchange call to the P. A. B. X. must be answered at the particular selected subscriber substation which is associated with the subscriber line connected to the particular trunk line over which the central exchange call is routed. Moreover, all incoming central exchange calls to the P. A. B. X., when night service is in force, must be answered at one of several selected subscriber substations. Furthermore, an incoming central exchange call to the P. A. B. X. will be routed thereto by way of the second-choice trunk line extending thereto if the first-choice trunk line extending thereto is busy at the time, rendering it impossible to answer all incoming central exchange calls to the P. A. B. X. at any one subscriber substation, when night service is in force.

Accordingly, it is an object of the present invention to provide, in a private exchange of the character noted including an operator station and at least one subscriber substation, an arrangement for automatically rendering the apparatus at the subscriber substation effective to answer an incoming central exchange call to the private exchange in the event the incoming central exchange call is not answered at the operator station within a predetermined time interval.

Another object of the invention is to provide, in a private exchange of the character noted including an operator station and a plurality of subscriber substations, an arrangement for automatically rendering the apparatus at each of the subscriber substations independently operative to answer an incoming central exchange call to the private exchange in the event the incoming central exchange call is not answered at the operator station within a predetermined time interval.

Another object of the invention is to provide, in a private exchange of the character noted including an operator station, a plurality of subscriber substations and an automatic switch operative to seize an assigned one of a number of trunk lines extending to the P. A. B. X., a device at each subscriber substation operative to cause operation of the automatic switch and an improved arrangement for controlling the assignment of the trunk lines.

A further object of the invention is to provide, in a private exchange of the character noted including an operator station and a plurality of subscriber substations, a device at the operator station which is operative to render effective the apparatus at each of the subscriber substations

to answer an incoming central exchange call to the private exchange.

It is a further object of the invention to provide, in a private exchange of the character noted including an operator station and a plurality of subscriber substations, a device at the operator station and an arrangement controlled jointly by the operation of the device and the extension of an incoming call to the private exchange on any one of the trunk lines for rendering effective the apparatus at each of the subscriber substations to answer an incoming central exchange call to the private exchange and for causing ringing current to be projected over at least a number of the subscriber lines.

The features of the present invention are illustrated as being incorporated in a P. A. B. X. including an attendant cabinet or operator station, a number of each of three different classes of subscriber substations, a plurality of two-way trunk lines extending to the P. A. B. X. from a central exchange associated therewith, a plurality of subscriber lines individually extending to the subscriber substations, an information trunk extending to the attendant cabinet, a number of local links for setting up connections between the various subscriber lines, a number of trunk circuits individually associated with the trunk lines for setting up connections between the various trunk and subscriber lines, and an allotter for controlling the assignment of the local links and trunk circuits to the use of the subscriber substations. The classes of subscriber substations comprise authorized, semiauthorized and unauthorized subscriber substations, these classifications being indicative of the character of the service rendered thereto, as is more fully explained subsequently. Each of the local links comprises a finder switch or portion and a connector switch or portion, the finder switch having access to each subscriber line and the information trunk, and to a plurality of link lines individually associated with the trunk circuits, and the connector switch having access to each subscriber line and the information trunk. Each trunk circuit individually associated with a trunk line extending to the P. A. B. X. individually comprises a trunk finder-connector switch having access to each subscriber line extending to an authorized or semiauthorized subscriber substation in the P. A. B. X.

In accordance with one feature of the invention, the private exchange includes an operator station and at least one subscriber substation, a trunk line extending to the private exchange, normally effective apparatus at the operator station operative to answer an incoming call to the private exchange on the trunk line, normally ineffective apparatus at the subscriber substation operative to answer an incoming call to the private exchange on the trunk line, and automatic means operative in the event an incoming call to the private exchange is not answered within a predetermined time interval by the operation of the apparatus at the operator station for rendering effective the apparatus at the subscriber substation.

In accordance with another feature of the invention, the private exchange includes a plurality of subscriber substations, a plurality of trunk lines extending to the private exchange, normally ineffective apparatus at each of the subscriber substations operative to answer an incoming call to the private exchange on any one of the trunk lines, and automatic means operative in the event an incoming call to the private exchange on any one of the trunk lines is not answered within a predetermined time interval by the operation of the apparatus at the operator station for rendering effective the apparatus at each of the subscriber substations.

In accordance with another feature of the invention, there is provided a device at each subscriber substation, normally effective means responsive to the operation of the device at any one of the subscriber substations for causing an idle one of the trunk lines to be associated with the one subscriber substation, normally ineffective means responsive to the operation of the device at any one of the subscriber substations for causing one of the trunk lines having an incoming call to the private exchange thereon to be associated with the one subscriber substation, and automatic means operative in the event an incoming call to the private exchange on any one of the trunk lines is not answered within a predetermined time interval by the operation of the apparatus at the operator station for rendering ineffective the first-mentioned means and for rendering effective the last-mentioned means. More particularly, the P. A. B. X. comprises an automatic switch operative to set up a connection between the various trunk and subscriber lines, and an allotter including a switch having normal and off-normal positions. The allotter is so constructed and arranged that when the switch occupies its normal position an idle trunk line is assigned to be included in a connection to be set up, and when the switch occupies its off-normal position a trunk line having an incoming call to the P. A. B. X. thereon is set up to be included in the connection. A timer is provided which is set into operation when an incoming call is extended to the P. A. B. X. on any one of the trunk lines, the operation of this timer being arrested when the call on the one of the trunk lines is answered by the operation of the apparatus at the operator station. In the event the timer operates for a predetermined time interval, it is effective to cause the switch to operate from its normal to its off-normal position. The operation of the device at any one of the subscriber substations is effective to cause the automatic switch to set up a connection between the subscriber line extending to the one subscriber substation and an assigned trunk line.

In accordance with a further feature of the invention, a device is provided at the operator station which is operative to render the apparatus at each of the subscriber substations effective to answer an incoming call to the private exchange on any one of the trunk lines. More particularly, this operation of the device at the operator position conditions the switch in the allotter to be operated from its normal to its off-normal position, this switch being operated from its normal to its off-normal position when an incoming call is extended to the private exchange.

In accordance with a further feature of the invention, the private exchange comprises an arrangement controlled jointly by the operation of the device at the operator station and the extension of an incoming call to the private exchange for rendering the apparatus at each of the subscriber substations operative to answer an incoming call to the private exchange on any one of the trunk lines and for causing ringing current to be projected over at least a number of

the subscriber lines. More particularly, the operation of the device at the operator station conditions a relay to be operated, which relay is operated when an incoming call is extended to the P. A. B. X. Upon operating, the relay operates the switch in the allotter from its normal to its off-normal position and completes a path for projecting ringing current over at least a number of the subscriber lines.

Further features of the invention pertain to the particular arrangement of the circuit elements thereof, whereby the above-outlined and additional operating features are attained.

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 following specification, taken in connection with the accompanying drawings, in which Fig. 6 illustrates the general arrangement of a telephone system including a private exchange incorporating the present invention, and Figs. 1 to 5, inclusive, taken together, illustrate the details of a system having incorporated therein the features of the invention as briefly outlined above.

Description of the apparatus incorporated in the telephone system

Referring now more particularly to Fig. 6 of the drawings, the telephone system there illustrated comprises a P. A. B. X. 10, a central exchange 20, and a plurality of two-way trunk lines extending therebetween including the trunk line 1005. Briefly, the P. A. B. X. 10 comprises a number of each of three different types of subscriber substations comprising authorized, semi-authorized and unauthorized subscriber substations respectively including the subscriber substations indicated at A, B and C, an attendant cabinet or operator position 40, a plurality of local links including the local link indicated at 21, and an allotter 50 for assigning the local links and trunk lines to the use of the subscriber substations. The number of local links and trunk lines employed is determined by the volume and character of the traffic to be handled by the P. A. B. X., and reasonable service can be rendered in a P. A. B. X. of this character when three local links and three trunk lines are provided. The first local link 21 comprises a finder portion or switch 22 and a connector portion or switch 23; and the first trunk line 1005 is individually provided with a trunk circuit 60 including a trunk finder-connector switch 30 individual thereto. A subscriber line and a line circuit individual thereto are associated with each subscriber substation, the subscriber lines 401, 402 and 403 being respectively associated with the subscriber substations C, B and A. Also, an information trunk 650 and a line circuit individual thereto are associated with the attendant cabinet 40.

The finder switch 22 of the first local link 21 and each of the other finder switches of the local links have access to each subscriber line, to the information trunk, and to a link line individually associated with each trunk circuit, the link line 830 being individually associated with the first trunk circuit 60. The connector switch 23 of the local link 21 and each of the other connector switches of the local links have access, by way of a trunk line 200, to each subscriber line and to the information trunk. The trunk finder-connector switch 30 of the first trunk circuit 60 and each of the other trunk finder-connector switches of the other trunk circuits have access to the authorized and semiauthorized subscriber lines.

Preferably, the attendant cabinet 40, as shown to the left of the dashed line in Fig. 3, comprises a telephone instrument including a transmitter 565 and a receiver 566 associated with a voice current repeater 577, a dialing mechanism 582 and a group of control switches. The repeater 577 is associated with the line conductors of a trunk line at the attendant cabinet 40 by way of an impedance 500, and talking battery current is supplied to the telephone instrument at the attendant cabinet 40 by way of an impedance 520. The information trunk 650 extends to the attendant cabinet 40 and is provided with a signal 561 and a line circuit including a combined line and cut-off relay R280. An impulsing relay R510 is associated with the dialing mechanism 582 and a number of control relays R530, R540 and R550, a thermostatic device T570 and a trunk signal buzzer M576 are commonly associated with the trunk circuits terminating at the attendant cabinet 40.

The group of control switches provided at the attendant cabinet 40 comprises a trunk release switch 590, a grounding switch 560, and a night switch 570 commonly associated with the trunk circuits terminating thereat, and a trunk hold switch, a connect switch and a dial-split switch individually associated with each trunk circuit terminating thereat, the trunk hold switch 563, the connect switch 600 and the dial-split switch 610 being individually associated with the first trunk circuit 60. Also, an answer and supervisory lamp is individually associated with each trunk circuit terminating at the attendant cabinet, the answer and supervisory lamp 564 being individually associated with the first trunk circuit 60. Also, an information trunk switch 593 is individually associated with the information trunk 650 and a trunk switch 567 is individually associated with the trunk signal buzzer M576.

Each of the subscriber substations is provided with a telephone instrument, a ringer and a line circuit associated with the subscriber line extending thereto. Each of the line circuits comprises a combined line and cut-off relay, the combined line and cut-off relays includes in the line circuits individually associated with the subscriber lines 401, 402 and 403 being respectively indicated at R370, R380 and R390 in Fig. 2. The telephone instrument of each of the authorized subscriber substations has associated therewith a grounding push button which is operative to apply direct ground potential to the line conductor of the subscriber line extending thereto, the grounding push button associated with the telephone instrument at the telephone substation A being indicated at 393. Also it is noted that the receivers of the telephone instruments at the authorized subscriber substations are of the permanent magnet type, for a purpose more fully described subsequently. Also, a control relay is individually associated with each of at least a selected number of the authorized subscriber substations, this control relay individually associated with the authorized subscriber substation A being indicated at R430. These control relays are controlled by a common relay R420 in order to cause coded ringing current to be projected over the corresponding subscriber lines, when night

service is in force and an incoming central exchange call is extended to the P. A. B. X., in a manner more fully described subsequently. Also, a general incoming trunk signal 387 is commonly associated with the authorized subscriber substations which is operated when temporary direct answering of incoming central exchange calls to the P. A. B. X. is in force.

Preferably, each of the local links is connected and arranged in a manner similar to that of the link line 21; and the latter local link comprises, as shown in Fig. 1, in addition to the finder switch 22 and the connector switch 23, an impulsing relay R130, a hold relay R140, a ring cut-off relay R120, and a number of control relays R100, R110 and R150. Operatively connected to the finder switch 22 is a motor M171, and operatively connected to the connector switch 23 is a motor M170, these motors preferably being connected to the corresponding switches by a pawl and ratchet mechanism (not shown). Also, the local link 21 includes a thermostatic device T160 which is operative in the event the first local link fails to find a calling subscriber line within a predetermined time interval to cause the second local link to hunt for the calling subscriber line.

The finder switch 22 comprises four rotary switches, 260, 264, 268 and 272, each including a contact bank and an associated wiper, the contact banks being respectively indicated at 262, 266, 270 and 274, and the associated wipers being respectively indicated at 261, 265, 269 and 273. Preferably, the contact bank of each rotary switch includes twenty-five contacts, and the associated wiper thereof is of the double-ended type. The rotary switches 260, 264 and 272 respectively terminate the negative, positive and general control conductors of the subscriber and link lines and the information trunk. The rotary switch 268 terminates the special control conductors of the link lines. More particularly, the subscriber lines terminating at the rotary switches 260, 264 and 272 are arranged in three groups, the first group utilizing the contacts between 1 and 9, the second group utilizing the contacts between 11 and 19, and the third group utilizing the contacts between 21 and 23 in the contact banks of these rotary switches. The link lines terminating at the rotary switches 260, 264, 268 and 272 utilize the tenth, twentieth and twenty-fifth contacts in the contact banks of the switches. The information trunk 650 utilizes the twenty-fourth contacts in the contact banks of the rotary switches 260, 264 and 272.

The connector switch 23 comprises five rotary switches, 240, 244, 248, 252 and 256, each including a contact bank and an associated wiper, the contact banks being respectively indicated at 242, 246, 250, 254 and 258, and the associated wipers being respectively indicated at 241, 245, 249, 253 and 257. Preferably, the contact bank of each rotary switch includes twenty-five contacts and the associated wiper thereof is of the double-ended type. The rotary switches 248, 252 and 256 respectively terminate the general control, positive and negative conductors of the subscriber lines and information trunk. The rotary switch 240 is utilized in returning the connector switch 23 to its home position, all of the contacts in the contact bank thereof with the exception of the twenty-fifth contact being multipled together. The rotary switch 244 terminates a group of control conductors extending to the trunk finder switches of the trunk circuits. As previously noted, the subscriber lines terminating at the rotary switches 248, 252 and 256 are arranged in three groups, the first group utilizing the contacts between 1 and 9, the second group utilizing the contacts between 11 and 19, and the third group utilizing the contacts between 21 and 23 in the contact banks of these rotary switches. The tenth, twentieth and twenty-fifth contacts in the rotary switches 248, 252 and 256 are utilized for control purposes in a manner more fully explained subsequently. The information trunk utilizes the twenty-fourth contacts in the contact banks of the rotary switches 248, 252 and 256.

From the foregoing it is apparent that the directory numbers of the subscriber lines in the first, second and third groups respectively comprise the numbers between 1 and 9, 01 and 09, and 001 and 003, and that the directory number of the information trunk comprises the number 004.

Preferably, each of the trunk circuits is connected and arranged in a manner similar to that of the first trunk circuit 60, the latter trunk circuit comprising, as shown in the Figs. 3, 4 and 5, a plurality of trunk conductors, the trunk finder-connector switch 30, and a group of relays and a group of thermostatic devices for controlling the operation of the first trunk circuit. This group of relays comprises two impulsing relays R700 and R790, a hold relay R770, a ring cut-off relay R760, two differential relays R900 and R910, two ringing relays R710 and R980, four switching relays R720, R740, R920 and R940, and a plurality of control relays, R730, R750, R780, R905, R930, R950, R960 and R970. The group of thermostatic devices comprises the thermostatic devices indicated at T805, T810, T815, T962 and T964.

Certain auxiliary wiring is provided, including the wiring illustrated at "X," "Y" and "Z" which is connected in a manner more fully described subsequently, in order to accommodate the use of the P. A. B. X. in connection with a central exchange of the automatic, common manual battery or manual local battery types. The "X" wiring comprises a connection between the lower terminal of the lower winding of the relay R960 and the armature RA977 of the relay R970, and a connection between the contact associated with the armature RA977 and the positive trunk conductor 1011. The "Y" wiring comprises a connection between the lower terminal of the winding of the thermostatic device T815 and the armature TA816 thereof. The "Z" wiring comprises a connection in multiple to the contacts controlled by the armature RA921 of the relay R920, a connection in multiple to the contacts controlled by the armatures RA923 of the relay R920, a connection between the contact controlled by the armature RA945 of the relay R940 and the contact controlled by the armature RA974 of the relay R970 and a connection between the armature RA974 and the upper terminal of the winding of the relay R980. When the central exchange is of the automatic type, only the "X" wiring illustrated is connected; when the central exchange is of the manual common battery type only the "X" and "Y" wiring illustrated are connected; and when the central exchange is of the manual local battery type only the "X" and "Z" wiring illustrated are connected. Also, the auxiliary wiring illustrated at "A" and comprising a connection in multiple to the contacts controlled by the armature RA947 of the relay R940 is pro-

vided for the purpose of facilitating the transfer of a central exchange connection back and forth between two authorized subscriber substations, in a manner more fully described subsequently.

The trunk finder-connector switch **30** comprises five rotary switches **670**, **674**, **678**, **682** and **686**, each including a contact bank and an associated wiper, the contact banks being respectively indicated at **672**, **676**, **680**, **684** and **688**, and the associated wipers being respectively indicated at **671**, **675**, **679**, **683** and **687**. Operatively connected to the trunk finder-connector switch **30** is a motor **M615**, this motor preferably being connected to the switch by a pawl and ratchet mechanism (not shown). Preferably, the contact bank of each rotary switch includes twenty-five contacts, and the associated wiper thereof is of the double-ended type. The rotary switches **678**, **682** and **686** respectively terminate the general control, positive and negative conductors of the authorized and semiauthorized subscriber lines. The rotary switch **674** terminates the control conductor extending to the connector switch **23** of the local link **21**, and the corresponding conductors extending to the connector switches of the other local links. The rotary switch **670** is utilized in returning the trunk finder-connector switch **30** to its home position, and all of the contacts in the bank contact thereof with the exception of the twenty-fifth contact therein are multipled together.

The allotter **50**, as shown in Fig. 2, comprises a plurality of relays **R300**, **R310**, **R320**, **R330**, **R340**, **R350** and **R360** and a thermostatic device **T326**. These relays in the allotter **50** are operated in a manner more fully described subsequently, to cause the local links and the trunk circuits to be assigned to the use of the calling subscriber lines. The thermostatic device **T325** is operative to cause the allotter **50** to be released in the event that the finder-connector switch of one of the trunk circuits does not find a calling authorized subscriber line within a predetermined time interval, in a manner more fully described subsequently.

Also, an arrangement comprises a number of chain switches, two of which are illustrated at **302** and **306**, in Fig. 2, are provided for the purpose of varying the sequence of first-choice local links assigned by the allotter **50** to the use of calling subscriber lines.

Also, it is noted that the conductors of the subscriber lines and information trunk are respectively multipled together between the finder and connector switches **22** and **23**, respectively, of the local link **21** by way of the multiple **275**. Further, this multiple **275** extends to the finder and connector switches of the other links, thereby to render the finder switch of each local link accessible to each subscriber line and the information trunk. Also, it is noted that the connector switches **22** of the local link **21**, and the finder-connector switch **30** of the first trunk circuit **60**, have access to the subscriber lines by way of the trunk line **200**. Also, each of the other local links and trunk circuits have access to the subscriber lines by way of this trunk line.

Substation to substation calls

A call which is to be extended from one subscriber substation to another is initiated at the calling substation by removing the telephone receiver thereat from its hook. For example, in extending a call from the authorized subscriber substation A to the semiauthorized subscriber substation B, the call is first initiated at the substation A by removing the telephone receiver thereat from its hook, thereby to complete a bridging path including the receiver of the telephone instrument between the line conductors **C408** and **C409** of the subscriber line **403** individual to the substation A. When this bridge path is completed between the line conductors of the subscriber line **403**, a circuit is completed for energizing the combined line and cut-off relay **R390**, individually associated with the subscriber line **403**, which extends from battery at the lower terminal of the intermediate winding of **R390** by way of the intermediate winding of **R390**, the bridge path between the line conductors of the subscriber line **403**, the start conductor **C418**, the winding of the relay **R340** in the allotter **50** and the control conductor **C204** to ground in the assigned one of the local links. Assuming that the illustrated local link **21** is the link assigned, the circuit for energizing the intermediate winding of **R390** extends from ground at the armature **RA156** of the relay **R150** in the local link **21** and the back contact associated therewith by way of **C204**, **RA324**, the winding of the relay **R340** in the allotter **50**, **C418**, **RA391**, **RA431** and the back contact associated therewith, **C409**, the bridge path between **C409** and **C408** at the substation A, **C408**, **RA432** and the back contact associated therewith, **RA392** and the intermediate winding of **R390** to battery. When energized over the above-traced circuit, the relay **R390** partially operates and the relay **R340** fully operates. The partial operation of the relay **R390** closes the "X" contacts associated with the armatures **RA393** and **RA394** thereof, thereby to apply battery potential by way of the intermediate and upper windings of **R390** and **RA393** to the start conductor **C419** and to apply battery potential by way of the lower winding of **R390** and **RA394** to the control conductor **C203**.

Upon operating, the relay **R340** completes at **RA341**, an obvious circuit for energizing the relay **R350** in the allotter **50**. When energized, the relay **R350** operates to interrupt, at **RA352**, a circuit connection between the start conductor **C419** and the winding of the relay **R300** in the allotter **50**, thereby to prevent operation of the relay **R300** and the consequent operation of the allotter **50** incident to the initiation of a call at one of the subscriber substations, which is to be routed by way of an outgoing trunk line extending to the central exchange **20**, and completes at **RA351** a path for applying ground potential to the start conductor **C416**. The application of battery potential to the control conductor **C203** marks the subscriber line **403** as a calling line in the contact bank **274** of the rotary switch **272** of the finder switch **22** of the local link **21**. The application of ground potential to the start conductor **C416** completes a circuit for energizing in multiple the relay **R130** in the local link **21** and the thermostatic device **T160**. The circuit for energizing the relay **R130** extends from ground at **RA351** by way of the switch springs **308** and **307** of the chain switch **306**, **C210**, **C228** and the twenty-fifth or home contact in the contact bank **246** of the rotary switch **244** of the connector switch **23** of the local link **21**, the associated wiper **245**, **C226**, **RA114**, **RA143** and the back contact associated therewith, the resistor **179** and the upper winding of **R130** to battery; and the circuit for energizing the thermostatic device **T160** extends from the grounded conductor **C210** by way of the

winding of T160 to battery. The rotary switch 244 is included in the connector switch 23, the latter switch forming a part of the local link 21.

When energized over the above-traced circuit, the relay R130 operates to prepare at RA131 a circuit, traced hereinafter, for energizing the motor M171 associated with the finder switch 22, prepares at RA132 and the front contact associated therewith a point in a circuit, traced hereinafter, for energizing the relay R140, interrupts at RA133 a point in a circuit, traced hereinafter, for energizing the relay R110, and completes at RA134 a path for applying ground potential to the wiper 273 of the rotary switch 272. The path for applying ground potential to the wiper 273 of the rotary switch 272 extends from ground at RA134 by way of the intermediate winding of R150, RA141 and C233 to the wiper 273. When the circuit for energizing the motor M171 is prepared at RA131, a circuit is completed for initiating the operation of the common equipment, not shown, associated with the local link 21. This circuit extends from battery at the motor M171 by way of the winding of M171, RA131, C221, the twenty-fifth or home contact in the contact bank 242 of the rotary switch 240, the associated wiper 241, C222 and RA151 to the pulse ground lead C179. This application of battery potential to the pulse ground lead C179 initiates the operation of the common equipment as previously noted, thereby to cause the common equipment to transmit ground pulses by way of the pulse ground lead C179, over the above-traced circuit through the winding of the motor M171 to battery. These ground pulses energize the motor M171 causing intermittent operation thereof and the consequent step-by-step rotation in a clockwise direction of the wipers of the rotary switches 260, 264, 268 and 272 of the finder switch 22.

The intermittent operation of the motor M171 drives the wipers of the rotary switches of the finder switch 22 step by step until the contact in the contact bank 274 of the rotary switch 272 terminating the control conductor C203 and marking the subscriber line 403 is encountered by the associated wiper 273, at which time a circuit for energizing the relay R390 and the relay R150 in series is completed. This circuit extends from ground at RA134 by way of the intermediate winding of R150, RA141, C233, the wiper 273 of the rotary switch 272, the contact in the associated contact bank 274 terminating the control conductor C203, C203, RA394 and the lower winding of R390 to battery. When energized over the above-traced circuit, the relay R150 operates to interrupt, at RA151, the short circuit around the resistor 172, thereby to include this resistor in the circuit for energizing the motor M171. This resistor has a sufficiently high resistance to prevent the ground pulses on the pulse ground lead C179 from being effective to cause the motor M171 to be operated, thereby to arrest further operation of the finder switch 22. The application of battery potential through the winding of the motor M171 by way of the previously traced circuit including the resistor 172 to the pulse ground lead C179 is effective to maintain the common equipment in operation.

Upon operating, the relay R150 also interrupts at RA152 a point in a circuit, traced hereinafter, for energizing the relay R110 and completes at RA153 a circuit for energizing the relay R140, the latter circuit extending from ground at RA153 by way of RA132 and the front contact associated therewith and the winding of R140 to battery. Further, the relay R150 completes, at RA154, a shunt path around the armature RA141, thereby to retain the relay R150 in its operated position after the relay R140 operates, and completes at RA155 a circuit for energizing the upper winding of R150 in multiple with the intermediate winding thereof. At this time the multiple connected upper and intermediate windings of the relay R150 are included in a circuit including the lower winding of the relay R390, one path of this circuit extending from ground at RA134 by way of the upper winding of R150 and RA155 to RA154, and the other path extending from ground at RA134 by way of the intermediate winding of R150 to RA154, and the circuit extending from RA154 by way of C233, the wiper 273 of the rotary switch 272, the contact in the associated contact bank 274 terminating the control conductor C203, C203, RA394 and the lower winding of R390 to battery. The upper winding of the relay R150 is of relatively low resistance, thereby reducing the resistance of the circuit for energizing the lower winding of R390 and causing the relay R390 to be fully energized. Also, this application of ground potential to the wiper 273 of the rotary switch 272 in engagement with the contact in the associated contact bank 274 terminating the control conductor C203 of the subscriber line 403 marks the subscriber line 403 as busy to the connector switches of the other local links by way of the multiple 275 extending between the finder and connector switches of the local links. Further, the relay R150 interrupts, at RA156 and the back contact associated therewith, the previously traced circuit for energizing the relay R340 in series with the intermediate winding of the relay R390 and completes at RA156 and the front contact associated therewith, a circuit, traced hereinafter, for energizing the relay R100.

When the relay R390 is fully energized, it fully operates to interrupt at RA391 and at RA392 further points in the circuit for energizing in series the relay R340 and the intermediate winding of R390. When the circuit for energizing the relay R340 is interrupted, this relay restores to interrupt at RA341 the circuit for energizing the relay R350, causing the latter relay to restore. Upon restoring, the relay R350 interrupts at RA351 the path for applying ground potential to the start conductor C416, thereby to render the allotter 50 available for further use by the other subscriber substations. Further, the relay R350 prepares at RA352 a point in the circuit for energizing the relay R300 thereby conditioning the allotter 50 to be operable incident to the initiation of a call at one of the subscriber substations which is to be extended by way of a trunk line to the central exchange 20.

Also, upon operating, the relay R150 connects at RA157 and at RA158 the relay R130 across the subscriber line 403 seized by the finder switch 22, thereby to complete a loop circuit including the relay R130 and the telephone instrument at the substation A. This loop circuit extends from ground at the lower terminal of the lower winding of R130 by way of the lower winding of R130, RA158, RA124, C231, the wiper 265 of the rotary switch 264, the contact in the associated contact bank 266 terminating the positive line conductor of the subscriber line 403, the multiple 275 between the finder switch 22 and the connector switch 23, the trunk conductor 200, the positive line conductor C409 of the subscriber line 403, RA431, C409, the bridge at the substation A be-

tween C409 and C408, C408, RA432, the negative line conductor C408 of the subscriber line 403, the trunk line 200, the multiple 275 between the connector switch 23 and the finder switch 22, the contact in the contact bank 262 of the finder switch 260 terminating the negative line conductor of the subscriber line 403, the associated wiper 261, RA123, RA157, and the upper winding of R130 to battery. Finally, the relay R150 prepares at RA159 a circuit, traced hereinafter, for projecting busy tone current over the subscriber line 403 to the substation A in the event the called subscriber substation is busy.

When the relay R140 is energized over the previously traced circuit, it operates to interrupt at RA141 a point in the original circuit for energizing the relays R150 and R390, a path being completed around this point at this time at RA154, and applies at RA142 multiple ground to the lower terminal of the upper winding and the upper terminal of the intermediate winding of the relay R150, thereby to insure that the relays R150 and R390 are maintained in their operated positions during the impulsing period. Further, the relay R140 completes at RA144 a connection between the start conductor C416 and the control conductor C423, the latter control conductor extending to the second local link, thereby to render another local link available to the use of a subscriber substation initiating a call. This connection extends from the start conductor C416 by way of the switch springs 308 and 307 of the chain switch 306, C210, RA144, C211 and the switch springs 305 and 303 of the chain switch 302 to the control conductor C423. The previously noted circuit for energizing the relay R100 extends from ground at RA156 and the front contact associated therewith, by way of RA115, the lower and upper windings of R100, C225, the wiper 249 of the rotary switch 248, the twenty-fifth or home contact in the associated contact bank 250, C224 and the upper winding of R110 to battery. When energized over the above-traced circuit, the relay R100 operates. However, the relay R110 does not operate, due to the high series resistance of this circuit.

Upon operating, the relay R100 completes at RA102 a path for short-circuiting the lower winding thereof, this path extending from the upper terminal of the lower winding of R100 by way of the lower winding of R100, RA115 and RA102 to the upper terminal of the lower winding of R100, and prepares a point at RA101 in a circuit, traced hereinafter, for energizing the relay R120. When the lower winding of the relay R100 is short-circuited, the series resistance of the circuit for energizing the relay R110 is considerably reduced thereby to cause the relay R110 to operate. Upon operating, the relay R110 completes at RA113 a circuit for energizing the relay R120, this circuit extending from ground at RA101 by way of RA113 and the lower winding of R120 to battery. Further, the relay R110 prepares at RA111 a holding circuit, traced hereinafter, for itself, prepares at RA116 a path for short-circuiting the relay R100, traced hereinafter, prepares at RA112 and the front contact associated therewith a circuit, traced hereinafter, for energizing the motor M170 associated with the connector switch 23, interrupts at RA114 a point in the original circuit for energizing the relay R130, and interrupts at RA115 a point in the short-circuit around the lower winding of the relay R100.

When energized over the above-traced circuit, the relay R120 operates first to close the "X" contacts associated with its armature RA122, thereby to complete a holding circuit for itself extending from ground at RA101 by way of RA122, and the lower winding of R120 to battery. Subsequently, the relay R120 operates to interrupt at RA121 a point in a circuit, traced hereinafter, for energizing the motor M170 in order to cause the motor M170 to drive the connector switch 23 back into its normal or home position, interrupts at RA123 a point in the path for short-circuiting the resistor 175, interrupts at RA124 a point in the path for short-circuiting the resistor 176, interrupts at RA125 and the back contact associated therewith a point in a path, traced hereinafter, for projecting ringing current over a called subscriber line, and completes at RA126 a circuit for returning dial tone current over the calling subscriber line 403. The circuit for returning dial tone current over the subscriber line 403 extends from the ungrounded terminal of a source of dial tone current, not shown, by way of the dial tone lead C178, the condenser 174, the twenty-fifth or home contact in the contact bank 258 of the rotary switch 256, the associated wiper 257, C230, RA104, RA126 and the front contact associated therewith, C230', the wiper 261 of the rotary switch 260, the contact in the associated contact bank 262 terminating the negative conductor of the subscriber line 403, the multiple 275, the trunk line 200, the negative conductor C408 of the trunk line 403, RA432 and the back contact associated therewith, C408, the bridge including the receiver of the telephone instrument at the substation A across C408 and C409, C409, RA431 and the back contact associated therewith, the positive conductor C409 of the subscriber line 403, the trunk line 200, the multiple 275, the contact in the contact bank 266 of the rotary switch 264 terminating the positive conductor of the subscriber line 403, the associated wiper 265, C231, the resistor 176, RA158 and the lower winding of R130 to ground. The dial tone produced by the dial tone current in the receiver of the telephone instrument at the substation A indicates to the subscriber thereat that a local link has been seized and that the first digit of the directory number of the called subscriber line may be dialed.

The subscriber at the substation A then dials the first digit of the directory number of the called subscriber line at the dialing mechanism thereat, thereby to transmit a first series of impulses by way of the subscriber loop circuit to the relay R130. The relay R130 follows the dialed impulses in the usual manner, restoring each time the loop circuit is interrupted and operating each time the loop circuit is completed. Each time the relay R130 restores, it interrupts at RA132 and the front contact associated therewith the energizing circuit of the relay R140 and completes at RA132 and the back contact associated therewith the holding circuit of the relay R110. The holding circuit of the relay R110 extends from ground at RA153 by way of RA132 and the back contact associated therewith, RA111 and the lower winding of R110 to battery. On the other hand, each time the relay R130 operates, it completes at RA132 and the front contact associated therewith the circuit for energizing the relay R140 and interrupts at RA132 and the back contact associated therewith the holding circuit of the relay R110. Thus, during the impulsing period, the relays R110 and R140, being of the slow-to-release type, remain operated. On the first pulse of the first series of impulses, when the re-

lay R130 restores, it completes at RA132 and the back contact associated therewith a circuit for energizing the motor M170, interrupts at RA131 a point in the circuit for energizing the motor M171, and completes at RA133 a path for short-circuiting the relay R100. The path for short-circuiting the relay R100 extends from ground at RA101 by way of RA133, RA116, C224, the twenty-fifth or home contact in the contact bank 250 of the rotary switch 248, the associated wiper 249, C225, the upper winding of R100, RA102 and RA156 and the front contact associated therewith to ground, thereby to cause the relay R100 to restore. Upon restoring, the relay R100 interrupts at RA102 a further point in its energizing circuit and a further point in the circuit for short-circuiting the lower winding thereof, and interrupts at RA101 a point in the circuit for energizing the relay R120, thereby to cause the latter relay to restore.

Upon restoring, the relay R120 prepares at RA121 a further point in a circuit, traced hereinafter, for energizing the motor M170, thereby to cause the motor to operate to drive the connector switch 23 back into its normal or home position. Further, the relay R120 interrupts at RA122 a further point in its holding circuit, completes at RA123 a point in the path for short-circuiting the resistor 175, completes at RA124 a point in the path for short-circuiting the resistor 176, interrupts at RA126 and the front contact associated therewith a point in the circuit for returning dial tone current over the loop circuit extending to the calling substation A, and prepares at RA125 and the back contact associated therewith and at RA126 and the back contact associated therewith points in a circuit, traced hereinafter, for projecting ringing current over the called subscriber line. The circuit for energizing the motor M170 extends from ground at RA153 by way of RA132 and the back contact associated therewith, RA112 and the front contact associated therewith, and the winding of M170 to battery. When energized over the above-traced circuit, the motor M170 operates to condition the wipers of the rotary switches 240, 244, 248, 252 and 256, comprising the connector switch 23 to be rotated one step in a counterclockwise direction. Upon the first reoperation of the relay R130, the above-traced circuit for energizing the motor M170 is interrupted causing the motor M170 to restore and drive the wipers of the rotary switches comprising the connector switch 23 one step in a counterclockwise direction. When the wiper 257 of the rotary switch 256 is stepped into its first position, the twenty-fifth or home contact in the associated contact bank 258 is disengaged, thereby to interrupt a further point in the circuit for returning dial tone current over the loop circuit including the calling subscriber line 403. When the wiper 249 of the rotary switch 248 is stepped into its first position, the twenty-fifth or home contact in the associated contact bank 250 is disengaged, thereby to interrupt the original circuit for energizing the relay R110. When the wiper 245 of the rotary switch 244 is stepped into its first position, the twenty-fifth or home contact in the associated contact bank 246 is disengaged, thereby to interrupt a further point in the original circuit for energizing the relay R130. When the wiper 241 of the rotary switch 240 is stepped into its first position, the twenty-fifth or home contact in the associated contact bank 241 is disengaged, thereby to interrupt a point in the circuit for energizing the motor M171 associated with the finder switch 22. Also, when the wiper 241 of the rotary switch 240 is stepped into its first position, it engages the first contact in the contact bank 242, thereby to prepare a circuit, traced hereinafter, for energizing the motor M170, thereby to cause the motor M170 to drive the connector switch 23 back into its normal or home position. The relay R130 follows the impulses dialed at the substation A, thereby to cause the motor M170 to be intermittently energized. The intermittent energization of the motor M170 causes the motor M170 to drive the rotary switches comprising the connector switch 23 step by step in a counterclockwise direction.

The subscriber lines terminating at the connector switch 23 are arranged in three groups. The first group includes nine subscriber lines to which the directory numbers between 1 and 9 are assigned. The second group includes nine subscriber lines to which the directory numbers between 01 and 09 are assigned. The third group includes three subscriber lines and an information trunk to which the directory numbers between 001 and 004 are assigned, the directory number 004 being assigned to the information trunk. Assuming that the called subscriber line is arranged in the second group, the first digit dialed at the substation A is 0. Thus, at the conclusion of the first digit the wipers of the rotary switches comprising the connector switch 23 occupy their tenth positions and engage the tenth contacts in the respective associated contact banks. In the contact bank 250 of the rotary switch 248, it will be noted that the tenth, twentieth and twenty-fifth contacts are multipled together and connected to the conductor C224. At the conclusion of the first digit dialed, the relay R130 is reoperated to interrupt at RA132 and the back contact associated therewith the holding circuit of the relay R110, and remains in its operated position until the next digit of the directory number of the subscriber line is dialed at the substation A. Shortly after the holding circuit of the relay R110 is interrupted, this relay, being of the slow-to-release type, restores. Upon restoring, the relay R110 completes at RA115 an auxiliary circuit for energizing the relays R100 and R110 in series, this circuit extending from ground at RA156 and the front contact associated therewith by way of RA115, the lower and upper windings of R100, C225, the wiper 249 of the rotary switch 248, the tenth contact in the associated contact bank 250, C224 and the upper winding of R110 to battery. When the relays R100 and R110 are energized over the above-traced circuit, the relay R100 operates. However, the relay R110 does not operate due to the high series resistance of this circuit. Upon operating, the relay R100 completes at RA102 the previously traced circuit for short-circuiting the lower winding of R100, thereby to reduce the series resistance of the circuit for energizing the relay R110. The relay R110 then operates to complete at RA113 the previously traced circuit for energizing the relay R120. The relay R120 then operates as previously explained.

The subscriber at the substation A then dials the second digit of the directory number of the called subscriber line and the relay R130 follows the impulses comprising the second digit dialed at the substation A. On the first pulse of the series of impulses comprising the second digit dialed at the substation A, the relay R130 restores to complete at RA133 an auxiliary circuit for short-circuiting the relay R100, this circuit ex-

tending from ground at RA101 by way of RA133, RA116, C224, the tenth contact in the contact bank 250 of the rotary switch 248, the associated wiper 249, C225, the upper winding of R100, RA102 and RA156 and the front contact associated therewith to ground. When the relay R100 is short-circuited, it restores to interrupt at RA101 the operating and holding circuits of the relay R120 causing the latter relay to restore as previously explained. The relay R130 follows the impulses comprising the second digit dialed at the substation A, thereby to cause intermittent energization of the motor M170 as previously explained. The intermittent energization of the motor M170 causes the motor to drive the wipers of the rotary switches comprising the connector switch 23 to a position corresponding to the called subscriber line. At the conclusion of the second digit dialed at the substation A, the wipers 249, 253 and 257 of the rotary switches 248, 252 and 256 engage the contacts in the associated contact banks 250, 254 and 258 respectively terminating the control, positive and negative conductors of the called subscriber line 402.

The subsequent operation of the local link 21 depends upon whether the called subscriber line is idle or busy. Assuming that the called subscriber line is busy, ground potential through a low resistance is present upon the control conductor thereof, terminating at the contact in the contact bank 250 of the rotary switch 248 engaged by the associated wiper 249. This ground potential is derived in a busy link associated with the called subscriber line 402. More particularly, the ground potential is derived in the busy link associated with the busy subscriber line 403 at an armature corresponding to the armature RA142 of the relay R140 in the local link 21, in the event the subscriber line is busy on a call initiated at the subscriber substation B, and at an armature corresponding to the armature RA156 of the relay R150 in the local link 21, in the event the subscriber line is busy on a call initiated at another subscriber substation and extended to the subscriber substation B. This ground potential on the wiper 249 of the rotary switch 248 completes a path for short-circuiting the relay R100, subsequent to the restoration of the relay R110 shortly after the conclusion of the second digit dialed at the substation A, this path extending from ground potential on the wiper 249 by way of C225, the upper and lower windings of R100 and RA115 to ground at RA156 and the front contact associated therewith. At this time busy tone current is returned over the loop extending to the calling substation A, the circuit for returning busy tone current extending from the ungrounded terminal of a source of busy tone current, not shown, by way of the busy tone lead C177, RA105 and the back contact associated therewith, the condenser 173, RA159, C231, the wiper 265 of the rotary switch 264, the contact in the associated contact bank 266 terminating the positive conductor of the subscriber line 403, the multiple 275, the trunk line 200, the positive conductor C409 of the subscriber line 403, RA431, C409, the bridge including the receiver of the telephone instrument across C409 and C408, at the substation A, RA432, the negative conductor C408 of the subscriber line 403, the trunk line 200, the multiple 275, the contact in the contact bank 262 of the rotary switch 260 terminating the negative conductor of the subscriber line 403, the wiper 261, C230', RA123, RA157 and the upper winding of R130 to battery. The resultant busy tone produced by the receiver of the telephone instrument at the substation A indicates to the subscriber thereat that the desired connection can not immediately be had due to the busy condition of the called subscriber line. At this time, the subscriber at the substation A may abandon the call and release the apparatus, by replacing the receiver of the telephone instrument at the substation A upon its hook, in a manner more fully described subsequently, or he may wait for the called subscriber line to become idle. When the subscriber line becomes idle, the local link 21 operates to project ringing current over the called subscriber line, provided the subscriber at the substation A "camps on" the busy called subscriber line 402.

At the conclusion of the second digit dialed at the substation A and after the relay R110 restores, a circuit is completed for energizing the relay R100 in the event the called subscriber line 402 is idle. This circuit extends from ground at RA156 and the front contact associated therewith by way of RA115, the lower and upper windings of R100, C225, the wiper 249 of the rotary switch 248, the contact in the associated contact bank 250 terminating the control conductor of the subscriber line 402, the trunk line 200, the control conductor C422 of the subscriber line 402 and the lower winding of R380 to battery. When energized over the above-traced circuit, the relay R100 operates to complete at RA102 the previously traced path for short-circuiting the lower winding thereof, thereby to reduce the series resistance of the circuit for energizing the relay R380 causing the relay R380 to completely operate. Further, this operation of the relay R100 marks the control conductor of the called subscriber line 402 as busy to the connector switches of the other links and to the trunk finder-connector switches by the application of ground potential thereto. Upon operating, the relay R380 interrupts at RA381 and at RA382 points in the path for applying battery potential at the lower terminal of the intermediate winding of R380 to the start conductor C418 when the call is answered at the substation B, thereby to prevent the finder switch of a local link from being associated with the subscriber line 402 when the call is answered at the substation B. Further, the relay R100 prepares at RA101 a point in the holding circuit of the relay R120 and completes at RA103 and at RA104 points in a circuit for projecting ringing current over the called subscriber line 402. The circuit for projecting ringing current over the called subscriber line 402 extends from the ungrounded terminal of a source of ringing current, not shown, by way of the ringing current lead C106, the upper winding of R120, RA125 and the back contact associated therewith, RA103, C227, the wiper 253 of the rotary switch 252, the contact in the associated contact bank 254 terminating the positive conductor of the called line 402, the trunk line 200, the positive conductor C413 of the subscriber line 402, the bridge including a ringer and a condenser at the substation B across C413 and C412, the negative conductor C412 of the subscriber line 402, the trunk line 200, the contact in the contact bank 258 of the rotary switch 256 terminating the negative conductor of the subscriber line 402, the associated wiper 257, C230 and RA104 to ground at RA126 and the back contact associated therewith. A portion of this ringing current is returned over the loop

extending to the calling substation A in order to provide ring-back tone at the receiver of the telephone instrument thereat. The circuit for returning ring-back tone current to the calling substation A extends from the ringing current lead C106 by way of the upper winding of R120, RA125 and the back contact associated therewith, RA103, C227, C229, RA105 and the front contact associated therewith, the condenser 173, RA159, C231, the wiper 265 of the rotary switch 264, the contact in the associated contact bank 266 terminating the positive conductor of the calling subscriber line 403, the multiple 275, the trunk line 200, the positive conductor C409 of the subscriber line 403, RA431, C409, the bridge including the receiver of the telephone instrument at the substation A across C409 and C408, C408, RA432, the negative conductor C408 of the subscriber line 403, the trunk line 200, the multiple 275, the contact in the contact bank 262 of the rotary switch 260 terminating the negative conductor of the subscriber line 403, the associated wiper 261, C230', RA123, RA157 and the upper winding of R130 to battery. The ring-back tone produced in the receiver of the telephone instrument at the substation A indicates to the subscriber thereat that ringing current is being projected over the called subscriber line. The ringing current projected over the subscriber line 402 operates the ringer at the called substation B, thereby to indicate to a subscriber thereat that this substation is being called.

When the subscriber at the substation B answers the call by removing the receiver of the telephone instrument thereat from its hook, a bridge including the telephone instrument at the substation B is connected across the line conductors C412 and C413 of the called subscriber line 402. This bridge across the line conductors C412 and C413 of the called subscriber line 402 completes a low resistance circuit substantially identical to the circuit for projecting ringing current over the called subscriber line 402, thereby to cause the relay R120 to be effectively energized. The relay R120, being of the slow-to-operate type, operates shortly thereafter. First, the relay R120 operates partially to close its "X" contacts associated with the armature RA122, thereby to complete its holding circuit. The relay R120 then completely operates to interrupt at RA125 and the back contact associated therewith and at RA126 and the back contact associated therewith, the circuit for projecting ringing current over the called subscriber line 402 and the circuit for returning ring-back tone current over the calling subscriber line 403. Further, the relay R120 interrupts at RA121 a point in the path for applying battery potential at the motor M170 to the pulse ground lead C179, thereby to cause the operation of the common equipment connected to the pulse ground lead C179 to be arrested. Further, the relay R120 completes, at RA125 and the front contact associated therewith and at RA126 and the front contact associated therewith, a loop circuit between the calling and called subscriber lines 403 and 402, respectively, this loop circuit extending from the positive line conductor of the calling subscriber line 403 terminating at the contact in the contact bank 266 of the rotary switch 264 engaged by the associated wiper 265, by way of the wiper 265, C231, RA125 and the front contact associated therewith, RA103 and C227 to the wiper 253 of the rotary switch 252 engaging the contact in the associated contact bank 254 terminating the positive conductor of the called subscriber line 402, and from the negative line conductor of the calling subscriber line 403 terminating at the contact in the contact bank 262 of the rotary switch 260 engaged by the associated wiper 261, by way of the wiper 261, C230', RA126 and the front contact associated therewith, RA104 and C230 to the wiper 257 of the rotary switch 256 engaging the contact in the associated contact bank 258 terminating the negative conductor of the called subscriber line 402, the telephone instrument at the calling substation A being bridged across the positive and negative line conductors of the subscriber line 403, and the telephone instrument at the called substation B being bridged across the positive and negative line conductors of the subscriber line 402. Finally, the relay R120 interrupts at RA123 the path for short-circuiting the resistor 175 and interrupts at RA124 the path for short-circuiting the resistor 176, thereby to complete a circuit including the upper and lower windings of the relay R130 and the resistors 175 and 176 for supplying talking battery current to the loop circuits extending to calling and called subscriber substations, this circuit extending from ground at the lower terminal of the lower winding of R130 by way of the lower winding of R130, RA158 and the resistor 176 to C231 and from battery at the upper terminal of the upper winding of R130 by way of the upper winding of R130, RA157 and the resistor 175 to C230', the conductors C230' and C231 being connected together by way of the loop circuits extending to the called and calling substations.

The release of an established connection between the calling substation A and the called substation B is under the control of the last subscriber to replace his telephone instrument upon its hook. When the last subscriber replaces his telephone instrument upon its hook, the loop circuit including the upper and lower windings of the relay R130 is interrupted, thereby to cause the relay R130 to restore. Upon restoring, the relay R130 interrupts at RA132 and the front contact associated therewith the circuit for energizing the relay R140 and removes at RA134 the ground potential from the lower and upper terminals of the upper and intermediate windings, respectively, of the relay R150. Shortly thereafter, the relay R140, being of the slow-to-release type, restores to remove ground potential at RA142 from the previously mentioned terminals of the upper and intermediate windings of the relay R150, thereby to cause the relay R150 to restore. The relay R140 also prepares at RA143 and the back contact associated therewith a point in the path for connecting the upper winding of the relay R130 by way of the twenty-fifth or home contact in the contact bank 246 of the rotary switch 244 to the start conductor C416 and interrupts at RA144 the connection between the start conductor C416 and the control conductor C423 extending to the second link.

When the relay R140 interrupts at RA142 the path for applying ground potential to the previously mentioned terminals of the upper and intermediate windings of relay R150, the circuit for energizing the relay R390 associated with the calling subscriber 403 is interrupted, thereby to cause the relay R390 to restore. Upon restoring, the relay R390 prepares at RA391 and RA392 points in the circuit for operating the relay R340

in the allotter 50 when the next subscriber substation call is initiated at the substation A. At this time, the apparatus associated with the substation A is completely released for further use. Upon restoring, the relay R150 interrupts at RA156 and the front contact associated therewith the circuit for energizing in series the upper winding of R100 and the relay R380 associated with the called subscriber line 402, thereby to cause these relays to restore. When the relay R380 restores, it prepares at RA381 and RA382 points in the circuit for energizing the relay R340 in the allotter 50 when a call is initiated at the substation B. At this time, the apparatus associated with the substation B is completely released for further use. Further, the relay R150 prepares at RA156 and the back contact associated therewith a point in the circuit for energizing the relay R340 in the allotter 50 when the next subscriber substation call is initiated at one of the substations. Also, the relay R150 interrupts at RA154 a further point in the circuit for energizing the upper and lower windings thereof, interrupts at RA155 a further point in the circuit for energizing the upper winding thereof, interrupts at RA157 and at RA158 points in the circuit for connecting the upper and lower windings of the relay R130 to the conductors C230' and C231, and interrupts at RA159 a point in the circuit for returning busy tone over the calling subscriber line. Finally, the relay R150 completes at RA151 a point in the path for short-circuiting the resistor 172.

Upon restoring, the relay R100 interrupts at RA101 the holding circuit of the relay R120 causing the latter relay to restore, interrupts at RA102 a point in the path for short-circuiting the lower winding thereof and interrupts at RA103 and at RA104 points in the connections between the rotary switches 252, 264 and 256, 260, respectively. Finally, the relay R100 interrupts at RA105 and the front contact associated therewith a further point in the circuit for returning ring-back tone current over the calling subscriber line and prepares at RA105 and the back contact associated therewith a point in the circuit for returning busy tone current over the calling subscriber line. Upon restoring, the relay R120 completes at RA121 a circuit for connecting battery potential at the upper terminal of the lower winding of R110 to the pulse ground lead C179, this circuit extending from battery at the upper terminal of the lower winding of R110 by way of the lower winding of R110, RA152, RA121, C223, the multiple connected contacts in the contact bank 242 of the rotary switch 240, the associated wiper 241, C222 and RA151 to C179. This application of battery potential to the pulse ground lead C179 initiates the operation of the common equipment connected thereto and causes the relay R110 to be energized over the above-traced circuit. When energized, the relay R110 operates to interrupt at RA114 a further point in the original operating circuit of the relay R130, thereby to prevent operation of the relay R130 incident to the operation of the relay R350 in the allotter 50 before the local link 21 is completely released, and completes at RA111 and at RA112 and the front contact associated therewith a circuit for energizing the motor M170, this circuit extending from the pulse ground lead C179 by way of RA151, C222, the wiper 241 of the rotary switch 240, the multiple connected contacts in the associated contact bank 242, C223, RA121, RA152, RA111, RA112 and the front contact associated therewith and the winding of M170 to battery. The motor M170 is intermittently energized by way of the above-traced circuit, thereby to cause intermittent operation thereof. The intermittent operation of the motor M170 drives the wipers of the rotary switches comprising the connector switch 23 step by step in a counterclockwise direction until these wipers are driven into their twenty-fifth or home positions. When the wiper 241 of the rotary switch 240 is moved into its twenty-fifth or home position, the multiple connected contacts in the associated contact bank 242 are disengaged, thereby to interrupt the circuits for energizing the motor M170 and for energizing the relay R110. Thus, operation of the motor M170 is arrested and the relay R110, being of the slow-to-release type, restores shortly thereafter. When the circuits for energizing the motor M170 and the relay R110 are interrupted, operation of the common equipment connected to the pulse ground lead C179 is arrested. At this time the start lead C416 is connected by way of the switch springs 308 and 307 of the chain switch 306, C210, C228, the twenty-fifth or home contact in the contact bank 246 of the rotary switch 244, the associated wiper 245, C226, RA114, RA143 and the back contact associated therewith, the resistor 179 and the upper winding of R130 to battery. Thus, at this time, the local link 21 is completely released and is again in condition to be seized when a subscriber substation call is initiated at one of the substations.

It will be understood that a call initiated at any one of the authorized, semiauthorized or unauthorized subscriber substations will cause the combined line and cut-off relay individually associated therewith to operate in a manner similar to the operation of the relay R390 and that the allotter 50 will cause the finder switch of a local link to operate and find the calling subscriber line as previously explained. After a local link is associated with the subscriber substation initiating the call, the call may be extended to any one of the authorized, semiauthorized or unauthorized subscriber substations by dialing at the dialing mechanism at the calling subscriber substation the directory number of the desired called subscriber substation, the operation of the connector switch of the local link associated with the calling subscriber line being the same as that previously described.

Also, it is noted that the attendant cabinet 40 has access and is accessible to the local links by way of the information trunk 650 in a manner similar to the subscriber substations. In order to initiate a subscriber substation call at the attendant cabinet 40 the information trunk switch 593 thereat is operated to its front position, thereby to complete at the switch springs 594 and 595 and the front contacts associated therewith a path for applying battery potential to the start conductor C418. This path extends from battery at the lower terminal of the upper winding of the relay R280 by way of the upper winding of R280, RA282, C651, the switch spring 594 and the front contact associated therewith, C654, RA531, RA512, C657, the impedance 500, C655, the switch spring 595 and the front contact associated therewith, C652, RA281, C424, and C937 to the start conductor C418. This application of battery potential to the start conductor C418 causes the allotter 50 to operate, thereby to cause the finder switch of an idle local link to find the

information trunk, as previously explained. A connection between a subscriber substation having a local link associated therewith and the attendant cabinet 40 may be established by dialing at the dialing mechanism at the substation the directory number of the information trunk 650, thereby to cause the connector switch of the local link to seize the information trunk, as previously explained.

When the finder switch 22 of the local link 21 seizes the calling subscriber line 403, the relay R150 is operated as previously explained. Upon operating, the relay R150 interrupts at RA156 and the front contact associated therewith the application of ground potential in the first local link 21 to the control conductor C204. When all of the local links are busy, all of the relays therein corresponding to the relay R150 occupy their operated positions. Accordingly, ground potential in each local link is removed from the control conductor C204. At this time, when a subscriber substation call is initiated at any one of the subscriber substations, the relay R340 in the allotter 50 is not operated due to the removal of ground potential in all of the local links from the control conductor C204. Thus, the relay R350 is not operated. When the relay R350 occupies its restored position, the circuit for energizing the relay R300 by way of the start conductor C419 is prepared at RA352. Accordingly, outgoing trunk or central exchange calls from authorized subscriber substations may be completed at this time, as such calls do not require the use of a local link in their completion.

Authorized substation to central exchange calls

A subscriber at an authorized substation may initiate a call to the central exchange without the assistance of the attendant at the attendant cabinet. For example, in initiating a call from the authorized substation A to the central exchange 20, the subscriber at the substation A momentarily presses or operates the grounding push button 393 of the telephone instrument at the substation A without removing the receiver of the telephone instrument from its hook. When the push button 393 is momentarily operated, a circuit is completed for energizing the relay R390 associated with the subscriber line 403 extending to the substation A, this circuit extending from ground at the push button 393 by way of C408, RA432, RA392 and the intermediate winding of R390 to battery. When the relay R390 is energized over the above-traced circuit, it partially operates to close the "X" contacts associated with the armatures RA393 and RA396, thereby to apply battery potential at the lower terminal of the intermediate winding of R390 by way of the intermediate and upper windings of R390 and RA393 to the start conductor C419 and to connect the control conductor C417 by way of RA395 and RA396 to the control conductor C406 of the subscriber line 403. The application of battery potential to the start conductor C419 completes a circuit for energizing the relay R300 in the allotter 50, this circuit extending from battery potential on the start conductor C419 by way of RA352, RA332, RA312 and the back contact associated therewith and the winding of R300 to battery. The relay R300, being of the slow-to-operate type, operates shortly thereafter to complete at RA301 a circuit for energizing the relay R320, this circuit extending from ground at RA301 by way of RA311 and the back contact associated therewith and the upper winding of R320 to battery. When energized over the above-traced circuit, the relay R320 operates to complete at RA321 obvious circuits for energizing the thermostatic device T325 and for energizing the relay R310, the circuit for energizing the relay R310 extending from ground at RA321 by way of the upper winding of R310 to battery. Further, the relay R320 completes at RA323 a circuit for holding the relay R390 operated after the grounding push button 393 is restored, this circuit extending from ground at RA323, by way of RA332, RA352, the start conductor C419, RA393 and the upper and intermediate windings of R390 to battery. Further, the relay R320 interrupts at RA324 a point in the circuit for energizing the relay R340 in series with the intermediate winding of the relay R390, thereby to prevent operation of the relay R340 incident to the initiation at one of the subscriber substations of a subscriber substation call before the call from the substation A to the trunk line extending to the central exchange 20 has been completed. Further, the relay R320 completes at RA325 a path for applying ground potential to the control conductor C417 connected to the control conductor C406 of the calling subscriber line 403, this path extending from ground at RA325 by way of C417, RA395 and RA396 to the control conductor C406. This application of ground potential marks the subscriber line 403 as a calling line in the trunk finder-connector switch of the trunk circuit assigned to the use of the next central exchange call. Assuming that the first trunk circuit 60 is assigned, the trunk finder-connector switch 30 thereof is thus marked, this path extending from the control conductor C406 of the calling subscriber line 403 by way of the trunk line 200 to the contact in the contact bank 676 of the rotary switch 674 of the trunk finder switch 30 terminating this control conductor. Finally, the relay R320 completes at RA322 a path for applying ground potential to the control conductor C638 of the first trunk circuit, this path extending from ground at RA322 by way of the lower winding of R320, TA326, RA331, and RA363 and the back contact associated therewith to the control conductor C638.

When energized over the above-traced circuit, the relay R310 operates to interrupt at RA311 and the back contact associated therewith the original circuit for energizing the relay R320, the relay R320 being held in its operated position at this time from battery potential in the first trunk circuit in a manner more fully explained subsequently. Further, the relay R310 interrupts at RA312 and the back contact associated therewith a point in the circuit for energizing the relay R300, causing the latter relay to restore, and completes at RA312 and the front contact associated therewith a holding circuit for itself, this circuit extending from ground at RA323 by way of RA312 and the front contact associated therewith, and the lower winding of R310 to battery. Upon restoring, the relay R300 interrupts at RA301 the original circuit for energizing the relay R320.

The application of ground potential on the control conductor C638 causes the first trunk circuit 60 to be associated with the calling subscriber line 403, this trunk circuit being assigned for use as it is assumed to be idle. This application of ground potential to the control conductor C638 of the first trunk circuit completes a circuit for energizing the relay R750

and the thermostatic device T805, this circuit extending from ground at RA322 by way of the lower winding of R320, TA326, RA331, RA363 and the back contact associated therewith, C638, the switch springs 613 of the dial-split switch 610 at the attendant cabinet 40, C631, RA773 and C852 to the terminal of the lower winding of R750, one branch of this circuit extending from the lower terminal of the lower winding of R750 by way of the lower winding of R750 to battery, and the other branch extending from the lower terminal of the lower winding of R750 by way of the winding of T805 to battery. When energized over the above-traced circuit, the relay R750 operates to interrupt at RA758 the connection between the control conductor C638 and the control conductor C802, the control conductor C802 extending to the second trunk circuit. This connection between the control conductor C638 and C802 constitutes a chain circuit between the first trunk circuit and the second trunk circuit, thereby to render the second trunk circuit accessible to a calling subscriber line in the event the first trunk circuit is busy. Further, the relay R750 applies at RA755 multiple ground potential to the start conductor C822, thereby to prepare a circuit, traced hereinafter, for holding the relay R750 in its operated position independently of the restored condition of the relay R330 in the allotter 50. Further, the relay R750 connects the lower winding of the relay R720 to the wiper 675 of the rotary switch 674 of the trunk finder-connector switch 30, thereby to prepare a circuit for energizing the relay R720 when the wiper 675 of the rotary switch 670 is operated to the position of the contact in the associated contact bank 676 terminating the control conductor C406 of the calling line 403. Further the relay R750 applies ground potential at RA751 to the control conductor C829 of the link line 830 extending between the first trunk circuit 60 and the finder switches of the local finder links. In the case of the local link 21, this path extends from ground at RA751 by way of the control conductor C829 of the link line 830 to the contact in the contact bank 270 of the rotary switch 268 terminating the control conductor of the link line, thereby to mark the first trunk circuit 60 as busy to all of the local links, the finder switch 22 of the local link 21 being multipled to the connector switch 23 thereof and to the finder and connector switches of the other local links. Finally, the relay R750 completes a path for applying battery potential to the pulse ground lead C179, one branch of this path extending from battery at the winding of the motor M615 by way of the winding of M615 and C625 to RA723, another branch of this path extending from battery at the lower terminal of the upper winding of R740 and by way of the upper winding of R740 to RA723, and the common portion of the path extending from RA723 by way of RA752, C616 and C831 to the pulse ground lead C179. This application of battery potential to the pulse ground lead C179 causes the operation of the common equipment to be initiated as previously noted.

The ground pulses on the pulse ground lead C179 intermittently energize the motor M615 over the path previously traced, thereby to cause intermittent operation thereof. The intermittent operation of the motor M615 causes the wipers of the rotary switches of the trunk finder-connector switch 30, to be driven step by step in a counterclockwise direction over the associated contact banks, until the wiper 675 of the rotary switch 674 engages the contact in the associated contact bank 676 terminating the control conductor C406 of the calling subscriber line 403 as marked by ground potential thereon. Also, the ground pulses on pulse ground lead C179 energize the relay R740 over the path previously traced, thereby to cause operation thereof. Upon operating, the relay R740 completes at RA745 an obvious path for short-circuiting the lower winding thereof, thereby to render the relay R740 slow-to-release. Due to this slow-to-release characteristic of the relay R740, this relay does not restore during the impulsing period while the trunk finder-connector switch 30 is hunting the calling subscriber line. Further, the relay R740 interrupts, at RA741 and at RA742, the connections between the trunk conductors C624, C835 and C622, C836, respectively, of the first trunk circuit 60, the conductors C624 and C622 being connected to the wipers 687 and 683, respectively, of the rotary switches 686 and 682. As the positive and negative conductors of the subscriber lines terminate in the contact banks 684 and 688 of the rotary switches 682 and 686, respectively, this disconnection of the conductors C624 and C622 connected to the wipers 687 and 683 of the rotary switches 686 and 682, respectively, from the conductors C835 and C836, respectively, prevents the operation of the trunk finder-connector switch 30 from interfering with completed calls on the busy subscriber lines as the wipers of the rotary switches 682 and 686 are driven over the associated contact banks. Finally the relay R740 completes at RA744 and the front contact associated therewith a path for connecting the upper and intermediate windings of the relay R720 in multiple for a purpose more fully explained subsequently, this path extending from the lower terminal of the upper winding of R720 by way of the upper winding of R720, RA744 and the front contact associated therewith and the intermediate winding of R720 to the lower terminal of the upper winding of R720.

The energization of the thermostatic device T805 causes the thermal responsive element thereof to become heated, which element, after being heated for a predetermined time interval, operates to reconnect at TA806 the control conductor C838 to the control conductor C802, thereby to extend ground potential into the second trunk circuit. This operation of the thermostatic device T805 occurs after a predetermined time interval, thereby to render the second trunk circuit operative to cause the trunk finder-connector switch thereof to operate and find the subscriber line 403 in the event the trunk finder-connector switch 30 of the first trunk circuit 60 does not find the calling line 403 in this predetermined time interval.

When the wiper 675 of the rotary switch 674 is rotated to a position corresponding to the position of contact in the associated contact bank 676 terminating the control conductor C406 of the calling subscriber line 403, a circuit for energizing the relay R720 is completed, this circuit extending from ground at RA325 by way of C417, RA395, RA396, the control conductor C406 of the subscriber line 403, the trunk line 200, the contact in the contact bank 676 of the rotary switch 674 terminating the control conductor C406 of the subscriber line 403, the associated wiper 675, C617, RA756 and the lower winding of F720 to battery. When energized over the

above-traced circuit, the relay R720 operates to interrupt at RA723 the path for energizing the motor M615 and the relay R740 from the pulse ground lead C179, thereby to cause further operation of the motor M615 to be arrested and to cause the relay R740 to restore shortly thereafter. Further, the relay R720 completes at RA724 a circuit for illuminating the answer and supervisory lamp 564 located at the attendant cabinet 40, this circuit extending from ground at RA724 by way of C838, RA902 and the back contact associated therewith, C846, the resistor 784, RA782 and the back contact associated therewith, C641, the switch spring 571 of the night switch 570 and the lamp 564 to battery. It will be noted that the circuit for illuminating the answer and supervisory lamp 564 includes the resistor 784, thereby causing the lamp 564 to be illuminated dimly. This illumination of the answer and supervisory lamp 564 indicates to the attendant at the attendant cabinet 40 that the first trunk circuit 60 is busy. Further, the relay R720 completes at RA727 a circuit for energizing in series the lower winding of the relay R390 associated with the calling subscriber line 403, and the multiple connected upper and intermediate windings of the relay R720. This circuit extends from ground at RA754 by way of C843 to RA727, one branch extending from RA727 by way of RA744 and the front contact associated therewith and the upper winding of R720 to C619, and the other branch extending from RA727 by way of the intermediate winding of R720 to C619, the circuit further extending from C619 by way of the wiper 679 of the rotary switch 678, the contact in the associated contact bank 680 terminating the control conductor C407 of the subscriber line 403, the trunk line 200, the control conductor C407 of the subscriber line 403, and the lower winding of R390 to battery. When energized over the above-traced circuit the relay R390 operates completely.

Upon operating completely, the relay R390 interrupts at RA391 and at RA392 points in the circuit for energizing the relay R340 in the allotter 50, thereby to prevent operation of the relay R340 and the consequent association of a local link with the calling subscriber line 403 when the receiver of the telephone instrument at the substation A is removed from its hook. Further, the relay R390 interrupts at RA395 a point in the original circuit for energizing the lower winding of the relay R720. The application of ground potential through the multiple connected upper and intermediate windings of the relay R720 and the rotary switch 678 to the control conductor C407 of the subscriber line 403 marks the subscriber line 403 as busy in the other trunk finder-connector switches and in the local links. Further, upon operating, the relay R720 completes at RA729 a circuit for energizing in series the relay R770 and the thermostatic device T810, this circuit extending from ground at TA811 by way of C861, RA729, C860, the winding of T810, RA767 and the back contact associated therewith, C778 and the winding of R770 to battery. Finally, the relay R720 completes at RA721 a path for applying ground potential to the negative line conductor of the calling subscriber line 403 and at RA722 and the front contact associated therewith a path for applying direct generating potential from the generator lead C800 by way of the lower winding of R760, to the positive line conductor of the subscriber line 403. The application of ground potential to the negative line conductor and the application of direct generator potential to the positive line conductor of the calling subscriber line 403 completes a circuit for operating the ringer at the substation A, this circuit extending from ground at RA762 and the back contact associated therewith, by way of C860, RA721, C624, the wiper 687 of the rotary switch 686, the contact in the associated contact bank 688 terminating the negative line conductor of the subscriber line 403, the trunk line 200, the negative line conductor C408 of the subscriber line 403, RA432, C408, the bridge between C408 and C409 including a ringer and a condenser at the substation A, C409, RA431, the positive line conductor C409 of the subscriber line 403, the trunk line 200, the contact in the contact bank 684 of the rotary switch 682 terminating the positive line conductor of the subscriber line 403, the associated wiper 683, C622, RA722 and the front contact associated therewith, C861, RA763 and the back contact associated therewith, C779, the lower winding of R760, RA714 and the back contact associated therewith, and the direct generator lead C800 to the ungrounded terminal of the generator, the other terminal of the generator being connected to ground. The operation of the ringer at the substation A indicates to the subscriber thereat that a trunk circuit has been associated with the subscriber line 403 extending to the subscriber substation A and is available for use.

Upon restoring the relay R740 prepares at RA741 and at RA742 the transmission circuit between the positive and negative conductors of the subscriber line 403 and the trunk conductors C835 and C836 of the first trunk circuit 60. At this time the trunk conductor C624 connected to the negative line conductor of the subscriber line by way of the rotary switch 686 is connected by way of RA741 and the condenser 812 to the trunk conductor C835, and the trunk conductor C622 connected to the positive line conductor of the subscriber line by way of the rotary switch 682 is connected by way of the condenser 815, RA742 and the condenser 813 to the trunk conductor C836. When the relay R770 is energized over the previously-traced circuit, it operates to complete at RA771 a path for applying ground potential to the control conductor C407 of the subscriber line 403, thereby to retain energized the intermediate winding of the relay R720 subsequent to the restoration of the relay R750. This circuit extends from ground at the switch spring 605 of the connect switch 600 located at the attendant cabinet 40 by way of the switch spring 606, C630, RA771, C843, RA727, the intermediate winding of R720, C619, the wiper 679 of the rotary switch 678 terminating the control conductor C407 of the subscriber line 403, the trunk line 200, the control conductor C407 of the subscriber line 403 and the lower winding of R390 to battery. This application of ground potential to the control conductor C407 of the subscriber line 403 marks the subscriber line 403 as busy, as previously explained. Further the relay R770 applies ground at RA775 to the conductor C635 for a purpose more fully described subsequently and interrupts at RA773 the circuit for energizing the multiple connected lower winding of the relay R750 and the thermostatic device T805 in series with the lower winding of the relay R320 in the allotter 50, thereby to cause the relays R750 and R320 to restore. Further, the relay R770 completes at RA776 a

path for applying ground potential to the motor start lead C1007, this path extending from ground at RA768 by way of RA776 and C864 to the motor start lead C1007. The application of ground potential to the motor start lead C1007 maintains the common equipment in operation. Finally, the relay R770 completes at RA774 a circuit for energizing the relay R950, this circuit extending from ground at RA793 by way of C855, RA774, C856 and the lower winding of R950 to battery.

Upon restoring, the relay R320 in the allotter 50 interrupts at RA322 a further point in the circuit for energizing the lower winding thereof and for applying ground potential to the control conductor C638 extending to the first trunk circuit 60, interrupts at RA321 the circuit for energizing in multiple the upper winding of R310 and the winding of the thermostatic device T325, and interrupts at RA323 a point in the holding circuit of the relay R310, causing the latter relay to restore. Also, the relay R320 interrupts at RA323 the original circuit for energizing in series the upper and intermediate windings of the relay R390, the relay R390 being retained in its operated position at this time due to the application of ground potential to the control conductor C407 of the subscriber line 403 in the first trunk circuit 60 as previously noted. Further, the relay R320 prepares at RA324 a point in the circuit for energizing the relay R340 in the allotter 50, thereby to condition this relay to be operated when the next subscriber substation call is initiated at one of the subscriber substations. Finally, the relay R320 interrupts at RA325 the application of ground potential to the control conductor C406 of the subscriber line 403, thereby to interrupt a further point in the circuit for energizing the lower winding of the relay R720 in the first trunk circuit 60. Upon restoring, the relay R310 in the allotter 50 prepares at RA311 and the back contact assoicated therewith a point in the circuit for energizing the upper winding of the relay R320 and prepares at RA312 and the back contact associated therewith a point in the circuit for energizing the relay R300 thereby to condition the relay R300 to be operated when the next central exchange call is initiated at one of the subscriber substations.

Upon restoring, the relay R750 in the first trunk circuit 60 connects the control conductor C638 extending to the first trunk circuit 60 to the control conductor C802 extending to the second trunk circuit, thereby rendering the next idle trunk circuit available to be seized when an outgoing central exchange call is initiated at one of the subscriber substations. At this time the relay R770 is held in its operated position over the energizing circuit including the winding of the thermostatic device T810 and the armature TA811 thereof. After a predetermined time interval, the thermal responsive element of the thermostatic device T810 operates to interrupt at TA811 the circuit for energizing the relay R770, in the event that the subscriber at the substation A does not remove the receiver of the telephone instrument thereat from its hook in order to cause the circuit to be completed for energizing the relay R770 independently of the thermostatic device T810. Thus, the subscriber at the substation A has a predetermined time interval within which to remove the receiver of the telephone instrument from its hook after the operation of the ringer at the substation A is initiated. In the event the subscriber at the substation A does not remove the receiver of the telephone instrument thereat from its hook within this predetermined time interval, the relay R770 restores as previously noted, thereby to cause the first trunk circuit 60 to be released in a manner more fully described subsequently.

The subscriber at the substation A then completes the connection between the substation A and the first trunk circuit 60 by removing the receiver of the telephone instrument at the substation A from its hook, thereby to complete a bridge connection including the telephone instrument at the substation A across the line conductors C408 and C409 of the subscriber line 403. When this bridge connection is completed, a circuit for energizing the lower winding of the relay R760 is completed, this circuit being substantially the same as the circuit for projecting ringing current over the subscriber line 403. When the lower winding of the relay R760 is energized over this circuit it operates and completes at RA766 a holding circuit for itself extending from the grounded conductor C630 by way of RA771, C843, RA726, C844, RA776 and the upper winding of R760 to battery. Also, the relay R760 interrupts at RA762 and the back contact associated therewith and at RA763 and the back contact associated therewith the circuit for projecting ringing current over the subscriber line 403 to the substation A and completes at RA762 and the front contact associated therewith and at RA763 and the front contact associated therewith a metallic loop between the subscriber line and the relays R900 and R790, this connection extending from ground at the upper terminal of the lower winding of R790 by way of the lower winding of R790, C848, the lower winding of R900, C836, RA763 and the front contact associated therewith, C861, RA722 and the front contact associated therewith, C622 and the rotary switch 682 to the positive conductor C409 of the subscriber line 403, the bridge across the positive and negative line conductors at the substation A to the negative line conductor C408, and from C408 by way of the rotary switch 686, C624, RA721, C860, RA762 and the front contact associated therewith, C835, the upper winding of R900 and the upper winding of R790 to battery. Finally, the relay R760 interrupts at RA767 and the back contact associated therewith the circuit for energizing in series the relay R770 and the thermostatic device T810. The relay R770, being of the slow-to-release type, does not immediately restore and the holding circuit therefore is completed by the operation of the relay R790 in a manner more fully described subsequently. When the metallic loop circuit is completed between the telephone instrument at the substation A and the relays R900 and R790, the relay R790 is operated; however, the relay R900 is not operated, as the energizing currents traversing the upper and lower windings thereof are in opposite directions, the relay R900 being of the differential type. Upon operating, the relay R790 completes at RA793 and the front contact associated therewith an obvious circuit for holding the relay R770 in its operated position and interrupts at RA793 and the back contact associated therewith the circuit for energizing the relay R950, causing the latter relay to restore. Finally, the relay R790 completes at RA791 a path for connecting the relay R920 across the positive and negative trunk leads C1011 and C1010, respectively, of the trunk circuit 60, the positive trunk lead C1011 being connected by

way of RA943 and the back contact associated therewith, the winding of R920, C834, RA791, C833 and RA942 and the back contact associated therewith to the negative trunk lead C1010. At this time the positive and negative trunk conductors C1011 and C1010 of the first trunk line 60 are respectively connected by way of RA982 and the back contact associated therewith and by way of RA981 and the back contact associated therewith to the positive and negative conductors C1004 and C1003, respectively, of the trunk line 1005 extending to the central exchange 20. It will be noted that the established connection between the substation A and the trunk line 1005 by way of the first trunk circuit 60 does not include a local link in the P. A. B. X.

The subsequent operations which are performed at the subscriber substation A and at the central exchange 20 depend upon the character of the central exchange 20. In the event the central exchange 20 is of the automatic type, the subscriber at the called substation A is connected through to the central office, causing the finder switch of the switch train in the central exchange to seize the trunk line 1005 and return dial tone current thereover by way of the first trunk circuit 60 and the subscriber line 403 to the subscriber substation A. The subscriber at the substation A then dials the directory number of the desired subscriber line terminating at the central exchange 20 and accessible to the switch train therein associated with the trunk line 1005 in the usual manner, thereby to cause the switch train to seize the desired subscriber line. The relay R790 included in the metallic loop circuit extending to the calling subscriber substation A follows the impulses of each digit dialed at the substation A. Each time the metallic loop circuit is interrupted at the dialing mechanism at the substation A, the relay R790 restores, and each time the metallic loop circuit is completed at the dialing mechanism at the substation A the relay R790 reoperates. Upon restoring, the relay R790 interrupts at RA791 the loop circuit extending by way of the trunk line 1005 and including the relay R920 to the central exchange 20 and, upon reoperating, the relay R790 recompletes at RA791 this loop circuit extending to the central exchange. Thus, the relay R790 repeats the impulses received over the metallic loop circuit extending to the subscriber substation A to the loop circuit extending to the central exchange 20. Further, the relay R790 repeats the impulses to the relay R950 by opening and closing at RA793 and the back contact associated therewith the circuit for energizing the lower winding of R950. When energized, the relay R950 operates to complete at RA955 and the front contact associated therewith an obvious circuit for short-circuiting the upper winding thereof, thereby to render the relay R950 slow to release. Accordingly, the relay R950 remains in its operated position during each series of impulses repeated thereto by the relay R790. Further, the relay R950 completes at RA952 an obvious path for short-circuiting the winding of the relay R920, thereby to reduce the impedance of the loop circuit extending to the central exchange 20 in order to improve the impulse transmission qualities thereof. Finally, the relay R950 completes at RA953 an obvious path for connecting the resistor 966 in multiple with the dialing mechanism at the subscriber substation A, thereby to complete a relatively high resistance shunt circuit extending from ground at the upper terminal of the lower winding of R790 through the lower winding of R790, C848, the lower winding of R900, RA953, the resistor 966, the upper winding of R900, C847 and the upper winding of R790 to battery. This relatively high shunt circuit renders the relay R790 relatively fast to operate, thereby to improve the impulse following characteristic of the relay R790.

In the event the central exchange 20 is of the manual common battery type, the operator thereat is signaled when the winding of the relay R920 is connected at RA791 by the operation of the relay R790 across the positive and negative conductors of the first trunk circuit 60, connected by way of the trunk line 1005 to the central exchange 20. The operator in the central exchange, in this event, answers the call in the usual manner and receives the information concerning the desired connection from the subscriber at the substation A. The operator in the central exchange then sets up a connection between the trunk line 1005 and the desired subscriber line in the usual manner.

In the event the central exchange 20 is of the manual local battery type, after the connection is established between the substation A and the trunk line 1005 by way of the subscriber line 403 and the first trunk circuit 60, the subscriber at the substation A dials an appropriate digit. The relay R790 follows the impulses comprising the digit dialed at the subscriber substation A as previously explained. On the first impulse, when the relay R790 restores, it completes at RA792 a circuit for energizing the relay R980, this circuit extending from the grounded conductor C630 by way of RA771, C843, RA792, C842, RA764, C841, RA945, the "Z" wiring illustrated, RA974 and the winding of R980 to battery. When energized over the above-traced circuit, the relay R980 operates to complete at RA981 and the front contact associated therewith and at RA982 and the front contact associated therewith a circuit for ringing down the drop or other signal in the central exchange, this circuit extending from the ungrounded terminal of direct generator by way of the direct generator lead C1002, RA981 and the front contact associated therewith, C1003, the winding of the drop or other signal device in the central exchange 20 connected across the line conductors C1003 and C1004 of the trunk line 1005, C1004 and RA982 and the front contact associated therewith to ground, the other terminal of the generator being connected to ground. The drop or other signal in the central exchange 20 is actuated by the ringing current projected over the line 1005 in order to attract the attention of the operator in the central exchange. The relay R790 follows the impulses comprising the digit dialed at the substation A, thereby to intermittently complete the circuit for energizing the relay R980. As the relay R980 is of the slow-to-release type, it does not restore during the series of impulses comprising the digit dialed at the substation A. At the conclusion of the digit dialed at the substation A, the relay R790 reoperates to interrupt at RA792 the circuit for energizing the relay R980, causing the latter relay to restore shortly thereafter. Upon restoring, the relay R980 disconnects the positive and negative line conductors of the trunk line 1005 at RA982 and the front contact associated therewith and at RA981 and the front contact associated therewith, respectively, from ground and the direct generator lead C1002, respectively. Further, the relay R980

connects the positive and negative line conductors C1004 and C1003, respectively, of the trunk line 1005 to the positive and negative conductors C1011 and C1010 respectively of the first trunk circuit 60, thereby to recomplete the connection between the subscriber substation A and the trunk line 1005 by way of the subscriber line 403 and the first trunk circuit 60. The operator in the central exchange 20 then receives the information concerning the desired substation and sets up the connection between the trunk line 1005 and the desired subscriber line terminating at the central exchange in the usual manner.

More particularly, the loop circuit extending to the subscriber substation A is connected to the loop circuit extending to the central exchange 20 by way of the voice frequency current condensers 969 and 968, the trunk conductor C835 being connected by way of the condenser 969, the "Z" wiring illustrated, when the central exchange is of the manual local battery type, C834, RA791, C833 and RA942 and the back contact associated therewith to the negative trunk conductor C1010, and the trunk conductor C836 being connected by way of the condenser 968, the "Z" wiring illustrated, when the central exchange is of the manual local battery type, and RA943 and the back contact associated therewith to the positive trunk conductor C1011. It is noted that, when the central office 20 is of the automatic or manual common battery type, the trunk conductor C835 is connected to the trunk conductor C834 by way of the condenesr 968 and RA921, the "Z" wiring illustrated being omitted, and the trunk conductor C836 is connected to the relay armature RA943 by way of the condenser 968 and RA923, the "Z" wiring illustrated being omitted. Talking battery is supplied to the subscriber substation A over the loop extending thereto from ground and battery potentials associated with the upper terminal of the lower winding and the lower terminal of the upper winding, respectively, of the relay R790, and talking battery is supplied to the loop circuit extending to the called subscriber substation from a battery disposed in the central exchange 20.

The release of the established connection between the subscriber substation A and the called subscriber line terminating at the central exchange 20 is primarily under the control of the subscriber at the substation A and is influenced by the character of the central exchange 20, as is more fully described subsequently. When the receiver of the telephone instrument at the subscriber substation A is replaced upon its hook, the loop circuit between the substation A and the relay R790 is interrupted, causing the latter relay to restore. Upon restoring, the relay R790 interrupts at RA791 the loop circuit extending by way of the trunk line 1005 to the central exchange 20, thereby to cause the switch train and other apparatus in the central exchange to be released in the event the central exchange is of the automatic type or to give disconnect supervision to the operator in the central exchange 20 in the event the central exchange is of the manual common battery type. In the event the central exchange is of the automatic type, the interruption of the loop circuit extending thereto by way of the trunk line 1005 causes a portion of the apparatus in the central exchange to be released, the release of the remainder of the apparatus in the central exchange being under the control of the called subscriber. Further, the relay R790 interrupts at RA793 and the front contact associated therewith, the circuit for holding the relay R770 operated and completes at RA793 and the back contact associated therewith the circuit for energizing the lower winding of the relay R950. In the event the central exchange 20 is of the manual local battery type, the relay R790 completes at RA792 the circuit for energizing the relay R980, causing the relay R980 to operate. Upon operating, the relay R980 connects the positive and negative line conductors of the trunk line 1005 to ground and the direct generator lead C1002, thereby to cause ringing current to be projected over the trunk line 1005 as previously explained. The ringing current projected over the trunk line 1005 signals the operator at the central exchange 20 that the connection to the substation A has been released. The operator in the central exchange 20 then takes down the connections to the called substation in the usual manner.

In the event the central exchange 20 is of the automatic type, the relay R770 restores shortly after its holding circuit is interrupted by the restoration of the relay R790. Upon restoring, the relay R770 interrupts at RA771 the circuit for energizing the intermediate winding of the relay R720 in series with the lower winding of the relay R390 associated with the subscriber line 403 causing the latter relays to restore. Upon restoring, the relay R390 prepares at RA391 and RA392 points in the circuit for energizing the relay R340 in the allotter 50 when the next subscriber substation call at the substation A is initiated. The interruption at RA771 of the circuit for energizing in series the intermediate winding of R720 and the lower winding of R390 also removes ground potential from the control conductor C407 of the subscriber line 403, the presence of which marks the subscriber line 403 as busy. At this time, the subscriber line 403 and the apparatus associated therewith is completely released for further use. Further, the relay R770 interrupts at RA771 the circuit for energizing the upper winding of the relay R760, causing the latter relay to restore.

Upon restoring, the relay R720 completes at RA723 the path for connecting the winding of the motor M615 and the upper winding of the relay R740 to the pulse ground lead C179, one branch of this path extending from battery at the winding of the motor M615 by way of the winding of M615, C625, to RA723, and the other branch extending from battery at the lower terminal of the upper winding of R740 by way of the upper winding of R740 to RA723, the path extending from RA723 by way of RA712 and the back contact associated therewith, C837, RA931, C615, the multiple connected contacts in the contact bank 672 of the rotary switch 670, the associated wiper 671, C616 and C831 to the pulse ground lead C179. This application of battery potential to the pulse ground lead C179 initiates the operation of the common equipment connected thereto, thereby to cause the common equipment to transmit ground impulses by way of the path previously traced for intermittently energizing the motor M615 and the upper winding of the relay R740. When energized over the above-traced circuit, the relay R740 operates to complete at RA745 an obvious circuit for short-circuiting the lower winding thereof, thereby to render the relay R740 slow to release. Accordingly, the relay R740 does not restore during the impulsing period. Further, the relay R740 interrupts at RA741 and RA742 the connections between the

trunk conductors C624, C835 and C622, C836, thereby to prevent the movement of the wipers 687 and 683 of the rotary switches 686 and 682 connected to the trunk conductors C624 and C622, respectively, over the contacts in the associated contact banks 688 and 684, respectively, from interfering with established connections including other of the subscriber substations.

The intermittent energization of the motor M615 causes intermittent operation thereof which drives the wipers of the rotary switches 670, 674, 678, 682, and 686 comprising the trunk finder switch 30 in a counterclockwise direction back into their twenty-fifth or home positions. When the wiper 671 of the rotary switch 670 is driven into its twenty-fifth or home position it disengages the multiple connected contacts in the associated contact bank 672, thereby to interrupt the circuit for energizing the winding of the motor M615 and the upper winding of the relay R740 from the pulse ground lead C179. Shortly thereafter, the relay R740 restores and further operation of the motor M615 is arrested. At this time, the first trunk circuit 60 is completely released for further use.

When the trunk line 1005 is connected to either a manual common battery or a manual local battery central exchange 20, an auxiliary circuit for energizing the relay R770 is completed, when the relay R790 restores. Upon restoring the relay R790 interrupts the normally completed path for short-circuiting the thermostatic device T815, this path for normally short-circuiting the thermostatic device T815 extending from ground at RA793 and the front contact associated therewith by way of C778, RA767 and the front contact associated therewith, RA772, TA816, the "Y" wiring illustrated, the winding of T815, C862, RA979' and the back contact associated therewith, RA934 and the back contact associated therewith and C861 to ground at TA811. When this path for short-circuiting the thermostatic device T815 is interrupted at RA793 and the front contact associated therewith, upon the restoration of the relay R790, the relay R770 is energized in series with the thermostatic device T815, this circuit extending from ground at TA811 by way of C861, RA934, and the back contact associated therewith, RA979' and the back contact associated therewith, C862, the winding of T815, the "Y" wiring illustrated, TA816, RA772, RA767 and the front contact associated therewith, C778 and the winding of R770 to battery. The energization of the relay R770 over the above-traced circuit retains the relay R770 in its operated position, thereby to retain the relays R720 and R760 in their operated positions and to prevent the release of the first trunk circuit 60. After a predetermined time interval, the thermal responsive element of the thermostatic device T815 operates to interrupt at TA816 the above-traced circuit for energizing the relay R770 in series with the thermostatic device T815, thereby to cause the relay R770 to restore shortly thereafter. The restoration of the relay R770 causes the relays R720 and R760 to restore, thereby to release the first trunk circuit 60 as previously explained. Thus, the release of the first trunk circuit 60 is delayed for a predetermined time interval after the receiver of the telephone instrument at the subscriber substation A is replaced upon its hook in the event the trunk line 1005 is connected to a central exchange of either the manual common battery or the local battery type. This delayed release of the first trunk circuit 60 provides a time interval for the operator in the central exchange 20 to disconnect from the trunk line 1005 before the subscriber substation A is released, thereby to reduce the possibility of a subscriber substation seizing the first trunk circuit for an outgoing call before the central exchange end of the connection is released.

When the first trunk circuit 60 is busy, the relay R770 occupies its operated position, thereby to interrupt, at RA773, the previously traced circuit for energizing the lower winding of R750 in the first trunk circuit 60 in series with the lower winding of the relay R320 in the allotter 50. Also, the relay R750 in the first trunk circuit 60 occupies its restored position, thereby to connect the control conductor C638 extending to the first trunk circuit to the control conductor C602 extending to the second trunk circuit. Accordingly, it will be understood that, when all of the trunk circuits are busy, all of the relays corresponding to the relay R770 will occupy their operated positions and there will be no relay in any one of the trunk circuits corresponding to the relay R750 which may be energized in series with the relay R320 in the allotter 50. Accordingly, at this time, when an outgoing trunk call is initiated at one of the authorized subscriber substations, the relay R320 in the allotter 50 is not held energized in series with a relay corresponding to the relay R750 in an idle one of the trunk circuits. Accordingly, when the grounding push button at the calling authorized subscriber substation is restored to its normal position, thereby to interrupt the circuit for energizing the intermediate winding of the relay corresponding to the relay R390 and associated with the calling subscriber line, the latter relay restores, the circuit for energizing the upper and lower windings of this relay by way of the start lead C419 being incompleted due to the fact that the relay R320 is restored. Under these conditions the relay R310 in the allotter 50 is retained in its operated position by way of the start lead C419 only as long as the relay corresponding to R390 remains in its operated position. Thus, when the grounding push button at the authorized subscriber substation is restored to its normal position, the relay R310 restores, the allotter 50 being completely released at this time. Accordingly, the ringer at the authorized subscriber substation is not rung shortly after the grounding push button thereat is restored to its normal position as previously explained, as no trunk circuit seized the calling subscriber line, all of the trunk circuits being busy at this time, as previously assumed. This non-operation of the ringer at the authorized subscriber substation attempting to initiate an outgoing trunk call indicates to the subscriber thereat the all-busy condition of the trunk circuits.

Semi-authorized substation to central exchange calls

A subscriber at a semi-authorized substation may obtain a connection to the central exchange only with the assistance of the attendant at the attendant cabinet. For example, in initiating a call from the semi-authorized substation B which is to be completed to the central exchange 20, the subscriber at the substation B first removes the receiver of the telephone instrument thereat from its hook, thereby to cause operation of the relay R380 associated with the subscriber line 402 in a manner similar to that previously described in connection with the initiation of a call between the authorized subscriber substation A and the semi-authorized subscriber substation B. This operation of the relay R380 causes operation of the relay R340 in the allotter

50 in the manner previously described. Assuming that the first local link 21 is assigned to the use of the call initiated at the subscriber substation B, the operations of the relay R350 in the allotter and the relay R130 in the local link 21 are the same as previously described. The other relays in the local link 21 operate as previously explained in order to cause the finder switch 22 to find the calling subscriber line 402. After the calling subscriber line 402 is found by the finder switch 22, the local link is in condition to be responsive to the first series of digits dialed at the substation B. As previously noted, the positive and negative conductors C652 and C651, respectively, of the information trunk 650 terminate in the contact banks of the rotary switches 22 and 256, respectively, in the third groups of contacts in these contact banks, the directory number of the information trunk being 004 as previously noted. Accordingly, the digits 0, 0 and 4 are successively dialed at the calling substation B, thereby to cause the connector switch 23 of the local link 21 to seize the information trunk 650.

The subsequent operation of the apparatus in the local link 21 depends upon the idle or busy condition of the information trunk 650 as previously explained. In the event that the information trunk 650 is busy, the relay R280 associated therewith occupies its operated position and ground potential appears upon the control conductor C659 causing the relay R100 to be short-circuited as previously explained. The ground potential appearing upon the control conductor C659 of the information trunk 650 is derived by way of the control conductor C284 in the finder switch of a local link in the event the information trunk 650 is rendered busy by the initiation of a call thereover at the attendant position 40, and the ground potential appearing upon the control conductor C659 of the information trunk 650 is derived by way of a conductor corresponding to the conductor C225 in the connector switch of one of the local links in the event the information trunk is rendered busy by the completion of a call thereover initiated at one of the other subscriber substations. Accordingly, the relay R100 is not operated and busy tone current is returned over the subscriber line 402 to the receiver of the telephone instrument at the subscriber substation B, thereby to indicate to the subscriber thereat that the call to the attendant cabinet 40 can not immediately be completed, in a manner similar to that previously explained in connection with the return of busy tone current to the subscriber substation A.

In the event the information trunk 650 is idle at this time, battery potential appears upon the control conductor C659 thereof, thereby to cause the relays R100 and R280 to be operated as previously explained, this potential being derived from battery at the upper terminal of the lower winding of the relay R280. Upon operating, the relay R100 completes at RA103 and RA104 a circuit for projecting ringing current over the information trunk 650, this circuit extending from the ungrounded terminal of a source of ringing current by way of C106, the upper winding of R120, RA125 and the back contact associated therewith, RA103, C227, the wiper 253 of the rotary switch 252, the contact in the associated contact bank 254 terminating the positive conductor of the information trunk, the trunk line 200, C652, the condenser 653, the ringer 561 at the attendant cabinet 40, C651, the trunk line 200, the contact in the contact bank of the rotary switch 256 terminating the negative conductor of the information trunk, the associated wiper 257, C230, RA104 and RA126 and the back contact associated therewith to ground, the other terminal of the source of ringing current being connected to ground. The operation of the ringer 561 at the attendant cabinet 40 indicates to the attendant thereat that a call to be answered is on the information trunk 650.

The attendant at the attendant cabinet 40 answers the call on the information trunk 650 by operating the information trunk switch 593 to its front position, thereby to connect the impedance 500 across the positive and negative conductors C652 and C651, respectively, of the information trunk 650. The path for connecting the impedance 500 across the positive and negative line conductors of the information trunk 650 extends from the negative line conductor C651 by way of the switch spring 594 and the front contact associated therewith, C654, RA531, RA512, C657, the impedance 500, C655 and the switch spring 595 and the front contact associated therewith to the positive line conductor C652. The connection of the impedance 500 across the positive and negative line conductors of the information trunk 650 completes a low resistance circuit similar to the previously traced circuit for projecting ringing current over the information trunk 650 to the ringer 561 for energizing the upper winding of the relay R120, thereby to cause the relay R120 to operate shortly thereafter, this relay R120 being of the slow-to-operate type. Upon operating, the relay R120 interrupts the projection of ringing current over the information trunk 650 and completes a connection between the rotary switches 252 and 256 in the connector switch 23 and the rotary switches 264 and 260, respectively, in the finder switch 22, of the local link 21, thereby to complete a loop circuit between the telephone instrument at the subscriber substation B and the telephone instrument at the attendant cabinet 40, one terminal of the transmitter 565 of the telephone instrument at the attendant cabinet 40 being connected by way of the condenser 660, to the conductor C657 and the other terminal of the transmitter being connected by way of the intermediate winding 579 of the repeater 577 and the condenser 661 to the conductor 655, and the receiver 566 of the telephone instrument at the attendant cabinet 40 being connected across the terminals of the right-hand winding 580 of the repeater 577. Also, the repeater 577 is provided with a left-hand winding 578 which is connected in a path including a condenser 581 across the terminals of the transmitter 565, the windings 578 and 580 of the repeater 577 being inductively coupled and arranged in such a manner that side tones generated by the transmitter 565 are suppressed in order to prevent objectionable side tones in the receiver 566.

Also, when the information trunk switch 593 is operated to its front position, an obvious circuit is completed at the switch spring 596 and the front contact associated therewith for energizing the relay R540, causing this relay to operate. Upon operating, the relay R540 completes at RA543 and the front contact associated therewith an obvious path for short-circuiting the thermostatic device T570 and completes at RA542 and the front contact associated therewith a path for applying ground potential to the motor start lead C641, the latter path extending from the grounded switch spring 572 of the night switch 570 and the

back contact associated therewith by way of RA542 and the front contact associated therewith to the motor start lead C641. The application of ground potential to the motor start lead C641 initiates the operation of the common equipment. The attendant at the attendant cabinet 40 is then advised by the subscriber at the substation B concerning the particular central exchange connection desired. The subscriber at the substation B then replaces the receiver of the telephone instrument thereat upon its hook, thereby to cause the release of the relay R380 associated with the subscriber line 402, the release of the relay R280 associated with the information trunk 650, and the release of the local link 21, in the manner previously described in connection with the release of the established connection between the subscriber substations A and B, and waits for the attendant at the attendant cabinet 40 to establish the desired central office exchange connection and forward it to the subscriber substation B. The attendant at the attendant cabinet 40 disconnects the telephone instrument thereat from the information trunk 650 by operating the information trunk switch 593 to its back position. When the information trunk switch 593 is operated to its back position, the circuit for energizing the relay R540 is interrupted, thereby to cause the relay R540 to restore shortly thereafter, this relay being of the slow-to-release type.

The attendant at the attendant cabinet 40 initiates the outgoing call to the central exchange 20 by operating the connect switch of an idle trunk circuit to its front position. Assuming that the first trunk circuit 60 is idle, the connect switch 600 is operated to its front position, thereby to complete a loop circuit between the impedance 500 and the relays R900 and R790, in the first trunk circuit, the telephone instrument at the attendant cabinet 40 being associated with the terminals of the impedance 500 as previously noted. This loop circuit extends from ground at the upper terminal of the lower winding of R790 by way of the lower winding of R790, C848, the lower winding of R900, C836, C623, the switch spring 603 of the connect switch 600 and the front contact associated therewith, the switch spring 595 of the information trunk switch 593 and the back contact associated therewith, C655, the impedance 500, C657, RA512, RA531, C654, the switch spring 594 of the information trunk switch 593 and the back contact associated therewith, the switch spring 601 of the connect switch 600 and the front contact associated therewith, C620, C835, the upper winding of R900, C847 and the upper winding of R790 to battery. When energized over the above-traced circuit, the relay R790 operates; however, the relay R900, being of the differential type, does not operate, as previously noted. Also, the operation of the connect switch 600 to its front position completes at the switch spring 609 and the front contact associated therewith an obvious circuit for energizing the relay R540, thereby to cause this relay to operate as previously explained.

Upon operating, the relay R790 completes at RA791 the previously traced loop circuit including the relay R920 extending by way of the trunk line 1005 to the central exchange 20 and completes at RA793 and the front contact associated therewith the circuit for energizing the relay R770. When energized, the relay R770 operates as previously noted to interrupt at RA773 a point in the circuit for energizing in multiple the lower winding of the relay R750 and the winding of the thermostatic device T805 by way of the control conductor C638 extending to the first trunk circuit 60, thereby to prevent the seizure of the first trunk circuit upon operation of the relay R320 in the allotter 50 incident to the initiation of an outgoing central exchange call on another of the authorized subscriber substations. Further, the relay R770 completes at RA776 the path for applying ground potential to the motor start lead C1007, thereby to provide a circuit for retaining the common equipment in operation subsequent to the restoration of the relay R540.

In the event the central exchange 20 is automatic, the attendant at the attendant cabinet 40 dials at the dialing mechanism 582 a series of digits corresponding to the directory number of the desired subscriber line terminating at the central exchange, thereby to cause the switch train therein to seize the desired line in the usual manner, busy tone current being returned over the trunk line 1005 in the event the desired called line is busy and ring-back tone current being returned over the trunk line 1005 in the event the desired called line is idle, incident to the projection of ringing current over the desired called line, in a well known manner. When the dialing mechanism 582 is operated to its off-normal position at the beginning of a digit, the switch springs 586 and 587 are moved into engagement, thereby to complete an obvious path for short-circuiting the receiver 566 of the telephone instrument at the attendant cabinet 40 in order to eliminate clicks in the receiver corresponding to the impulses being transmitted. Also, the switch springs 584 and 585 are moved into engagement, thereby to complete an obvious path for short-circuiting the impedance 500, in order to provide a low impedance loop circuit including the relay R790. The impulsing springs 583 are alternately moved into engagement and into disengagement a number of times corresponding to the digit being dialed at the dialing mechanism 582. When the impulsing springs 583 are moved into engagement, an obvious circuit is completed for energizing the relay R510 and, when the impulsing springs 583 are moved into disengagement, this circuit is interrupted, thereby to cause the relay R510 to follow, by alternately operating and restoring, the impulses comprising the digit dialed. Upon operating, the relay R510 interrupts, at RA512, the loop circuit including the relay R790 and, upon restoring, the relay R510 completes at RA512 the loop circuit including the relay R790. Accordingly, the impulses are repeated from the relay R510 to the relay R790, which latter relay alternately makes and breaks, at RA791, the loop circuit extending by way of the trunk line 1005 to the central exchange 20. Thus, the relay R790 repeats the impulses to the switch train in the central exchange 20.

In the event the central exchange is of the manual common battery type, a signal thereat is operated immediately the relay R790 operates to complete at RA791 the loop circuit extending to the central exchange, the relay R790 operating immediately the connect switch 600 is operated to its front position, as previously noted. The operator in the central exchange then sets up the connection to the desired subscriber line terminated thereat in the usual manner.

In the event the central exchange 20 is of the manual local battery type, the attendant at the attendant cabinet 40 operates the ground switch 560 to its front position subsequent to the opera-

tion of the connect switch 600 to its front position. The operation of the ground switch 560 to its front position completes a path for applying ground potential to the trunk conductor C835, this path extending from the grounded switch spring of the switch 560 and the front contact associated therewith, by way of the switch spring 594 and the back contact associated therewith, the switch spring 601 and the front contact associated therewith and C620 to the trunk conductor C835. This application of ground potential to the trunk conductor C835 unbalances the upper and lower windings of the differential relay R900, causing this relay to operate. Upon operating, the relay R900 completes at RA901 a circuit for energizing the relay R980, this circuit extending from ground at RA724 and the back contact associated therewith, by way of C628, RA901, C841, RA945, the "Z" wiring illustrated, RA974 and the winding of R980 to battery. When energized over the above-traced circuit, the relay R980 operates to complete at RA981 and the front contact associated therewith and at RA982 and the front contact associated therewith the previously traced circuit for ringing down the drop or other signal device at the central exchange 20, thereby to indicate to the operator in the central exchange that the trunk line 1005 has a call thereon. When the ground switch 560 is returned to its back position, ground potential is removed at the grounded switch spring and the front contact associated therewith of the ground switch 560 from the trunk conductor C835, thereby to restore the balance between the upper and lower windings of the relay R900, causing the latter relay to restore. When the relay R900 restores, it interrupts at RA901 the circuit for energizing the relay R980, causing the latter relay to restore shortly thereafter, the latter relay being of the slow-to-release type. Upon restoring, the relay R980 interrupts at RA981 and the front contact associated therewith and at RA982 and the front contact associated therewith the circuit for ringing down the drop or signal in the central exchange 20. Due to the fact that the relay R980 is of the slow-to-release type, it is only necessary for the attendant at the attendant cabinet 40 to operate momentarily the ground switch 560 thereat in order to cause the drop or other signal at the central exchange 20 to be rung down. After the connection has been completed between the telephone instrument at the attendant cabinet 40 and the desired line terminating at the central exchange 20 by way of the first trunk circuit 60, the attendant at the attendant cabinet 40 forwards the connection to the subscriber substation B. This is accomplished by the attendant at the attendant cabinet 40 in the same manner that an incoming call from the central exchange 20 routed by way of the first trunk line 60 to the attendant cabinet is forwarded to an authorized or semiauthorized subscriber substation, as is explained more fully subsequently.

Central exchange to authorized or semiauthorized substation calls

When the attendant at the attendant cabinet is on duty, all incoming calls to the P. A. B. X. from the central exchange are intercepted at the attendant cabinet and are completed to authorized and semiauthorized subscriber substations by the attendant thereat. For example, in order to complete a connection from the central exchange 20 to the semiauthorized substation B, apparatus, either automatic or under the control of the operator at the central exchange is first operated to cause a trunk line extending to the P. A. B. X. to be seized. Assuming that the trunk line 1005 is seized, ringing current is then projected over this trunk line, thereby to complete a circuit for energizing the relay R970 in the first trunk circuit 60. This circuit extends from one terminal of a source of A. C. supply in the central exchange 20 by way of the line conductor C1004, RA982 and the back contact associated therewith, the condenser 978, the lower winding of R970, RA981 and the back contact associated therewith and the line conductor C1003 to the other terminal of the source of A. C. supply. When energized over the above-traced circuit, the relay R970 operates to complete, at RA976', a holding circuit for itself, this circuit extending from ground at RA976' by way of RA955 and the back contact associated therewith, and the upper winding of R970 to battery, and completes at RA979' and the front contact associated therewith a circuit for energizing in series the relay R770 and the thermostatic device T810, this circuit extending from ground at TA811 by way of C861, RA934 and the back contact associated therewith, RA979' and the front contact associated therewith, C860, the winding of T810, RA767 and the back contact associated therewith, C778 and the winding of R770 to battery. Further, the relay R970 completes at RA972 a circuit for illuminating the answer and supervisory lamp 564 located at the attendant cabinet 40, this circuit extending from a source of ground pulses in the common equipment by way of the pulse ground lead C1001, RA972, C825, C641, the switch spring 571 of the night switch 570 and the back contact associated therewith, and the lamp 564 to battery. Further, the relay R970 completes at RA978 a circuit for energizing the relay R780, this circuit extending from ground at the upper terminal of the winding of the thermostatic device T570 by way of the winding of T570, RA557, C632, RA978, C857 and the lower winding of R780 to battery. When energized over the previously traced circuit, the relay R770 operates to complete at RA774 a circuit for energizing the relay R950, this circuit extending from ground at RA793 and the back contact associated therewith, C855, RA774, C856 and the lower winding of R950 to battery. Also, the relay R770 interrupts at RA773 a point in the path for energizing the lower winding of R750 from the control conductor C638 extending to the first trunk circuit 60, thereby to render the first trunk circuit busy to the allotter 50 in order to prevent seizure of the first trunk circuit by one of the authorized subscriber substations when an outgoing call to the central exchange 20 is initiated thereat. Further, the relay R770 completes at RA776 a path for applying ground potential to the motor start lead C1007 to which the common equipment is connected, this path extending from ground at RA768 by way of RA776 and C864 to the motor start lead C1007. This application of ground potential to the motor start lead C1007 initiates the operation of the common equipment connected thereto. When energized over the previously traced circuit, the relay R780 operates to apply at RA783 multiple ground potential to the motor start lead C1007 and to complete at RA781 a circuit for energizing the trunk signal buzzer M576 at the attendant cabinet 40, this circuit extending from a source of ground potential in the common equipment by way of the pulse

ground lead C1000, C823, RA781, C840, the switch spring of the trunk signal switch 567 and the back contact associated therewith, the switch spring 574 of the night switch 570 and the back contact associated therewith, the self-interrupting contacts 576' of the trunk signal buzzer M576 and the winding of M576 to battery. The operating common equipment applies ground pulses therein to the pulse ground leads C1000 and C1001. The ground pulses applied to the pulse ground lead C1000 cause the trunk signal buzzer M576 to operate, buzzer fashion, and the application of ground pulses to the pulse ground lead C1001 causes the answer and supervisory lamp 564 to flash. The flashing of the answer and supervisory lamp 564 and the operation of the trunk signal buzzer M576 indicate to the attendant at the attendant position 40 that an incoming call is on the first trunk circuit 60.

When energized over the previously traced circuit, the relay R950 operates to interrupt at RA955 and the back contact associated therewith the original holding circuit of the relay R970, the relay F970 being held operated at this time by way of an alternative holding circuit completed at RA771 upon operation of the relay R770. This alternative holding circuit for the relay R970 extends from ground at the switch springs 605 and 606 of the connect switch 600 by way of C630, RA771, C843, RA792, C842, RA975 and the upper winding of R970 to battery. Further, the relay F950 completes at RA955 and the front contact associated therewith an obvious path for short-circuiting the upper winding thereof and completes at RA952 an obvious path for short-circuiting the relay R920. At this time the relay R770 is held operated in series with the thermostatic device T810 as previously noted. Should the call on the first trunk circuit 60 remain unanswered for a predetermined interval of time, the thermal responsive element of the thermostatic device T810 operates to interrupt at TA811 the circuit for energizing in series the windings of the thermostatic device T810 and the relay R770, thereby to cause the relay R770 to restore. Upon restoring, the relay R770 effects the release of the first trunk circuit 60, this being accomplished by the restoration of the relay R770 due to the interruption at RA771 of the holding circuit of the relay R970 and the interruption at RA774 of the circuit for energizing the relay R950, thereby to cause the latter relay to restore. Upon restoring, the relay R970 interrupts at RA978 the circuit for energizing in series the lower winding of R780 and the winding of the thermostatic device T570, thereby to cause the relay R780 to restore. At this time the first trunk circuit 60 is completely released for further use. Prior to the operation of the thermal responsive element of the thermostatic device T810 to cause the release of the first trunk circuit 60, the thermal responsive element of the thermostatic device T570 operates to initiate night service operation. Operation of the thermal responsive element of the thermostatic device T570 completes at TA571 a circuit for energizing the relay R550, this circuit extending from ground at RA543 and the back contact associated therewith, TA571 and the winding of R550 to battery. When energized over the above-traced circuit, the relay R550 operates to complete at RA555 a circuit for energizing the relay R530, this circuit extending from ground at the switch spring 572 of the night switch 570 and the back contact associated therewith, RA542 and the back contact associated therewith, RA555 and the winding of R530 to battery. The operations of the relays R550 and R530 initiate night service operation in a manner more fully described subsequently.

Ordinarily, the attendant at the attendant cabinet 40 answers the incoming call from the central exchange 20 on the first trunk circuit 60 by operating the connect switch 600 to its front position, the connect switch 600 being individually associated with the first trunk circuit 60. This operation of the connect switch 600 completes at the switch spring 609 thereof and the front contact associated therewith an obvious circuit for energizing the relay R540, thereby to cause operation of this relay. Further, at the switch spring 609 and the front contact associated therewith, there is completed a circuit for supplying talking battery to the transmitter 565 of the telephone instrument at the attendant cabinet 40, this circuit extending from ground at the switch spring 609 and the front contact associated therewith by way of RA558, the lower winding of the impedance 520, the intermediate winding 579 of the repeater 577, the transmitter 565 and the upper winding of the impedance 520 to battery. Further, this operation of the connect switch 600 completes at the switch springs 601 and 603 and the front contacts associated therewith a loop circuit extending from the attendant cabinet 40 to the first trunk circuit 60 and including the relays R790 and R900. This loop circuit extends from ground at the upper terminal of the lower winding of R790 by way of the lower winding of R790, C848, the lower winding of R900, C836, C623, the switch spring 603 and the front contact associated therewith, the switch spring 595 and the back contact associated therewith, C655, the impedance 500, C657, RA512, RA531, C654, the switch spring 594 and the back contact associated therewith, the switch spring 601 and the front contact associated therewith, C620, C835, the upper winding of R900 and the upper winding of R790 to battery. When energized over the above-traced loop circuit, the relay R790 operates and the relay R900 does not operate, as previously noted. Upon operating, the relay R790 completes at RA793 and the front contact associated therewith an obvious holding circuit for the relay R770 and completes at RA793 and the front contact associated therewith a path for short-circuiting the winding of the thermostatic device T810, this path extending from ground at RA793 by way of the front contact associated therewith, C778, RA767 and the back contact associated therewith, the winding of T810, C860, RA979' and the front contact associated therewith, RA934, C861 and TA811 to ground. Further, the relay R790 interrupts at RA793 and the back contact associated therewith, the circuit for energizing the lower winding of the relay R950 and interrupts at RA792 the circuit for energizing the upper winding of the relay R970, thereby to cause the latter relays to restore. Upon restoring, the relay R950 interrupts at RA952 the path for short-circuiting the relay R920. Further, the relay R790 completes at RA791 a path for connecting the relay R920 across the positive and negative trunk conductors of the first trunk circuit 60, this path extending from the positive trunk conductor C1011 by way of the armature RA943 and the back contact associated therewith, the winding of R920, C834, RA791, C833 and RA942 and the back contact associated therewith to the negative trunk conductor C1010.

The connection of the relay R920 across the positive and negative trunk conductors of the first trunk circuit 60 is effective to give answering supervision to the calling subscriber in the event the central exchange 20 is of the automatic type and to give answering supervision to the operator in the central exchange in the event this exchange is of the manual common battery or manual local battery type.

Upon restoring, the relay R970 interrupts at RA972 a point in the path for illuminating the answer and supervisory lamp 564 from the pulse ground lead C1001 and interrupts at RA978 the circuit for energizing in series the lower winding of the relay R780 and the winding of the thermostatic device T570, thereby to cause the relay R780 to restore. Further, the relay R970 completes at RA976 a circuit for energizing in series the intermediate winding of the relay R730 and the upper winding of the relay R720, this circuit extending from the grounded conductor C630 by way of RA771, C843, RA932 and the back contact associated therewith, RA976, C845, RA744 and the back contact associated therewith, the upper winding of R720, C619, the wiper 679 of the rotary switch 678, the twenty-fifth or home contact in the associated contact bank 680, C618 and the intermediate winding of R730 to battery. When energized over the above-traced circuit, the relay R730 operates and the relay R720 does not operate due to the high series resistance of this circuit.

Upon restoring, the relay R780 interrupts at RA781 the circuit for operating the buzzer M576 from the pulse ground lead C1000. At this time, if the central exchange 20 is of the manual common battery type, the relay R920 operates over the loop circuit extending from the first trunk circuit 60 to the central exchange, thereby to complete at RA921 and RA923 a connection between the loop circuit extending to the attendant cabinet 40 and the loop circuit extending to the central exchange 20. At this time, the negative trunk conductor C835 of the first-mentioned loop circuit is connected by way of the condenser 969, RA921, C834, RA791, C833 and RA942 and the back contact associated therewith to the negative conductor C1010 of the last-mentioned loop circuit and the positive trunk conductor C836 of the first-mentioned loop circuit is connected by way of the condenser 968, RA923 and RA943 and the back contact associated therewith to the positive conductor C1011 of the last-mentioned loop circuit. On the other hand, if the central exchange 20 is of the manual local battery type, the relay R920 is not operated and the loop circuit extending to the attendant cabinet 40 is connected to the loop circuit extending to the central exchange 20 by way of the "Z" wiring illustrated, the "Z" wiring being arranged to short-circuit the armatures RA921 and RA923 and the contacts associated therewith.

The attendant at the attendant cabinet 40, upon receiving the information concerning the subscriber substation desired by the calling subscriber, operates the dial-split switch 610 to its front position. This operation of the dial-split switch 610 completes at the switch spring 611 and the front contact associated therewith a circuit for energizing the relay R700, this circuit extending from ground at RA511 by way of the switch spring 592 of the trunk release switch 590 and the back contact associated therewith, the switch spring 607 of the connect switch 600 and the front contact associated therewith, the switch spring 611 of the dial-split switch 610 and the front contact associated therewith, C634, RA735 and the winding of R700 to battery. Also, this operation of the dial-split switch 610 completes at the switch spring 612 and the front contact associated therewith a circuit for energizing the lower winding of the relay R940, this circuit extending from ground at RA775 by way of C635, the switch spring 612 of the dial-split switch 610 and the front contact associated therewith, C636, the switch spring 608 of the connect switch 600 and the front contact associated therewith, C637 and the lower winding of R940 to battery. When energized over the above-traced circuit, the relay R700 operates to complete at RA703 and the front contact associated therewith a circuit for energizing the relay R710, thereby to cause this relay to operate, this circuit extending from the grounded control conductor C630 by way of RA771, C843, RA703 and the front contact associated therewith and the winding of R710 to battery. When energized over the above-traced circuit, the relay R710 operates. When energized over the previously traced circuit, the relay R940 operates to interrupt at RA942 and the back contact associated therewith and at RA943 and the back contact associated therewith the circuit for energizing the relay R920 by way of the loop circuit extending to the central exchange 20, thereby to cause the latter relay to restore in the event it is operated. Further, the relay R940 interrupts at RA942 and the back contact associated therewith and at RA943 and the back contact associated therewith the connection between the loop circuit extending to the attendant cabinet 40 and the loop circuit extending to the central exchange 20, thereby to prevent the calling subscriber from hearing the conversation between the attendant at the attendant cabinet 40 and the subscriber at the subscriber substation to which the call is to be routed. Further, the relay R940 completes at RA941 a path for energizing the lower winding of the relay R960 from the loop extending to the central exchange 20, this circuit extending from the positive trunk conductor C1011 by way of the "X" wiring illustrated, RA977, the lower winding of R960 and RA941 to the negative trunk conductor C1010. This connection of the lower winding of the relay R940 across the positive and negative trunk conductors of the first trunk circuit 60 retains the switch train in the central exchange in its operated position in the event the central exchange is of the automatic type. Upon operating, the relay R710 prepares at RA714 and the front contact associated therewith a point in a path, traced hereinafter, for projecting ringing current over the called subscriber line.

The call extending from the central exchange 20 by way of the first trunk circuit 60 to the attendant cabinet 40 is then routed to the desired subscriber substation B. At this point it is noted that the incoming call on the first trunk circuit 60 is routed to the subscriber substation B in the same manner that a call initiated at the attendant cabinet and completed by way of the first trunk circuit 60 to the central exchange 20 is transferred to the subscriber substation B. In routing the call to the subscriber substation B, the attendant at the attendant cabinet 40 dials at the dialing mechanism 582 the directory number of the subscriber substation B, thereby to cause the relay R510 to repeat the impulses com-

prising a dialed digit in the manner previously explained. Upon operating, the relay R510 interrupts at RA511 the previously traced circuit for energizing the relay R700 and upon restoring completes at RA511 the previously traced circuit for energizing the relay R700 thereat, causing the impulses comprising the digit dialed to be repeated to the relay R700. Upon restoring, the relay R700 interupts at RA703 and the front contact associated therewith the circuit for energizing the relay R710 and completes at RA703 and the back contact associated therewith the circuit for energizing in multiple the winding of the motor M615 and the upper winding of the relay R740, the latter circuit extending from the grounded control conductor C630 by way of RA771, C843, RA703 and the back contact associated therewith, RA732 and RA712 and the front contact associated therewith to RA723, one path extending from RA723 by way of C625 and the winding of M615 to battery, and the other path extending from RA723 by way of the upper winding of R740 to battery. Upon reoperating, the relay R700 interrupts at RA703 and the front contact associated therewith the circuit for energizing in multiple the winding of the motor M615 and the upper winding of the relay R740 and completes at RA703 and the front contact associated therewith the circuit for energizing the relay R710. Thus, the relay R700 repeats the impulses dialed at the dialing mechanism 582 to the motor M615 and the relay R740. Due to the fact that the relay R710 is of the slow-to-release type, it does not restore during the series of impulses. When energized over the above-traced circuit, the relay D740 operates to complete at RA745 an obvious path for short-circuiting the lower winding thereof, thereby to render the relay R740 slow-to-release. Thus, the relay R740 remains operated during the series of impulses. Also, the relay R740 completes at RA743 a path in multiple to RA732 in the circuit for energizing in multiple the winding of the motor M615 and the upper winding of the relay R740, thereby to cause energization of the winding of the motor M615 and the upper winding of the relay R740 subsequent to the restoration of the relay R730. Further, the relay R740 interrupts at RA744 and the back contact associated therewith the previously traced circuit for energizing in series the intermediate winding of the relay R730 and the upper winding of the relay R720, thereby to cause R730 to restore. This intermittent energization of the motor M615 causes the wipers or the rotary switches 670, 674, 678, 682 and 686 of the trunk finder-connector switch 30 to be rotated step by step in a counterclockwise direction. On the first step of the wiper 679 of the rotary switch 678, the twenty-fifth or home contact in the associated contact bank 680 is disengaged, thereby to interrupt a further point in the previously traced circuit for energizing in series the intermediate winding of R730 and the upper winding of R720. Also, upon operating, the relay R740 interrupts at RA741 and at RA742 the connections between the trunk conductors C624, C835 and C622, C836, respectively, the trunk conductors C624 and C622 being respectively connected to the wipers 687 and 683 of the rotary switches 686 and 682, respectively, thereby to prevent the operation of the rotary switches from interfering with established connections to other subscriber substations. In the event the subscriber line 402 extending to the subscriber sub station B is arranged in the second group o lines, the first digit of the directory numbe thereof is 0 and the first digit dialed at the dial ing mechanism 582 is 0. At the conclusion o the first digit dialed, the wipers of the rotar switches engage the tenth contacts in the asso ciated contact banks to which no subscribe line is connected, as previously noted. At th conclusion of the first series of impulses, th relay R700 reoperates to interrupt the circui for energizing the winding of the motor M615 an for energizing the upper winding of the rela R740, thereby to arrest operation of the moto M615 and to cause the relay R740 to restor shortly thereafter. Upon restoring, the rela R740 recompletes, at RA744 and the back con tact associated therewith, an alternative circui for energizing in series the intermediate wind ing of the relay R730 and the upper windin of the relay R720, this circuit extending from the grounded control conductor C630 by way o RA771, C843, RA932 and the back contact asso ciated therewith, RA976, C845, RA744 and the back contact associated therewith, the upper winding of R720, C619, the wiper 679 of the rotary switch 678, the tenth contact in the associated contact bank 680, the multiple between the tenth contact and C618, C618, and the intermediate winding of R730 to battery, causing the relay R730 to reoperate. Upon reoperating, the relay R730 again prepares at RA732 the circuit for energizing in multiple the winding of the motor M615 and the upper winding of the relay R740. The second digit of the directory number of the subscriber line 402 is then dialed, thereby to cause the wipers of the rotary switches of the trunk finder-connector switch 30 to be stepped into engagement with the contacts in the associated contact banks terminating the conductors of the subscriber line 402 and to cause reoperation of the relay R740. The reoperation of the relay R740 causes the relay R730 to restore, as previously noted. Finally, the relay R740 restores at the conclusion of the second series of impulses comprising the second digit dialed at the dialing mechanism 582. The subsequent operation of the apparatus included in the first trunk circuit 60 depends upon the idle or busy condition of the called subscriber line 402.

In the event the subscriber line 402 is busy, ground potential through a low resistance appears upon the control conductor C422 thereof, thereby to complete a path for short-circuiting the upper winding of the relay R720, this path extending from the grounded control conductor C422 of the subscriber line 402 by way of the trunk line 200, the contact in the contact bank 680 of the rotary switch 678 terminating the control conductor of the subscriber line 402, the associated wiper 679, C619, the upper winding of R720, RA744 and the back contact associated therewith, C845, RA976, RA932 and the back contact associated therewith, C843 and RA771 to the grounded control conductor C630. This short-circuiting path prevents the relay R720 from reoperating. At this time, the loop circuit extending from the attendant cabinet 40 by way of the trunk conductors C835 and C836 and including the relays R900 and R790 is connected to the busy subscriber line 402, the trunk conductor C835 being connected by way of the condenser 812, RA741,

C624, the wiper 687 of the rotary switch 686, the contact in the associated contact bank 688 terminating the negative conductor of the subscriber line and the trunk line 200 to the negative conductor C412 of the subscriber line 402, and the trunk conductor C836 being connected by way of the condenser 813, RA742, RA722 and the back contact associated therewith, C622, the wiper 683 of the rotary switch 682, the contact in the associated contact bank 684 terminating the positive conductor of the subscriber line, the trunk line 200 and the positive line conductor C413 of the subscriber line 402. A circuit is completed between the positive and negative line conductors of the subscriber line 402 at the substation B, including the telephone instrument thereat. Also tick tone current is projected over the subscriber line 402 to the substation B, the ungrounded terminal of a source of tick tone supply being connected by way of the tick tone lead C657, the switch spring 602 of the connect switch 600 and the front contact associated therewith, C621, RA731, RA741 and C624 to the wiper 687 of the rotary switch 686, this circuit extending by way of the negative line conductor of the subscriber line 402, the receiver of the telephone instrument at the substation B and the positive line conductor of the subscriber line 402 to the rotary switch 682 and from the wiper 683 of the rotary switch 682 by way of C622, RA722 and the back contact associated therewith, RA742, the condenser 813, C623, the switch spring 603 of the connect switch 600 and the front contact associated therewith, the switch spring 595 of the information trunk switch 593 and the back contact associated therewith, C655, the lower winding of the impedance 520, RA558 and the switch spring 609 of the connect switch 600 and the front contact associated therewith to ground. This projection of tick tone current over the subscriber line 402 indicates to the subscriber at the substation B that the attendant at the attendant cabinet 40 has cut into the established connection including his substation. The failure of the relay R720 to operate causes the answer and supervisory lamp 564 to remain dark, thereby to indicate to the attendant at the attendant cabinet that the subscriber line 402 is busy. As previously noted, the loop circuit including the telephone instrument at the attendant cabinet 40 and extending into the first trunk circuit 60 is connected to the busy subscriber line 402. Accordingly, the attendant at the attendant cabinet may converse with the subscriber at the substation B and advise him that a trunk call is waiting to be extended to his substation.

The subscriber at the substation B may accept the trunk call offered to him by replacing the receiver of the telephone instrument thereat on its hook. When the subscriber at the substation B replaces the receiver of the telephone instrument thereat upon its hook, the relay R380 associated with the subscriber line 402 restores to cause ground potential to be removed from the control conductor C422 of the subscriber line 402, as previously noted, thereby to cause battery potential at the upper terminal of the lower winding of the relay R380 to be applied to this control conductor. This application of battery potential to the control conductor C422 completes a circuit for energizing the upper winding of the relay R720, this circuit extending from the grounded conductor C630 by way of RA771, C843, RA932 and the back contact associated therewith, RA976, C845, RA744 and the back contact associated therewith, the upper winding of R720, C619, the wiper 679 of the rotary switch 678, the contact in the associated contact bank C680 terminating the control conductor of the subscriber line 402, the trunk line 200, the control conductor C422 of the subscriber line 402 and the lower winding of R380 to battery. When energized over the above-traced circuit, the relay R720 operates to complete at RA727 a path for connecting its intermediate winding in multiple with the upper winding thereof, this path extending from the upper terminal of the intermediate winding of R720 connected to C619 by way of the intermediate winding of R720, RA727, C843 and RA771 to the grounded control conductor C630. When the intermediate winding of the relay R720 is connected in multiple with the upper winding thereof, the series resistance of the circuit for energizing the lower winding of the relay R380 is reduced, thereby to cause the relay R380 to operate and mark the subscriber line 402 as busy to the trunk finder and connector switches and to the connector switches of the local links, as previously explained.

Further, the relay R720 completes at RA724 and the front contact associated therewith a circuit for illuminating the answer and supervisory lamp 564, this circuit extending from ground at RA724 by way of the front contact associated therewith, C838, RA902 and the back contact associated therewith, C846, RA711, C641, the switch spring 571 of the night switch 570 and the back contact associated therewith and the lamp 564 to battery. The circuit for illuminating the lamp 564 excludes the resistor 784, thereby to cause the lamp 564 to be illuminated to its full brilliance, in order to indicate to the attendant at the attendant cabinet 40 that the called subscriber line 402 is idle. Further, the relay R720 completes at RA722 and the front contact associated therewith and at RA721 a path for projecting ringing current over the called subscriber line 402, this path extending from the ungrounded terminal of an interrupted generator potential by way of the interrupted generator lead C801, RA714 and the front contact associated therewith, the lower winding of R760, C779, RA763 and the back contact associated therewith, C861, RA722 and the front contact associated therewith, and C622 to the wiper 683 of the rotary switch 682 and from the rotary switch 682 by way of the subscriber line 402, the ring and condenser connected between the positive and negative line conductors of the subscriber line 402 and the negative line conductor of the subscriber line 402 to the rotary switch 686, this circuit extending from the wiper 687 of the rotary switch 686 by way of C624, RA721 and C860 to ground at RA762 and the back contact associated therewith. The operation of the ringer at the subscriber substation B indicates to the subscriber thereat that a call is waiting to be answered. A portion of this ringing current projected over the subscriber line 402 to the substation B is returned as ring-back tone current over the loop extending between the attendant cabinet 40 and the first trunk circuit 60 to the receiver of the telephone instrument at the attendant cabinet. The circuit for returning ring-back tone current over the loop extending to the attendant cabinet 40 includes a connection extending from the trunk conductor C624 by way of RA741 and the condenser 812 to the trunk conductor C620, and a

connection extending from the trunk conductor C622 by way of the condenser 815, RA742 and the condenser 813 to the trunk conductor C623. The ring-back tone produced in the receiver of the telephone instrument at the attendant cabinet 40 indicates to the attendant thereat that ringing current is being projected over the subscriber line 402.

The attendant at the attendant cabinet 40 may maintain the connection between the telephone instrument thereat and the first trunk circuit 60 until the subscriber at the subscriber substation B answers the call or disconnect the telephone instrument at the attendant cabinet 40 from the first trunk circuit 60 as soon as ring-back tone is produced in the receiver of the telephone instrument. Assuming that the attendant disconnects the telephone instrument at the attendant cabinet 40 from the first trunk circuit 60 as soon as ring-back tone is produced in the receiver of this telephone instrument, the dial-split switch 610 and, then, the connect switch 600 are returned to their back positions. When the dial-split switch 610 is returned to its back position, the circuit for energizing the relay R700 is interrupted at the switch spring 611 and the front contact associated therewith, thereby to cause the relay R700 to restore. Upon restoring, the relay R700 interrupts at RA703 and the front contact associated therewith the original circuit for energizing the relay R710, the latter relay being retained in its operated position at this time by way of a holding circuit extending from the grounded control conductor C630 by way of RA771, C843, RA765, RA725, RA713 and the winding of R710 to battery. When the connect switch 600 is operated to its back position, a further point in the circuit for energizing the relay R700 is interrupted at the switch springs 607 and the front contact associated therewith. Also, at the switch spring 609 and the front contact associated therewith a point in the circuit for energizing the relay R540 is interrupted thereby to cause the latter relay to restore shortly thereafter, the latter relay being of the slow-to-release type.

When the subscriber at the substation B answers the call extending thereto by removing the receiver of the telephone instrument thereat from its hook, a low resistance circuit is completed around the ringer at the substation B, thereby to complete a circuit similar to the circuit for projecting ringing current to the substation B between the interrupted generator lead C801 and ground at RA762 and the back contact associated therewith. This circuit includes the lower winding of the relay R760 and causes this winding to be fully energized, thereby to cause the relay R760 to operate. Upon operating, the relay R760 completes at RA766 a holding circuit for itself extending from the grounded control conductor C630 by way of RA771, C843, RA726, C844, RA766 and the upper winding of R760 to battery. Also the relay R760 interrupts at RA762 and the back contact associated therewith and at RA763 and the back contact associated therewith the circuit for projecting ringing current over the subscriber line 402 and completes at RA762 and the front contact associated therewith and at RA763 and the front contact associated therewith a loop circuit between the subscriber substation B and the relays R900 and R790 in the first trunk circuit 60. This loop circuit extends from ground at the upper terminal of the lower winding of R790 by way of the lower winding of R790, C848, the lower winding of R900, C836, RA763 and the front contact associated therewith, C861, RA722 and the front contact associated therewith, and C622 to the wiper 683 of the rotary switch 682 and from battery at the lower terminal of the upper winding of R790 by way of the upper winding of the relay R790, C847, the upper winding of R900, C835, RA762 and the front contact associated therewith, C860, RA721 and C624 to the wiper 687 of the rotary switch 686, the rotary switches 682 and 686 being connected together by way of the line conductors of the subscriber line 402 and the telephone instrument at the substation B. Further, the relay R760 interrupts at RA765 a point in the circuit for energizing the relay R710, thereby to cause the latter relay to restore shortly thereafter, the latter relay being of the slow-to-release type. Upon restoring, the relay R710 interrupts at RA716 a point in the circuit for energizing the lower winding of the relay R940, thereby to cause the latter relay to restore. Upon restoring, the relay R940 completes at RA942 and the back contact associated therewith and at RA943 and the back contact associated therewith a loop circuit extending to the central exchange 20 and including the relay R920. In the event the central exchange 20 is of the manual common battery type, the relay R920 operates to complete at RA921 and at RA923 a connection between the loop circuit extending to the subscriber substation B and the loop circuit extending to the central exchange 20. In the event the central exchange 20 is of the automatic type, the relay R940 interrupts at RA941 the path for connecting the lower winding of the relay R960 across the positive and negative trunk conductors C1011 and C1010 of the first trunk circuit 60. More particularly, the loop circuit extending to the subscriber substation B is connected to the loop circuit extending to the central exchange 20 by an arrangement including the coupling condensers 969 and 968 as previously noted, thereby to complete an established connection between the subscriber substation B and the exchange 20 for two-way communication therebetween.

In the event the attendant at the attendant cabinet 40 wishes to converse with the subscriber at the substation B after the call is answered at this substation, the attendant retains the connect switch 600 and the dial-split switch 610 in their front positions instead of returning these switches to their back positions as described above. In this event, when the subscriber at the substation B answers the call, the relay R760 is operated as previously described. However, operation of this relay does not cause the relay R710 to restore as the operated relay R700 maintains the original circuit for energizing the relay R710 completed at RA703 and the front contact associated therewith and the relay R700 is retained in its operated position as both the connect switch 600 and the dial-split switch 610 occupy their forward positions at this time. Further, the operated relay R710 retains completed at RA716 the circuit for energizing the lower winding of the relay R940, thereby to retain the latter relay in its operated position. The operated relay R940 retains interrupted at RA942 and the back contact associated therewith and at RA943 and the back contact associated therewith the connection between the loop circuit extending to the subscriber substation B and the loop circuit extending to the central exchange 20. At this time a loop circuit is completed between the substation B and the attendant cabinet 40, the

trunk conductor C620 being connected by way of RA762 and the front contact associated therewith, C660, RA721 and C624 to the wiper 687 of the rotary switch 686, and the trunk conductor 623 being connected by way of RA763 and the front contact associated therewith, C661, RA722 and the front contact associated therewith and C622 to the wiper 683 of the rotary switch 682. Finally, the trunk conductors C620 and C623 are connected together by a bridge path including the impedance 500 with which the telephone instrument at the attendant cabinet 40 is associated, and the rotary switches 682 and 686 are connected together by a bridge path including the telephone instrument at the subscriber substation B. Accordingly, a loop circuit is completed between the subscriber substation B and the attendant cabinet 40 for two-way communication therebetween. Moreover, it is noted that the loop circuit extending to the central exchange 20 is disconnected from the previously mentioned loop circuit so that the conversation between the attendant at the attendant cabinet 40 and the subscriber at the substation B may not be heard by the subscriber at the substation connected by way of the central exchange 20 to the trunk line 1005 extending to the first trunk circuit 60.

In order to establish a connection between the substation B and the calling subscriber substation while maintaining a monitoring supervision of this connection at the attendant cabinet 40, the dial-split switch 610 is operated to its back position. As previously noted, when the dial-split switch 610 is operated to its back position, the circuit for energizing the relay R700 is interrupted, thereby to cause this relay to restore. Upon restoring, the relay R700 interrupts at RA703 and the front contact associated therewith the original circuit for energizing the relay R710, thereby to cause the latter relay to restore. Upon restoring, the relay R710 interrupts at RA711 the direct connection between the conductor C646 and the conductor C641 included in the circuit for illuminating the answer and supervisory lamp 564, thereby to cause the resistor 784 to be inserted into the circuit for illuminating the lamp 564. This circuit for illuminating the lamp 564 extends from ground at RA724 and the front contact associated therewith by way of C838, RA902 and the back contact associated therewith, C646, the resistor 784, RA782 and the back contact associated therewith, C641, the switch spring 571 of the night switch 570 and the back contact associated therewith, and the lamp 564 to battery. The inclusion of the resistor 784 in the circuit for illuminating the answer and supervisory lamp 564 causes this lamp to be illuminated dimly, thereby to indicate to the attendant at the attendant cabinet 40 that the call has been answered and to remind her that the connect switch 600 occupies its forward position for monitoring purposes. Further, the relay R710 interrupts at RA716 a point in the circuit for energizing the lower winding of the relay R940, thereby to cause the latter relay to restore. Upon restoring, the relay R940 completes the connection between the loop circuit extending to the substation B and the loop circuit extending to the central exchange 20, thereby to complete a connection between the subscriber substation B and the calling subscriber substation for two-way communication therebetween, as previously explained. The completion of the connection between the loop circuit extending to the subscriber substation B and the loop circuit extending to the central exchange 20 causes the relay R920 to be energized over the loop circuit extending to the central exchange, as previously noted, in the event the central exchange is of the manual common battery type. Further, the restoration of the relay R940 interrupts, at RA941, the path for connecting the lower winding of the relay R960 the positive and negative trunk conductors C1011 and C1010, respectively, of the first trunk circuit 60 in the event the central exchange 20 is of the automatic type, as previously noted. During the time the attendant at the attendant cabinet 40 retains the connect switch 600 operated to its front position, tick tone current is superimposed upon the established connection extending between the subscriber substation B and the calling subscriber substation, thereby to indicate to the subscriber at this substation that the attendant at the attendant cabinet 40 is monitoring the established connection.

In order to interrupt the monitoring connection between the attendant cabinet 40 and the established connection extending between the subscriber substation B and the calling subscriber substation associated with the central exchange 20, the attendant at the attendant cabinet 40 operates the connect switch 600 to its back position. This operation of the connect switch 600 interrupts at the switch spring 602 of the connect switch 600 and the front contact associated therewith the previously traced circuit for projecting tick tone current over the established connection including the subscriber substation B and interrupts at the switch spring 609 of the connect switch 600 and the front contact associated therewith the circuit for energizing the relay R540, thereby to cause the latter relay to restore shortly thereafter, this relay being of the slow-to-release type.

In the event the called subscriber line 402 is idle, when the wipers of the rotary switches of the finder-connector switch 30 are stepped into engagement with the contacts in the associated contact banks terminating the conductors of the subscriber line 402, the upper winding of the relay R720 is not short-circuited as it is when the subscriber line 402 is busy, and a circuit is immediately completed for energizing the upper winding of R720, this circuit extending from the grounded control conductor C630 by way of the circuit previously traced to battery at the upper terminal of the lower winding of the relay R380 and including the upper winding of the relay R720, thereby to cause the relay R720 to operate as previously explained. The subsequent operation of the apparatus in the first trunk circuit 60 to cause ringing current to be projected over the called subscriber line 402 and the operations of the apparatus in the first trunk circuit incident to the answering of the call at the subscriber substation B are identical to those described previously.

The release of the established connection between the subscriber substation B and the calling subscriber substation is primarily under the control of the subscriber at the substation B and is affected by the character of the central exchange 20. When the subscriber at the substation B replaces the receiver of the telephone instrument thereat upon its hook, the loop circuit extending between the substation B and the first trunk circuit 60 and including the relays R900 and R790 is interrupted, thereby to cause the relay R790 to restore. Upon restoring, the relay R790 interrupts at RA791 the loop circuit extending to the central exchange 20

including the relay R920. This interruption of the loop circuit extending to the central exchange 20 gives the operator thereat disconnect supervision in the event the central exchange is of the manual common battery type. Further, the relay R790 interrupts at RA793 and the front contact associated therewith the circuit for energizing the relay R770, thereby to cause the relay R770 to restore in the event the central exchange 20 is of the automatic type. In the event the central exchange is of the manual common battery or manual local battery type, the path for short-circuiting the winding of the thermostatic device T815 is interrupted at RA793 and the front contact associated therewith when the relay R790 restores, thereby to cause the relay R770 to be energized in series with the winding of the thermostatic device T815 in order to retain the relay R770 in its operated position for an additional time interval and until the thermal responsive element of the thermostatic device T815 operates to interrupt the previously traced series circuit in order to cause the relay R770 to restore as previously noted. In the event the central exchange 20 is of the manual local battery type, upon restoring, the relay R790 completes at RA792 the previously traced circuit for energizing the relay R980. When energized, the relay R980 operates to cause ringing current to be projected over the trunk line 1005 in the manner previously described, thereby to give disconnect supervision to the operator at the central exchange. The operator at the central exchange 20 then pulls down the connection extending to the calling subscriber substation in a well-known manner. Shortly after the relay R770 is deenergized, it restores to interrupt at RA771 the circuit for energizing the multiple connected upper and intermediate windings of the relay R770 in series with the lower winding of the relay R380, the latter relay being associated with the subscriber line 402. The relay R380 then restores, thereby to mark the subscriber line 402 as idle to the trunk finder-connector switches and the connector switches of the local links. In the event the central exchange is of the manual local battery type, upon restoring, the relay R770 interrupts at RA771 the circuit for energizing the relay R980, thereby to cause the relay R980 to restore shortly thereafter, the latter relay being of the slow-to-release type. Upon restoring, the relay R980 interrupts the previously traced path for projecting ringing current over the trunk line 1005 extending to the central exchange 20.

Upon restoring, the relay R720 interrupts at RA726 the circuit for holding the relay R760 in its operated position, thereby to cause the latter relay to restore. Further, the relay R720 interrupts at RA724 the circuit for illuminating the answer and supervisory lamp 564, thereby to cause this lamp to be extinguished in order to indicate to the attendant at the attendant cabinet 40 that the established connection between the subscriber substation B and the calling subscriber substation including the first trunk circuit 60 has been released. Finally, the relay R720 completes at RA723 the previously traced circuit for connecting the winding of the motor M615 and the upper winding of the relay R740 in multiple to the pulse ground lead C179, this previously traced circuit including the multiple connected contacts in the contact bank 672 of the rotary switch 670 and the associated wiper 671. The ground pulses on the pulse ground lead C179 intermittently energize the winding of the motor M615 and the upper winding of the relay R740. When energized, the relay R740 operates, as previously explained, thereby to render the relay R740 slow to release and to prevent the rotation of the wipers of the rotary switches 682 and 686 over the associated contact banks from interfering with established connections to other of the subscriber substations. The intermittent energization of the motor M615 causes the wipers of the rotary switches of the finder-connector switch 30 to be rotated step by step in a counterclockwise direction until the wipers of these switches are returned to their twenty-fifth or home positions. When the wiper 671 of the rotary switch 670 is returned to its twenty-fifth or home position, the multiple connected contacts in the associated contact bank 672 are disengaged, thereby to interrupt the circuit for energizing in multiple the winding of the motor M615 and the upper winding of the relay R740 in order to cause the relay R740 to restore and to cause further operation of the motor M615 to be arrested. At this time the first trunk circuit 60 and the relay R380 associated with the line 402 are released for further use.

As previously noted, in the event the central exchange 20 is of the manual common battery or manual local battery type, when the relay R790 restores, it interrupts, at RA793, the path for short-circuiting the winding of the thermostatic device T815, thereby to cause the circuit for energizing in series the relay R770 and the winding of the thermostatic device T815 to be completed. The last-mentioned circuit extends from ground at TA811 by way of C861, RA934, and the back contact associated therewith, RA979' and the back contact associated therewith, C862, the winding of T815, the "Y" wiring illustrated, TA816, RA772, RA767 and the front contact associated therewith, C778 and the winding of R770 to battery. After a predetermined time interval, the thermal responsive element of the thermostatic device T815 operates to interrupt at TA816 the circuit for energizing in series the relay R770 and the winding of T815, thereby to cause the relay R770 to restore. The restoration of the relay R770 effects the release of the first trunk circuit 60 and the restoration of the relay R380 associated with the subscriber line 402 in the manner previously described. This delay in causing the release of the first trunk circuit 60 and the restoration of the relay R380 associated with the subscriber line 402 gives the operator in the central exchange 20 an opportunity to take down the circuit extending by way of the trunk line 1005 to the first trunk circuit 60 prior to the release of the first trunk circuit and the subscriber line 402, in order to prevent the seizure of the first trunk circuit by one of the authorized subscriber substations incident to the initiation of an outgoing central exchange call thereat before this connection is taken down.

The attendant at the attendant cabinet may release the P. A. B. X. end of an established connection while retaining a connection between the attendant cabinet and the calling subscriber substation. For example, assuming that the attendant at the attendant cabinet 40 desires to release the established connection extending by way of the first trunk circuit 60 and the trunk line 1005 between the subscriber substation B and the calling subscriber substation while retaining a connection between the attendant cabinet and the calling subscriber substation, the attendant at the attendant cabinet 40 first operates the con-

nect switch 600 individual to the first trunk circuit 60 to its front position thereby to establish a monitoring connection between the attendant cabinet 40 and the established connection between the subscriber substation B and the calling subscriber substation. As previously noted, this operation of the connect switch 600 projects tick tone current over the established connection between the subscriber substation B and the calling subscriber and causes a portion of this tick tone current to be returned through the receiver 565 of the telephone instrument at the attendant cabinet, thereby to produce tick tone therein. The common trunk release switch 590 is then momentarily operated to its front position, thereby to cause release of the first trunk circuit 60 in a manner more fully described subsequently. This operation of the common trunk release switch 590 interrupts at the switch spring 591 and the back contact associated therewith the path for applying ground potential to the control conductor C630, thereby to cause the circuit for energizing in series the multiple connected upper and intermediate windings of the relay R720 and the lower winding of R380 to be interrupted. When this circuit is interrupted, the relay R380 restores, thereby to mark the subscriber line 402 as idle, assuming that the subscriber at the substation B immediately replaces the receiver of the telephone instrument thereat upon its hook. Also, the removal of ground potential from the control conductor C630 interrupts the circuit for energizing the upper winding of the relay R760, thereby to cause this relay to restore. Upon restoring, the relay R720 completes at RA723 the previously traced path for energizing in multiple the winding of the motor M615 and the upper winding of the relay R740 from the pulse ground lead C179, thereby to cause the relay R740 to operate, as previously explained, and to cause the motor M615 to operate intermittently. The intermittent operation of the motor M615 rotates the wipers of the rotary switches of the finder-connector switch 30 in a counterclockwise direction until the wipers are rotated into their twenty-fifth or home positions, as previously explained. When the wiper 671 of the rotary switch 670 is rotated into its twenty-fifth or home contact, the multiple connected contacts in the contact bank 672 are disengaged, thereby to disconnect the winding of the motor M615 and the upper winding of the relay R740 from the pulse ground lead C179 in order to cause the relay R740 to restore and further operation of the motor M615 to be arrested. Also, when the wiper 679 of the rotary switch 678 is rotated into engagement with the twenty-fifth or home contact in the associated contact bank 680, the previously traced circuit for energizing in series the intermediate winding of the relay R730 and the upper winding of the relay R720 is completed. When thus energized, the relay R730 operates and the relay R720 does not operate. The portion of the tick tone current returned to the receiver of the telephone instrument at the attendant cabinet 40 produces tick tone therein, thereby to indicate to the attendant at the attendant cabinet 40 that the dialing mechanism 582 should not be operated at this time as the trunk finder-connector switch 30 has not been completely restored to its home position. As previously noted, when the trunk finder-connector switch is returned to its home position, the relay R730 operates as previously explained. Upon operating, the relay R730 interrupts at RA731 a point in the circuit for returning tick tone current to the receiver of the telephone instrument at the attendant cabinet 40, thereby to indicate to the attendant at the attendant cabinet that the dialing mechanism 582 may then be operated in order to transfer the call on the first trunk circuit 60 to another semiauthorized subscriber substation or to one of the authorized subscriber substations. The attendant at the attendant cabinet 40 then operates the dial-split switch 610 to its front position and operates the dialing mechanism 582, as previously explained, thereby to cause the trunk finder-connector switch 30 to seize a subscriber line extending to any desired authorized or semiauthorized substation in the P. A. B. X. in the manner previously explained.

The release of an established connection between a calling subscriber substation associated with the central exchange 20 and an authorized or semiauthorized subscriber substation in the P. A. B. X., routed therebetween by way of the first trunk circuit 60 and the subscriber line extending to the subscriber substation in the P. A. B. X., is the same as the release of an established connection between the calling authorized subscriber substation A in the P. A. B. X. and the central exchange 20 and routed therebetween by way of the first trunk circuit 60 and the subscriber line 403, previously explained.

Authorized substation to unauthorized, semiauthorized or authorized substation calls while holding a call to the central exchange

A subscriber at an authorized substation may complete a connection between his substation and an unauthorized, semiauthorized or authorized subscriber substation in the P. A. B. X while holding a connection to the central exchange. For example, the subscriber at the authorized substation A may complete a connection therefrom to the semiauthorized subscriber substation B while retaining a connection to the central exchange 20 regardless of whether the connection was established between the authorized substation A and the central exchange 20 by the initiation of an outgoing call at the subscriber substation A or by the initiation of an incoming call to the P. A. B. X. from a subscriber substation associated with the central exchange 20. Assuming that a connection is established between the authorized subscriber substation A and a subscriber substation associated with the central exchange 20 by way of the first trunk circuit 60 in the manner previously described, in order to cause the semiauthorized subscriber substation B to be associated with the authorized subscriber substation A, the subscriber at the substation A momentarily operates the grounding push button 393 thereat, thereby to cause direct ground potential to be applied to the negative line conductor C408 of the subscriber line 403. This application of ground potential to the negative line conductor C408 of the subscriber line 403 causes an unbalancing current to traverse the upper winding of the differential relay R900, this path extending from ground at the grounding push button 393 at the subscriber substation A by way of the negative conductor C408 of the subscriber line 403, RA432, C408 of the subscriber line 403, the trunk line 200, the contact in the contact bank 688 of the rotary switch 686 terminating the negative conductor of the subscriber line 403, the associated wiper 687, C624, RA721, C860, RA762 and the front contact associated therewith, C835, the upper winding of R900 and the upper wind-

ing of R790 to battery. This unbalancing of the windings of the differential relay R900 causes this relay to operate. Upon operating, the relay R900 completes at RA904 a circuit for energizing the lower winding of the relay R730, this circuit extending from ground at RA724 and the front contact associated therewith by way of C838, RA904, RA948, TA963, C851 and the lower winding of R730 to battery. Also, at RA906, the relay R900 completes a circuit for energizing the winding of the thermostatic device T962, this circuit extending from ground at RA724 and the front contact associated therewith by way of C938, RA906 and the winding of T962 to battery. When energized over the above-traced circuit, the relay R730 operates to prepare at RA733 a circuit, traced hereinafter, for energizing the upper winding of R730 in multiple with the lower winding of the relay R930. When the grounding push button 393 at the subscriber substation A is released, the previously traced circuit for applying direct ground potential to the negative line conductor C403 of the subscriber line 403 is interrupted thereat, thereby to cause the windings of the differential relay R900 to be balanced again, resulting in the restoration of R900. Upon restoring, the relay R900 completes at RA903 a circuit for energizing in series the upper winding of the relay R940 and the multiple connected lower winding of the relay R930 and the upper winding of the relay R730, this circuit extending from ground at RA724 and the front contact associated therewith to RA733, one path extending from RA733 by way of C849 and the lower winding of R930 to RA903, and the other path extending from RA733 by way of the upper winding of R730 and C850 to RA903, the circuit further extending from RA903 by way of the upper winding of R940 to battery. Further, the relay R900 interrupts at RA904 the previously traced circuits for energizing the winding of the thermostatic device T962 and for energizing the lower winding of the relay R730. At this time, the relay R730 remains in its operated position due to the energization of the upper winding thereof over the above-traced circuit. When energized over the above-traced circuit, the relay R940 operates to interrupt at RA942 and the back contact associated therewith and at RA943 and the back contact associated therewith the connection between the subscriber line 403 and the trunk line 1005 extending to the central exchange 20, thereby to prevent the subscriber at the substation associated with the central exchange 20 from hearing the conversation between the subscriber at the station A and the subscriber at the station B, after the connection is completed between the station A and the station B. Further, the relay R940 completes, at RA941, a path for connecting the lower winding of the relay R960 to the positive and negative line conductors C1011 and C1010, respectively, of the first trunk circuit 60, this path extending from the positive line conductor C1011 by way of the "X" wiring illustrated, RA977, the lower winding of R960, RA941 to the negative line conductor C1010. The connection of the lower winding of the relay R960 across the positive and negative line conductors of the first trunk circuit 60 holds the central office connection in an obvious manner. Further, the relay R940 interrupts at RA942 and the back contact associated therewith and at RA943 and the back contact assocated therewith the connection of the relay R920 across the positive and negative line conductors C1011 and C1010, respectively, of the first trunk circuit 60. Further, the relay R940 completes at RA942 and the front contact associated therewith and at RA943 and the front contact associated therewith a path for connecting the relay R920 across the positive line conductors C827 and C826, respectively, of the link line 830, this path extending from the positive line conductor C827 of the link line 830 by way of RA943 and the front contact associated therewith, the winding of R920, C934, RA791, C833 and RA942 and the front contact associated therewith to the negative line conductor C826 of the link line 830. The disconnection of the relay R920 from across the positive and negative line conductors C1011 and C1010, respectively, of the first trunk circuit 60 causes this relay to restore in the event it is operated.

When energized over the previously traced circuit, the relay R930 operates to close its "X" contacts associated with the armatures RA933 and RA935 thereof, thereby respectively to complete a path for connecting the upper winding of the relay R930 to the control conductor C828 of the link line 830 and to complete a path for applying battery potential to the start lead C418 extending to the allotter 50. The first-mentioned path extends from battery at the lower terminal of the upper winding of R930 by way of the upper winding of R930, RA933, RA947, C832, and RA761 to the control conductor C828 of the link line 830. The last-mentioned path extends from battery at the resistor 936 by way of 936, RA935', RA936 and C937 to the start lead C418 extending to the allotter 50. The connection of the upper winding of the relay R930 to the control conductor C828 of the link line 830 applies battery potential to the control conductor C828, thereby to provide a marking potential on the contact in the contact bank of a particular rotary switch in the finder switch of a selected local link terminating the control conductor C828 in order to mark the first trunk circuit 60 as a calling trunk in a manner more fully described subsequently. The application of battery potential to the start conductor C418 extending to the allotter 50 causes the relay R340 in the allotter 50 to be operated by way of the control conductor C204, ground potential being applied to the control conductor C204 in an idle one of the local links. Assuming that the local link 21 is the first idle local link available, ground potential at R156 and the back contact associated therewith is applied to the control conductor C204 thereby to complete a circuit for energizing the relay R340, this circuit extending from the grounded control conductor C204 by way of RA324 and the winding of R340 to the start conductor C418 having battery potential thereon. When thus energized, the relay R340 operates to complete at RA341 the circuit for energizing the relay R350, thereby to cause the latter relay to operate. Upon operating, the relay R350 interrupts at RA352 a point in the circuit for energizing the relay R300 in the allotter 50 by way of the start lead C419, thereby to prevent the initiation at authorized subscriber substations of outgoing central exchange calls until the local link 21 has found the link line 830 extending to the first trunk circuit 60. Also, the relay R350 completes at RA351 a path for applying ground potential to the start conductor C416, thereby to complete the previously traced circuit for energizing the upper winding of the relay R130 in the first local link 21. When energized, the relay R130 operates to complete at

RA134 the previously traced path for applying ground potential to the wiper 273 of the rotary switch 272 of the finder switch 22 and to complete at RA131 the previously traced path for applying battery potential at the terminal of the winding of the motor M171 to the pulse ground lead C179 to which the common equipment is connected. This application of battery potential to the pulse ground lead C179 causes the initiation of the operation of the common equipment as previously noted, thereby to cause ground pulses to be transmitted by way of the previously traced circuit for energizing the winding of the motor M171. This intermittent energization of the winding of the motor M171 causes the wipers of the rotary switches of the finder switch 22 to be rotated step by step in a clockwise direction as previously noted until the wiper 273 of the rotary switch 272 engages the contact in the associated contact bank 274 terminating the control conductor of the link line 830. When the wiper 273 of the rotary switch 272 is operated to this position, a circuit for energizing the intermediate winding of the relay R150 is completed, this circuit extending from ground at RA134 by way of the intermediate winding of R150, RA141, C233, the wiper 273 of the rotary switch 272, the contact in the associated contact bank 274 terminating the control conductor of the link line 830, the control conductor C828 of the link line 830, RA761, C832, RA947, RA933 and the upper winding of R930 to battery. When energized over the above-traced circuit, the relay R150 operates and the relay R930 fully operates. The operation of the relay R150 is effective to cause operation of the apparatus comprising the finder switch in the manner previously described, and the full operation of the relay R930 is effective to interrupt at RA935' the path for applying battery potential to the start conductor C418 extending to the allotter 50, thereby to cause the relay R340 to restore. Upon restoring, the relay R340 interrupts, at RA341, the circuit for energizing R350, thereby to cause the latter relay to restore. Upon restoring, the relay R350 prepares at RA352 a point in the previously traced circuit for energizing the relay R300 from the start conductor C419 when the next outgoing central exchange call is initiated at one of the authorized subscriber substations and interrupts at RA351 a point in the original circuit for energizing the upper winding of the relay R130 by way of the start conductor C416. At this time, a loop circuit is completed between the relay R920 in the first trunk circuit 60 and the relay R130 in the local link 21, this loop circuit extending from ground at the lower terminal of the lower winding of R130 by way of the lower winding of R130, RA158, RA124, C231, the wiper 265 of the rotary switch 264, the contact in the associated contact bank 266 terminating the positive line conductor of the link line 830, the positive line conductor C827, of the link line 830, RA943 and the front contact associated therewith, the winding of R920, C834, RA791, C833, RA942 and the front contact associated therewith, the negative line conductor C826 of the link line 830, the contact in the contact bank 262 of the rotary switch 260 terminating the negative line conductor of the link line 830, the associated wiper 261, C230', RA123, RA157 and the upper winding of R130 to battery. The relay R130 in the local link 21 is retained in its operated position by way of the above-traced loop circuit, and the relay R920 in the first trunk circuit 60 is operated over this loop circuit.

Upon operating, the relay R920 completes at RA921 and at RA923 a path for returning dial tone current through the receiver of the telephone instrument at the subscriber substation A, this path extending from the ungrounded terminal a source of dial tone current by way of the dial tone lead C178, the condenser 174, the twenty-fifth or home contact in the contact bank 258 of the rotary switch 256 of the connector switch 23, the associated wiper 257, C230, RA104, RA126 and the front contact associated therewith, C230', the wiper 261 of the rotary switch 260 of the finder switch 22, the contact in the associated contact bank 262 terminating the negative line conductor of the link line 830, the negative line conductor C826 of the link line 830, RA942 and the front contact associated therewith, C833, RA791, C834, RA921, and the condenser 969 to the negative trunk conductor C835 of the first trunk circuit 60. The circuit then extends from the negative trunk conductor C835 to the positive trunk conductor C836 of the first trunk circuit 60 by way of the trunk finder-connector switch 30, the subscriber line 403 and the telephone receiver of the telephone instrument at the subscriber substation A, as previously tracd; further, the circuit extends from the positive trunk conductor C836 of the first trunk circuit 60 by way of the condenser 968, RA923, RA943 and the front contact associated therewith, the positive line conductor C827 of the link line 830, the contact in the contact bank 266 of the rotary switch 264 of the finder switch 22 terminating the positive line conductor of the link line 830, the associated wiper 265, C231, RA124, RA158 and the lower winding of R130 to ground. The tone dial produced in the receiver of the telephone instrument at the subscriber station A indicates to the subscriber thereat that he may dial the directory number of the subscriber substation B, thereby to cause the connector switch 23 of the local link 21 to seize the subscriber line 402. When the first digit of the directory number of the subscriber substation B is dialed at the substation A, the loop circuit extending between the substation A and the relay R790 in the first trunk circuit 60 is intermittently interrupted and completed as previously noted, thereby to cause the relay R790 to restore and operate in order to repeat the impulses comprising the first digit dialed. Upon restoring, the relay R790 completes at RA793 and the back contact associated therewith the previously traced circuit for energizing the lower winding of R950, thereby to cause the latter relay to operate. Upon operating, the relay R950 completes at RA955 and the front contact associated therewith an obvious path for short-circuiting the upper winding thereof, thereby to render the relay R950 slow to release and to prevent the restoration of this relay during the series of impulses comprising the first digit dialed at the subscriber station A.

Also, upon operating, the relay R950 completes at RA952 an obvious path for short-circuiting the relay R920, completes at RA953 an obvious path for connecting the resistor 966 across the positive and negative trunk conductors C836 and C835 of the first trunk circuit 60. The resistor 966 has a relatively high resistance, thereby to improve the following characteristic of the relay R790 included in the loop circuit extending to

the subscriber substation A. Finally, the relay R950 completes at RA951 an obvious circuit for connecting the resistor 967 across the positive and negative line conductors C827 and C826 of the link line 830. The resistor 967 has a relatively high resistance, thereby to improve the following characteristic of the relay R130 in the local link 21. Also, upon restoring, the relay R790 interrupts at RA791 the previously traced loop circuit extending between the relay R130 in the local link 21 and the relay R920 in the first trunk circuit 60, the relay R920 being short-circuited at this time as previously noted, thereby to cause the relay R130 to restore and operate in order to repeat the impulses comprising the first digit dialed. The operation and restoration of the relay R130 repeats the impulses of the first digit dialed by intermittently interrupting and completing, at RA132 and the back contact associated therewith, the previously traced circuit for energizing the motor M170, thereby to cause the motor M170 to drive the wipers of the rotary switches of the connector switch 23 step by step in a counterclockwise direction as previously explained. The digits comprising the directory number of the subscriber substation B are successively dialed at the substation A, thereby to cause the wipers of the rotary switches of the connector switch 23 of the link 21 to be rotated into engagement with the contacts in the associated contact banks terminating the conductors of the subscriber line 402 extending to the subscriber substation B. When the connector switch 23 seizes the subscriber line 402 extending to the subscriber substation B, the apparatus in the local link 21 operates as previously explained, thereby to project ringing current over the subscriber line 402 in order to cause the ringer at the substation B to be operated in the event the subscriber line 402 is idle, or to return busy tone current over the calling subscriber line 403 extending to the substation A in the event the called subscriber line 402 is busy, in the usual manner. When the subscriber at the substation B answers the call extending thereto by removing the receiver of the telephone instrument thereat from its hook, the relay R120 in the local link 21 is operated as previously explained, thereby to complete at RA125 and the front contact associated therewith and at RA126 and the front contact associated therewith a loop circuit between the telephone instrument at the subscriber substation B and the relays R910 and R905 in the first trunk circuit 60 as soon as the relay R920 reoperates. At the conclusion of the last digit of the directory number of the subscriber substation B, the loop circuit between the subscriber substation A and the relay R790 in the first trunk circuit 60 is recompleted, thereby to cause the relay R790 to remain operated. Upon operating, the relay R790 interrupts at RA793 and the back contact associated therewith the circuit for energizing the lower winding of the relay R950, thereby to cause the relay R950 to restore shortly thereafter, the relay R950 being rendered slow to release due to the short-circuited upper winding thereof. Upon restoring, the relay R950 interrupts at RA951 the path for connecting the resistor 967 across the positive and negative line conductors C827 and C826, respectively, of the link line 830, interrupts at RA952 the path for short-circuiting the relay R920 and interrupts at RA953 the path for connecting the resistor 966 across the positive and negative trunk conductors C836 and C835, respectively, of the first trunk circuit 60. When the path for short-circuiting the relay R920 is interrupted, the relay R920 operates to complete at RA922 and at RA924 the previously mentioned loop circuit between the subscriber substation B and the relays R910 and R905 in the first trunk circuit 60. This loop circuit extends from ground at the upper terminal of the lower winding of the relay R905 by way of the lower winding of R905, the lower winding of R910 and RA924 to the positive line conductor C827 of the link line 830 and from battery at the lower terminal of the upper winding of the relay R905 by way of the upper winding of R905, the upper winding of R910 and RA922 to the negative line conductor C826 of the link line 830, the positive and negative line conductors C827 and C826, respectively, of the link line 830 being connected to the rotary switches 264 and 260, respectively, of the connector switch 22, the wiper 265 of the rotary switch 264 being connected by way of the previously traced circuit including the rotary switch 252 of the connector switch 23 to the positive line conductor C413 of the called subscriber line 402, and the wiper 261 of the rotary switch 260 being connected by way of the previously traced circuit including the rotary switch 256 of the connector switch 23 to the negative line conductor C412 of the called subscriber line 402. Finally, the telephone instrument at the subscriber substation B is connected across the positive and negative line conductors C413 and C412, respectively, of the called subscriber line 402, thereby completing the loop circuit between the subscriber substation B and the relays R905 and R910 in the first trunk circuit 60. When the last-mentioned loop circuit is completed, the relay R905 operates while the relay R910 does not operate, the latter relay being of the differential type.

Furthermore, upon operating, the relay R920 completes at RA921 and at RA923 a connection between the loop circuit extending between the subscriber substation A and the relays R790 and R900 in the first trunk circuit 60 and the loop circuit extending between the subscriber substation B and the relays R905 and R910 in the first trunk circuit 60, thereby to complete an established connection for two-way communication between the subscriber substations A and B. This connection between the two loop circuits mentioned extends from the negative trunk conductor C835 included in the first-mentioned loop circuit by way of the condenser 969, RA921, C834, RA791, C833 and RA942 and the front contact associated therewith to the negative line conductor C826 of the link line 830 included in the second-mentioned loop circuit, and extends from the positive trunk conductor C836 included in the first-mentioned loop circuit by way of the condenser 968, RA923 and RA943 and the front contact associated therewith to the positive line conductor C827 of the link line 830 included in the second-mentioned loop circuit.

The subscriber at the substation A may interrupt the established connection between the substations A and B and reestablish the connection between the substation A and the subscriber substation associated with the central exchange 20 by again momentarily operating the grounding push button 393 at the substation A. When the grounding push button 393 at the substation A is again momentarily operated, the previously traced circuit for energizing the upper winding of the relay R900 is again completed, thereby to

cause the upper and lower windings of the differential relay R900 to be unbalanced, resulting in the operation thereof. Upon operating, the relay R900 completes at RA902 and the front contact associated therewith a path for short-circuiting the multiple connected upper winding of the relay R730 and the lower winding of the relay R930, this path including one branch extending from RA733 by way of C849 and the lower winding of R930 to RA902, the other branch extending from RA733 by way of the upper winding of R730 and C850 to RA902, the path extending from RA902 by way of C838 to RA733. When this short-circuiting path is completed, the relay R730 restores. However, the relay R930 does not restore, this relay being retained in its operated position by the circuit for energizing the upper winding of R930, completed in the local link 21. Upon restoring, the relay R730 interrupts at RA733 the original circuit for energizing the upper winding of R940 in series with the multiple connected upper winding of the relay R730 and the lower winding of the relay R930. However, the relay R940 does not restore at this time as the operated relay R900 completes an alternative circuit for energizing the upper winding thereof. The alternative circuit for energizing the upper winding of R940 extends from ground at RA724 and the front contact associated therewith by way of C838, RA902 and the front contact associated therewith, RA946 and the upper winding of R940 to battery. When the grounding push button 393 is retored to its normal position, the previously traced circuit for energizing the upper winding of the relay R900 in order to cause unbalancing of the upper and lower windings of the relay R900 is interrupted, thereby to cause this relay to restore. Upon restoring, the relay R900 interrupts at RA902 and the front contact associated therewith the previously traced alternative circuit for energizing the upper winding of R940, thereby to cause the relay R940 to retsore. Upon restoring, the relay R940 interrupts at RA942 and the front contact associated therewith and at RA943 and the front contact associated therewith the connection between the loop circuit extending between the subscriber substation A and the relays R900 and R790 in the first trunk circuit 60 and the loop circuit extending between the subscriber substation B and the relays R905 and R910 in the first trunk circuit 60, thereby to interrupt the established connection between the substations A and B. Also, upon restoring, the relay R940 completes at RA942 and the back contact associated therewith and at RA943 and the back contact associated therewith the previously traced connection between the loop circuit extending between the subscriber substation A and the relays R900 and R790 in the first trunk circuit 60 and the trunk line 1005 extending to the central exchange 20, the trunk line 1005 being connected in the central exchange 20 to a subscriber substation associated therewith, thereby to complete an established connection between the subscriber substation A and the subscriber substation associated with the central exchange 20.

In the event the central exchange 20 is of the manual common battery type, when the relay R920 is connected at RA942 and the back contact associated therewith and at RA943 and the back contact associated therewith across the negative and positive trunk conductors C1010 and C 1011, respectively, of the first trunk circuit 60, the relay R920 is energized, thereby to cause it to operate. Also, when the relay R940 restores, it interrupts at RA947 the circuit for energizing the upper winding of R930, thereby to cause the latter relay to restore. Also, an arrangement is provided for enabling the subscriber at the substation A to interrupt the connection between the loop circuit extending between the subscriber substation A and the relays R900 and R790 in the first trunk circuit 60 and the loop circuit extending between the central exchange 20 and the relay R920 in the first trunk circuit 60, thereby to interrupt the established connection between the subscriber substation A and the subscriber substation associated with the central exchange 20 and to automatically recomplete the connection between the loop circuit extending between the subscriber substation A and the relays R900 and R790 in the first trunk circuit 60 and the loop circuit extending between the substation B and the relays R910 and R905 in the first trunk circuit 60, thereby to recomplete the established connection between the subscriber substations A and B. This arrangement comprises the "A" wiring illustrated connected in multiple to the contacts controlled by the armature RA947 of the relay R940, thereby preventing the restoration of the relay R940 from being effective to interrupt the circuit for energizing the upper winding of the relay R930 and the consequent restoration of the latter relay. By utilizing the "A" wiring illustrated, the restoration of the relay R930 may be prevented by the subscriber at the substation B, while the first trunk circuit is in use.

When this arrangement is utilized, the subscriber at the substation B does not replace the receiver of the telephone instrument thereat upon its hook after the original conversation between the subscriber substations A and B is completed, thereby to retain the local link 21 in its operated position, the local link 21 being retained in its operated position due to the fact that a loop circuit is completed between the relay R130 in the local link 21 and the substation B, this circuit extending from ground at the lower terminal of the lower winding of R130 by way of RA158, the resistor 176, RA125 and the front contact associated therewith, RA103 and C227 to the wiper 253 of the rotary switch 252 and from battery potential at the upper terminal of the upper winding of R130 by way of RA157, the resistor 175, RA126 and the front contact associated therewith, RA104 and C230 to the wiper 257 of the rotary switch 256, the rotary switches 252 and 256 being connected together by way of the trunk line 200 and the subscriber line 402 as the telephone instrument at the subscriber substation B is connected across the positive and negative line conductors C413 and C412, respectively, of the subscriber line 402. The operated relay R130 retains the local link 21 in its operated position and retains completed the circuit for energizing in series the multiple connected upper and intermediate windings of the relay R150 and the upper winding of R930, one branch of this circuit extending from ground at RA134 by way of the upper winding of R150 and RA155 to RA154, and the other branch extending from ground at RA134 by way of the intermediate winding of R150 to R154, the circuit extending from RA154 by way of C233, the wiper 273 of the rotary switch 272, the contact in the associated contact bank 274 terminating the control conductor of the link line 830, the control conductor C828 of the link line 830, RA761, C832,

the "A" wiring illustrated, RA333 and the upper winding of R930 to battery.

When this arrangement is utilized, the subscriber at the substation A may recomplete the established connection between the subscriber substations A and B by again momentarily operating the push button 393 at the substation A, thereby to cause direct ground potential to be applied to the negative line conductor C408 of the subscriber line 403. This application of direct ground potential to the negative line conductor C408 of the subscriber line 403 causes the upper winding of the relay R900 to be energized over the previously traced circuit, thereby to cause unbalancing of the upper and lower windings of R900 and the consequent operation thereof. Upon operating, the relay R900 completes, at RA904, the previously traced circuits for energizing the winding of the thermostatic device T962 and for energizing the lower winding of the relay R730. When energized over the previously traced circuit, the relay R730 operates to prepare at RA733 the previously traced circuit for energizing the multiple connected upper winding of R730 and the lower winding of R930 in series with the upper winding of the relay R940. When the grounding push button at the substation A is released, the previously traced circuit for energizing the upper winding of the relay R900, thereby to cause unbalancing of the upper and lower windings of this relay, is interrupted, thereby to cause this relay to restore. Upon restoring, the relay R900 completes at RA903 the previously traced circuit for energizing the multiple connected upper winding of R730 and lower winding of R930 in series with the upper winding of R940, thereby to cause operation of the relay R940. Upon operating, the relay R940 interrupts at RA942 and the back contact associated therewith and at RA943 and the back contact associated therewith the previously traced connection for completing the established connection between the subscriber substation A and the subscriber substation associated with the central exchange 20 and completes at RA942 and the front contact associated therewith and RA943 and the front contact associated therewith the previously traced connection for completing the established connection between the subscriber substations A and B.

When this arrangement is utilized, the subscriber at the substation A may alternatively complete an established connection between the substation A and the subscriber substation associated with the central exchange 20 and the established connection between the substation A and the subscriber substation B at will merely by repeatedly momentarily operating the grounded push button 393 at the substation A in the above-described manner.

After recompleting the established connection between the subscriber substation A and the subscriber substation associated with the central exchange 20, the subscriber at the substation A may release the apparatus including the first trunk circuit 60 and the first local link 21 by replacing the receiver of the telephone instrument at the subscriber substation A upon its hook, thereby to interrupt the loop circuit extending between the subscriber substation A and the relays R900 and R790 in the first trunk circuit 60. When this loop circuit is interrupted, the relay R790 restores. The restoration of the relay R790 causes the apparatus comprising the first trunk circuit and including the relays R770, R720, R760 and R920 to be released, thereby to cause the relays mentioned above to restore as previously explained. Upon restoring, the relay R920 interrupts at RA924 a point in the loop circuit extending between the called subscriber substation B and the relays R910 and R905 in the first trunk circuit 60, thereby to cause the relay R905 to restore. Upon restoring, the relay R760 interrupts at RA761 a point in the circuit for energizing in series the upper winding of the relay R930 and the multiple connected upper and intermediate windings of the relay R150 in the first local link 21, thereby to cause restoration of these relays. Upon restoring, the relay R150 interrupts at RA157 and RA158 the loop circuit extending between the subscriber substation B and the relay R130 in the first local link 21 thereby to cause the relay R130 to restore. The restoration of the relays R130 and R150 cause the remainder of the relays in the first local link 21 to restore and to cause the connector switch 23 of the first local link 21 to be returned to its home position in the manner previously described. When the relay R120 in the first local link 21 restores, it interrupts at RA125 and the front contact associated therewith and at RA126 and the front contact associated therewith further points in the loop circuit extending between the called subscriber substation B and the relays R910 and R905 in the first trunk circuit 60.

When the relay R150 in the first local link 21 restores, the path for applying ground potential to the control conductor C422 of the subscriber line 402 is interrupted, thereby to cause the circuit for energizing the lower winding of the relay R380 to be interrupted. The relay R380 then restores to complete at RA381 and RA382 a point in a path for applying battery potential to the start conductor C418, this path extending from battery at the lower terminal of the intermediate winding of R380 by way of the intermediate wnding of R380, RA382, the line conductor C412 of the subscriber line 402, the bridge including the telephone instrument at the subscriber substation B connected across the negative and positive line conductors C412 and C413, respectively, of the subscriber line 402, the positive line conductor C413 and RA381 to the start conductor C418 extending to the allotter 50. At this time, the first local link 21, the first trunk circuit 60 and the subscriber line 403 are completely released for further use.

The application of battery potential to the start conductor C418 causes the relay R340 in the allotter 50 to be operated, ground potential being applied to the control conductor C204 connected by way of RA324 to the lower terminal of the winding of R340 in the first idle local link. This local link then operates, as previously explained, to cause the finder switch thereof to seize the subscriber line 402 as a calling line. When the subscriber line 402 is seized by the finder switch of the local link, dial tone current is returned over the subscriber line 402 to the receiver of the telephone instrument at the substation B, thereby to cause the receiver to produce dial tone. This production of dial tone by the receiver of the telephone instrument at the substation B indicates to the subscriber thereat that the established connection between the subscriber substation A and the subscriber substation associated with the central exchange 20

has been released. The subscriber at the substation B then replaces the receiver of the telephone instrument thereat upon its hook, thereby to cause the release of the local link associated with the subscriber line 402 in the manner previously described. At this time, the last-mentioned local link and the subscriber line 402 are completely released for further use.

Direct transfer of a central exchange call from one authorized substation to another

A subscriber at an authorized substation may transfer a call to or from the central exchange to another authorized subscriber substation without the intervention of the attendant at the attendant cabinet 40. For example, in order to transfer a central exchange call from the authorized subscriber substation A to another authorized subscriber substation, the subscriber at the substation A first operates the grounding push button 393 thereat in order to cause the finder switch of a local link to seize the link line extending to the trunk circuit over which the call between the substation A and the central exchange is routed. For example, assuming that the call is routed over the first trunk circuit 60 and that the finder switch 22 of the local link 21 becomes associated with the link line 830 when the grounding push button 393 at the subscriber substation A is operated, the operation of the apparatus in the local link 21 and the first trunk circuit 60 to accomplish this end is the same as that previously described. The subscriber at the substation A then dials the directory number of the authorized subscriber substation to which the central office call is to be transferred in the usual manner, thereby to cause the connector switch 23 of the local link 21 to seize the subscriber line extending to the called authorized subscriber substation. The operation of the apparatus in the local link 21 and the first trunk circuit 60 in order to accomplish this end is the same as the operation thereof when a connection between the subscriber substations A and B was completed while a connection extending to the central exchange 20 was held as previously explained. After the subscriber at the called authorized subscriber substation answers the call, the subscriber at the substation A advises him that he wishes him to take over the central exchange connection.

The subscriber at the called substation accepts the central exchange connection by momentarily operating the grounding push button associated with the telephone instrument at the called subscriber substation. This operation of the grounding push button at the called subscriber substation causes direct ground potential to be applied to the negative line conductor of the called subscriber line and completes a path for energizing the upper winding of the relay R910 in the first trunk circuit 60, thereby to cause unbalancing of the upper and lower windings of the relay R910 and the consequent operation of this relay. The path for energizing the upper winding of the relay R910 extends from the grounded negative line conductor of the called subscriber line by way of the rotary switch 256 of the connector switch 23 of the local link 21, the rotary switch 260 of the finder switch 22 of the local link 21, the negative line conductor C826 of the link line 830, RA922, the upper winding of R910 and the upper winding of R905 to battery. Upon operating the relay R910 completes at RA912 a path for short-circuiting the intermediate winding of the relay R720, this path extending from C619 by way of the intermediate winding of R720, RA734, C840 and RA912 to C619. When this path for short-circuiting the intermediate winding of R720 is completed, this relay restores, as the circuit for energizing the upper winding thereof is interrupted at the armature RA932 and the front contact associated therewith, associated with the operated relay R930. Further, the relay R910 completes at RA914 an obvious circuit for energizing the lower winding of R940, thereby to complete a holding circuit for this relay, and connects at RA913 the lower winding of the relay R750 to the start lead C822, thereby to complete a circuit for energizing the lower winding of R750. The circuit for energizing the lower winding of R750 extends from ground at the armature RA333 of the relay R330 in the allotter 50 by way of the start lead C822, C853, RA913, C852 and the lower winding of R750 to battery. When the relay R910 is thus operated it completes at RA911 a holding circuit for itself extending from battery at the lower terminal of the upper winding of the relay R905 by way of the upper winding of R905, the upper winding of R910, RA911, the negative line conductor C826 of the link line 830, the rotary switch 260 of the finder switch 22 of the local link 21, the rotary switch 256 of the connector switch 23 of the local link 21, the loop circuit extending between the rotary switch 256 and the rotary switch 252 of the connector switch 23 including the called subscriber line and the telephone instrument at the called subscriber substation, C227, RA103, RA125 and the front contact associated therewith, the resistor 176, RA158 and the lower winding of R130 in the local link 21 to ground.

Upon restoring, the relay R720 interrupts at RA721 and at RA722 and the front contact associated therewith the loop circuit extending between the calling subscriber substation A and the relays R900 and R790 in the first trunk circuit 60, thereby to cause the relay R790 to restore. Further, the relay R720 interrupts at RA727 the path for applying ground potential from the grounded control conductor C630 by way of the intermediate winding of R720 to the control conductor C619. This removal of ground potential from the control conductor C619 interrupts the circuit for energizing the lower winding of the relay R390 associated with the subscriber line 403 extending to the calling subscriber substation A, thereby to cause the relay R390 to restore. Further, the relay R720 interrupts at RA724 the circuit for energizing the multiple connected upper winding of the relay R730 and the lower winding of the relay R930 in series with the upper winding of R940, thereby to cause the relay R730 to restore, the relay R940 being retained in its operated position by the completed holding circuit therefor including the lower winding thereof and the relay R930 being retained in its operated position by the operated relay R940. Finally, the relay R720 prepares at RA723 a circuit, traced hereinafter, for energizing in multiple the winding of the motor M615 and the upper winding of the relay R740. Upon restoring, the relay R790 interrupts at RA791 a point in the circuit for energizing the relay R920, thereby to cause the latter relay to restore, and completes at RA793 and the back contact associated therewith the circuit for energizing the lower winding of the relay R950, this

circuit extending from ground at RA793 and the back contact associated therewith by way of C855, RA774, C856 and the lower winding of R950 to battery. When energized over the above-traced circuit, the relay R950 operates to complete at RA955 and the front contact associated therewith the path for short-circuiting the upper winding of R950, thereby to render this relay slow to release. Further, the relay R790 interrupts at RA793 and the front contact associated therewith the circuit for energizing the relay R770, the relay R770 being held in its operated position by a holding circuit therefor extending from ground at RA906 by way of C859, RA934 and the front contact associated therewith, RA979' and the back contact associated therewith, C862, RA949, C863 and the winding of R770 to battery.

Assuming that no other authorized substation is initiating a transfer of a central exchange connection to another authorized subscriber substation at this time, ground potential applied to the start conductor C822 at the armature RA333 of the relay R330 in the allotter 50 completes a circuit for energizing the lower winding of the relay R750, this circuit extending from the grounded start conductor C822 by way of C853, RA913, C852 and the lower winding of R750 to battery. When energized over the above-traced circuit, the relay R750 operates to complete at RA755 a holding circuit for itself extending from ground at RA755 by way of C853, RA913, C852 and the lower winding of R750 to battery. Further, the relay R750 completes at RA757 a path for applying ground potential to the start conductor C821 extending to the allotter 50, this path extending from ground at RA906 by way of C859, RA757 to the start conductor C821. This application of ground potential to the start conductor C821 causes the relay R330 in the allotter 50 to operate. Upon operating, the relay R330 interrupts at RA333 the application of ground potential to the start conductor C822, thereby to prevent any other authorized subscriber substation from transferring a central exchange connection to another authorized subscriber substation until the present central exchange connection is transferred from the authorized subscriber substation A to the called authorized subscriber substation. Also, the relay R330 interrupts at RA332 a point in the circuit for energizing the relay R300 in the allotter 50 from the start lead C419, thereby to prevent the operation of R300 incident to the initiation of a trunk call from one of the authorized subscriber substations until the present transfer is completed. Further, the relay R750 connects at RA756 the lower winding of the relay R720 to the control conductor C617 connected to the wiper 675 of the rotary switch 674 included in the trunk finder-connector switch 30. This connection extends from battery at the upper terminal of the lower winding of R720 by way of the lower winding of R720, RA756 and C617 to the wiper 675 of the rotary switch 674. Further, the relay R750 completes at RA752 a path for energizing the multiple connected winding of the motor M615 and the upper winding of the relay R740 from the pulse ground lead C179, this path extending from the pulse ground lead C179 by way of C831, C616 and RA752 to RA723, one branch extending from RA723 by way of C625 and the winding of M615 to battery and the other branch extending from RA723 by way of the upper winding of R740 to battery. Finally, the relay R750 completes a RA751 a path for applying ground potential t the control conductor C829 of the link line 830 thereby to extend ground potential to the con tact in the contact bank 270 of the rotary switc 268 of the connector switch 22 terminating th control conductor C829 of the link line 830.

The winding of the motor M615 and the uppe winding of the relay R740 are intermittentl energized over the above-traced path includin the pulse ground lead C179. This intermitten energization of the relay R740 causes it to operate to complete at RA745 the path for short-circuiting the lower winding thereof, thereby t render this relay slow to release so that thi relay remains operated during the impulsing period. Further, the relay R740 interrupts a RA741 and RA742 the connection between the wipers 687 and 683 of the rotary switches 686 and 682, respectively, of the trunk finder-connector switch 30 and the negative and positive trunk conductors C835 and C836, respectively, of the first trunk circuit, thereby to prevent the rotation of the wipers 683 and 687 of the rotary switches 682 and 686, respectively, over the associated contact banks 684 and 688, respectively, from interfering with established connections extending to other subscriber substations. This intermittent energization of the motor M615 causes the wipers of the rotary switches comprising the trunk finder-connector switch 30 to be rotated step by step in a counterclockwise direction as previously explained until the wipers of the rotary switches are rotated into engagement with the contacts in the associated contact banks terminating the subscriber line extending to the called authorized subscriber substation. When the wiper 675 of the rotary switch 674 is rotated into engagement with the contact terminating the control conductor of the subscriber line extending to the called authorized subscriber substation, a circuit is completed for energizing the lower winding of the relay R720, this circuit extending from ground at RA751 by way of the control conductor C829 of the link line 830, the contact in the contact bank 270 of the rotary switch 268 terminating the control conductor of the link line 830, the associated wiper 269, C232, the lower winding of the relay R150 in the first local link 21, RA143 and the front contact associated therewith, RA114, C226, the wiper 245 of the rotary switch 244, the contact in the associated contact bank 246 terminating the control conductor of the subscriber line extending to the called authorized subscriber substation, the contact in the contact bank 676 of the rotary switch 674 of the trunk finder-connector switch 30 terminating the last-mentioned control conductor, the associated wiper 675, C617, RA756 and the lower winding of R720 to battery. When energized over the above-traced circuit, the relay R720 operates to interrupt at RA723 the previously traced path for energizing the multiple connected winding of the motor M615 and the upper winding of the relay R740, thereby to cause the relay R740 to restore shortly thereafter and to arrest further operation of the motor M615.

Also, upon operating, the relay R720 completes at RA721 and at RA722 and the front contact associated therewith a loop circuit between the called authorized subscriber substation and the relays R900 and R790 in the first trunk circuit 60, this circuit extending from ground at

the upper terminal of the lower winding of the relay R790 by way of the lower winding of R790, C848, the lower winding of R900, C836, RA763 and the front contact associated therewith, C861, RA722 and the front contact associated therewith, C622, the wiper 683 of the rotary switch 682, the contact in the associated contact bank 684 terminating the positive line conductor of the subscriber line extending to the called authorized subscriber substation, the connection between the positive and negative line conductors of the subscriber line extending to the called authorized subscriber substation including the telephone instrument at the called authorized subscriber substation, the contact in the contact bank 688 of the rotary switch 686 terminating the negative line conductor of the subscriber line extending to the called authorized subscriber substation, the associated wiper 687, C624, RA721, C860, RA762 and the front contact associated therewith, C835, the upper winding of R900 and the upper winding of R790 to battery.

At this time a circuit for energizing the intermediate winding of the relay R720 in series with the lower winding of the line relay associated with the called authorized subscriber substation is completed, this circuit extending from the grounded control conductor C630 by way of RA771, C843, RA727, the intermediate winding of R720, C619, the wiper 679 of the rotary switch 678, the contact in the associated contact bank 680 terminating the control conductor of the subscriber line extending to the called subscriber substation, the last-mentioned control conductor and the lower winding of the line relay associated with the subscriber line extending to the called authorized subscriber substation to battery.

The previously traced circuit for energizing the lower winding of R720 extending from ground at RA751 by way of the local link 21 and the trunk finder-connector switch 30 to battery at the upper terminal of the lower winding of R720 includes the lower winding of the relay R150 in the first local link 21. The relay R150 is of the differential type, the lower winding opposing the upper and intermediate windings thereof, thereby to cause the relay R150 to restore when the lower winding thereof is energized over the above-traced circuit. Upon restoring, the relay R150 interrupts at RA157 and RA158 points in the loop circuit extending between the called authorized subscriber substation and the first local link 21 and including the upper and lower windings of the relay R130, thereby to cause the latter relay to restore. Upon restoring, the relays R130 and R150 cause the first local link 21 to be completely released, the connector switch 23 thereof being returned to its home position, in the manner previously explained. When the local link 21 is completely released, the loop circuit extending between the called authorized subscriber substation and the relays R910 and R905 in the first trunk circuit 60 by way of the first local link 21 and the link line 830 is interrupted, thereby to cause the relays R905 and R910 to store. Upon restoring, the relay R910 interrupts at RA914 the previously traced circuit for energizing the lower winding of R940, thereby to cause the latter relay to restore. Upon restoring, the relay R940 completes at RA942 and the back contact associated therewith and at RA943 and the back contact associated therewith a loop circuit between the central exchange 20 and the relay R920 in the first trunk circuit 60, thereby to cause a connection to be completed between the loop extending between the central exchange and the relay R920 in the first trunk circuit 60 and the loop circuit extending between the called authorized subscriber substation and the relays R790 and R900 in the first trunk circuit 60 in order to complete an established connection between the called authorized subscriber substation and the subscriber substation associated with the central exchange. Also, upon restoring, the relay R910 interrupts at RA913 a point in the circuit for energizing the lower winding of the relay R750, thereby to cause this relay to restore. Upon restoring, the relay R750 interrupts at RA757 a point in the path for applying ground potential to the start conductor C821 extending to the allotter 50. When ground potential is removed from the start conductor C821, the relay R330 in the allotter 50 restores, thereby to release the equipment in the allotter for further use. When the loop circuit between the called authorized subscriber substation and the relays R790 and R900 in the first trunk circuit 60 is completed, the relay R790 operates, while the relay R900 does not operate. Upon operating, the relay R790 interrupts at RA793 and the back contact associated therewith a point in the circuit for energizing the lower winding of R950, thereby to cause the latter relay to restore shortly thereafter, the latter relay being rendered slow-to-release due to the completed path for short-circuiting the upper winding thereof.

When the trunk finder-connector switch 30 operates to find the subscriber line extending to the called authorized subscriber substation, the wipers of the rotary switches therein disengage the conductors comprising the subscriber line 403 extending to the authorized subscriber substation A, thereby to cause the relay R390 associated with the subscriber line 403 to restore and the apparatus at the subscriber substation A to be completely released for further use. When the first local link 21 is released, the circuit for energizing the upper winding of the relay R930 is interrupted, thereby to cause this relay to restore. At this time, an established connection is completed between the called authorized subscriber substation and the subscriber substation associated with the central exchange 20, by way of the first trunk circuit 60 and the apparatus associated with the central exchange 20 and the local link 21 is completely released for further use. In the event that the subscriber at the called authorized subscriber substation wishes to transfer the central exchange connection to another authorized subscriber substation or back to the authorized subscriber substation A, this may be accomplished in the same manner the central exchange connection was transferred from the authorized subscriber substation A to the called authorized subscriber substation, described above.

The established connection extending between the called authorized subscriber substation and the substation associated with the central exchange 20 by way of the first trunk circuit 60 may be released primarily under the control of the subscriber at the called authorized subscriber substation in the same manner that the established connection between the authorized subscriber substation A and the central exchange 20 routed by way of the first trunk circuit 60 is released, previously described.

Indirect transfer of a central exchange call from an authorized substation to a semiauthorized or authorized substation by calling the attendant at the attendant cabinet on the information trunk.

A subscriber at an authorized subscriber substation may transfer a central exchange call to a semiauthorized or authorized subscriber substation with the assistance of the attendant at the attendant cabinet by first calling the attendant on the information trunk. For example, in order to transfer a call from the central exchange **20** routed by way of the first trunk circuit **60** to the authorized subscriber substation A to a semiauthorized or authorized subscriber substation in the manner noted above, the subscriber at the substation A momentarily operates the grounding push button **393** at the authorized subscriber substation A, thereby to cause a local link to associate itself with the first trunk circuit in the manner previously explained in connection with the description of establishing a connection between the authorized subscriber substation A and the semiauthorized subscriber substation B while holding the central office connection. As previously noted, the momentary operation of the grounding push button **393** at the subscriber substation A causes the differential relay R**900** to operate and cause the allotter **50** to assign a local link to the use of the calling subscriber substation A. Assuming that the local link **21** is assigned by the allotter **50** to the use of the calling subscriber substation A, the finder-connector switch **22** thereof operates to find the link line **830** extending to the first trunk circuit **60**. After the finder switch **22** finds the link line **830**, dial tone current is transmitted by way of the finder switch **22**, the link line **830**, the first trunk circuit **60**, the trunk finder-connector switch **30** and the subscriber line **403** to the calling subscriber substation A, thereby to advise the subscriber thereat that he may dial the directory number of the information trunk **650** extending to the attendant cabinet **40**. The subscriber at the substation A then dials the digits comprising the directory number of the information trunk **650**, thereby to cause the connector switch **23** of the local link **21** to seize the information trunk. When the information trunk is seized, busy tone current is returned over the above-traced circuit to the subscriber substation substation A in the event the information trunk is busy, or ringing current is projected over the information trunk to the attendant cabinet **40** in the event the information trunk is idle, as previously explained. The projection of ringing current over the information trunk **650** causes operation of the ringer **561** at the attendant cabinet **40**, thereby to indicate to the attendant thereat that a call awaits an answer on the information trunk. The attendant answers the call as previously described and is advised as to which trunk circuit the central office call is being held on by intermittent operation of the grounding push button **393** at the subscriber substation A, performed by the subscriber thereat. This intermittent operation of the grounding push button at the subscriber substation A causes the differential relay R**900** in the first trunk circuit **60** to operate intermittently as previously explained. This intermittent operation of the differential relay R**900** intermittently interrupts at RA**902** and the front contact associated therewith a circuit for illuminating the answer and supervisory lamp **564** associated with the first trunk circuit **60**, this circuit extending from ground at RA**724** and the front contact associated therewith by way of C**838**, RA**902** and the back contact associated therewith, C**846**, the resistor **784**, RA**782** and the back contact associated therewith, C**641**, the switch spring **571** of the night switch **570** and the back contact associated therewith, and the lamp **564** to battery. This flashing of the answer and supervisory lamp **564** associated with the first trunk circuit **60** indicates to the attendant at the attendant cabinet **40** that the central exchange call is being held on the first trunk circuit **60**.

The attendant at the attendant cabinet **40** then takes over the connection to the first trunk circuit **60** by operating the trunk hold switch **563** and the connect switch **600** associated therewith to their front positions. When the trunk hold switch **563** and the connect switch **600** are thus operated, a bridge path is completed across the positive and negative trunk conductors C**623** and C**620**, respectively, thereby to complete a loop circuit for energizing the relays R**790** and R**900** in the first trunk circuit **60**, this circuit extending from ground at the upper terminal of the lower winding of R**790** by way of the lower winding of R**790**, C**848**, the lower winding of R**900**, C**836**, C**623**, the switch spring **603** of the connect switch **600** and the front contact associated therewith, the switch spring of the trunk hold switch **563** and the front contact associated therewith, the resistor **562**, the switch spring **601** of the connect switch **600** and the front contact associated therewith, C**620**, C**835**, the upper winding of R**900** and the upper winding of R**790** to battery. At this time, the above-traced loop circuit holds the first trunk circuit **60** in its operated position thereby to hold the central exchange call thereon and a loop circuit is completed between the attendant cabinet **40** and the subscriber substation A, the last-mentioned circuit extending therebetween by way of the information trunk switch **593**, the information trunk **650**, the local link **21**, the link line **830**, the trunk circuit **60**, the trunk finder-connector switch **30**, the subscriber line **403** and the telephone instrument at the subscriber substation A. After terminating the conversation between the attendant at the attendant cabinet **40** and the subscriber at the subscriber substation A, the attendant operates the information trunk switch **593** to its back position and operates the trunk hold switch **563** to its back position, thereby to complete a loop circuit between the impedance **500** and the relays R**790** and R**900** in the first trunk circuit **60**, this loop circuit extending from ground at the upper terminal of the lower winding of R**790** by way of the previously traced circuit to the switch spring **595** of the information trunk switch **593** and the back contact associated therewith and from battery at the lower terminal of the upper winding of R**790** by way of the previously traced circuit to the switch spring **594** of the information trunk switch **593** and the back contact associated therewith, the loop circuit further extending from the switch spring **595** of the information trunk switch **593** by way of C**655**, the impedance **500**, RA**512**, RA**531** and C**654** to the switch spring **594** of the information trunk switch **593**. The attendant at the attendant cabinet **40** then releases the established connection between the subscriber substation A and the first trunk circuit **60** by momentarily operating the common trunk release switch **590** after the in-

formation trunk switch 593 and the hold trunk switch 563 have been operated to their back positions. This operation of the common trunk release switch interrupts at the switch spring 591 and the back contact associated therewith the application of ground potential to the control conductor C630, thereby to cause the relays R720 and R760 in the first trunk circuit 60 to restore. The restoration of the relay R720 causes the trunk finder-connector switch 30 to be returned to its home position, thereby to cause the relay R730 to reoperate, as previously explained in connection with the release of the subscriber substation B heretofore described. The attendant at the attendant cabinet 40 may then operate the dial-split switch 610 associated with the first trunk circuit 60 and then dial at the dialing mechanism 582 the directory number of the line extending to the subscriber substation to which the trunk call is to be extended. The operation of the apparatus at the attendant cabinet 40 and in the first trunk circuit 60 incident to the operations of the dial-split switch 610 and the dialing mechanism 582 are the same as those previously described in connection with the completion of an established connection between the first trunk circuit 60 and the subscriber substation B incident to the routing of a call by way of the first trunk circuit 60 from the central exchange 20 thereto, previously described.

Indirect transfer of a central exchange call from an authorized substation to a semiauthorized or authorized substation by signaling the attendant at the attendant cabinet

A subscriber at an authorized subscriber substation may transfer a central exchange call to a semiauthorized or authorized subscriber substation with the assistance of the attendant at the attendant cabinet by first signaling the attendant. For example, in order to transfer a call from the central exchange 20 routed by way of the first trunk circuit 60 to the authorized subscriber substation A to a semiauthorized or authorized subscriber substation in the manner noted above, the subscriber at the substation A first operates the grounding push button 393, thereby to cause direct ground potential to be applied to the negative line conductor C408 of the subscriber line 403. This application of direct ground potential to the negative line conductor C408 of the subscriber line 403 causes the differential relay R900 to operate as previously explained, thereby to complete at RA904 the previously traced circuits for energizing the lower winding of the relay R730 and the winding of the thermostatic device T962. The subscriber at the substation A retains the grounding push button 393 in its operated position for a predetermined time interval, thereby to cause the thermal responsive element of the thermostatic device T962 to operate. Upon operating, the thermal responsive element of the thermostatic device T962 interrupts at TA963 and the back contact associated therewith a point in the previously traced circuit for energizing the lower winding of the relay R730 and completes at TA963 and the front contact associated therewith a circuit for energizing the upper winding of R780, the latter circuit extending from ground at RA724 and the front contact associated therewith by way of C838, RA904, RA948, TA963 and the front contact associated therewith, C854 and the upper winding of R780 to battery. When energized over the above-traced circuit, the relay R780 operates to complete at RA783 a path for applying ground potential to the motor start lead C1007, thereby to initiate operation of the common equipment connected to the motor start lead C1007 as previously noted. Further, the relay R780 completes at RA781 a path for operating the trunk signal buzzer M576 located at the attendant cabinet 40, this path extending from the pulse ground lead C1000 by way of C823, RA781, C640, the switch spring of the trunk signal switch 567 and the back contact associated therewith, the switch spring 574 of the night switch 570 and the back contact associated therewith, the self-interrupting contacts 576' and the winding of M576 to battery. Further, the relay R780 completes at RA782 and the front contact associated therewith a path for illuminating to its full brilliance the answer and supervisory lamp 564 located at the attendant cabinet 40, this path extending from the pulse ground lead C1000 by way of RA971, C824, RA782 and the front contact associated therewith, C641, the switch spring 571 of the night switch 570 and the back contact associated therewith and the lamp 564 to battery. The illumination of the lamp 564 and the operation of the trunk signal buzzer M576 at the attendant cabinet 40 indicate to the attendant thereat that a call on the first trunk circuit 60 is awaiting an answer. The attendant answers the call by operating the connect switch 600 to its front position, thereby to complete a loop circuit between the subscriber substation A and the attendant cabinet 40, this loop circuit extending from the upper terminal of the impedance 500 by way of RA512, RA531, C654, the switch spring 594 of the information trunk switch 593 and the back contact associated therewith, the switch spring 601 of the connect switch 600 and the front contact associated therewith, C620, RA762 and the front contact associated therewith, C860, RA721 and C624 to the wiper 687 of the rotary switch 686 and from the lower terminal of the impedance 500 by way of C655, the switch spring 595 of the information trunk switch 593 and the back contact associated therewith, the switch spring 603 of the connect switch 600 and the front contact associated therewith, C623, RA763 and the front contact associated therewith, C861, RA722 and the front contact associated therewith, and C622 to the wiper 683 of the rotary switch 682, the rotary switches 682 and 686 being connected together by way of the subscriber line 403 and the telephone instrument at the subscriber substation A.

When the subscriber at the substation A hears the attendant at the attendant cabinet 40 after the attendant answers, he releases the grounding push button 393 at the substation A, thereby to interrupt the previously traced path for applying direct ground potential to the negative line conductor C408 of the subscriber line 403, in order to cause the differential relay R900 to restore. Upon restoring, the relay R900 interrupts at RA904 the previously traced circuits for energizing the winding of the thermostatic device T962 and for energizing the upper winding of the relay R780, thereby to cause the latter relay to restore. Upon restoring, the relay R780 interrupts at RA781 and at RA782 and the front contact associated therewith the previously traced circuits for respectively operating the trunk signal buzzer M576 and for illuminating the answer and supervisory lamp 564. Due to the fact that the attendant at the attendant cabinet 40 must be able to talk to the subscriber at the subscriber substation A while direct

ground potential is applied at the grounding push button 393 at the substation A to the negative line conductor C408 of the subscriber line 403, it is essential that the receiver of the telephone instrument at the substation A be of the permanent magnet type. Otherwise, it would be impossible for the subscriber at the substation A to hear the attendant while direct ground potential is applied to the negative line conductor C408 of the subscriber line 403.

The attendant at the attendant cabinet 40 is then advised as to the semiauthorized or authorized subscriber substation to which the subscriber at the substation A wishes the central office call transferred. At this time a connection is established between the loop circuit extending between the central exchange 20 and the relay R920 in the first trunk circuit 60, and the loop circuit extending between the attendant cabinet 40 and the subscriber substation A, thereby rendering it possible for both the subscriber at the substation A and the subscriber at the substation associated with the central exchange to converse with the attendant at the attendant cabinet 40. In the event the attendant at the attendant cabinet 40 wishes to converse with the subscriber at the subscriber substation A to the exclusion of the subscriber at the substation associated with the central exchange 20, this may be accomplished by operating the dial-split switch 610 to its front position. This operation of the dial-split switch completes at the switch spring 612 and the front contact associated therewith a circuit for energizing the lower winding of the relay R940, this circuit extending from ground at RA775 by way of C635, the switch spring 612 of the dial-split switch 610 and the front contact associated therewith, C636, the switch spring 608 of the contact switch 600 and the front contact associated therewith, C637 and the lower winding of R940 to battery. When energized over the above-traced circuit, the relay R940 operates to interrupt at RA942 and the back contact associated therewith and at RA943 and the back contact associated therewith a point in the connection between the loop circuit extending between the central exchange 20 and the relay R920 in the first trunk circuit 60 and the loop circuit extending between the subscriber substation A and the attendant cabinet 40.

The attendant at the attendant cabinet 40 then proceeds to establish a connection between the first trunk circuit 60 and the desired subscriber substation to which the central office call is to be transferred in the same manner that an incoming central exchange call was established between the first trunk circuit 60 and the semiauthorized subscriber substation B, previously described.

Placing incoming central exchange calls in waiting at the attendant cabinet

Incoming calls from the central exchange 20 to the P. A. B. X. are first routed by way of an idle one of the trunk circuits to the attendant cabinet 40, thereby to cause the answer and supervisory lamp associated with the trunk circuit over which the call is routed to be illuminated and to cause the trunk signal buzzer to be operated, as previously explained. Assuming that an incoming call is routed from the central exchange 20 by way of the first trunk circuit 60 to the attendant cabinet 40 in the previously described manner, the attendant at the attendant cabinet 40 answers the call in the usual manner by operating the connect switch 600 associated with the first trunk circuit 60 to its front position. The attendant then is informed of the subscriber substation to which the call is to be extended and then operates the dial-split switch 610 to its front position. Finally, the attendant dials the digits comprising the directory number of the called subscriber substation, thereby to cause the trunk finder-connector switch 30 to seize the subscriber line extending to the called subscriber substation. In the event the called subscriber substation is busy, the answer and supervisory lamp 564 remains dark, thereby to indicate to the attendant at the attendant cabinet this condition of the called subscriber substation. The operator may then offer the central exchange call to the subscriber at the busy subscriber substation, and, in the event the subscriber is not in a position to accept the central exchange call immediately, the attendant may place the call "in waiting." The operations of the apparatus at the attendant cabinet 40 and in the first trunk circuit 60 incident to the answering of the incoming central exchange call and the seizure of the subscriber line extending to the busy called subscriber substation are the same as those previously described in connection with the extension of a call from the central exchange 20 to the subscriber substation B. At this time, the connect switch 600 and the dial-split switch 610 are operated to their front positions, and the relays R540, R770, R790, R700, R710 and R940 occupy operated positions.

The central exchange call is placed "in waiting" by operating the connect switch 600 to its back position while the dial-split switch 610 is operated to its front position. This operation of the connect switch 600 interrupts at the switch spring 609 of the connect switch 600 and the front contact associated therewith the previously traced circuit for energizing the relay R540, thereby to cause this relay to restore shortly thereafter, this relay being of the slow-to-release type. Further, at the switch spring 607 and the front contact associated therewith, the previously traced circuit for energizing the relay R700 is interrupted when the connect switch 600 is operated to its back position, thereby to cause this relay to restore. Upon restoring, the relay R700 interrupts at RA703 and the front contact associated therewith the previously traced circuit for energizing the relay R710, thereby to cause this relay to restore shortly thereafter, the latter relay being of the slow-to-release type. When the dial-split switch 610 is thus operated there is completed at the switch spring 612 thereof and the front contact associated therewith a circuit for energizing in series the lower winding of the relay R940 and the winding of the thermostatic device T964, the circuit extending from ground at RA775 by way of C635, the switch spring 612 of the dial-split switch 610 and the front contact associated therewith, C636, the winding of the thermostatic device T964 and the lower winding of the relay R940 to battery. When energized over the above-traced circuit, the relay R940 is retained in its operated position. At this time, the previously traced circuit for connecting the lower winding of the relay R960 across the positive and negative conductors C1011 and C1010 of the first trunk circuit 60 is completed, thereby to complete a loop circuit between the central exchange 20 and the lower winding of the relay R960.

When the connect switch 600 is operated to its back position, the previously traced loop circuit

extending between the attendant cabinet 40 and the relays R900 and R790 in the first trunk circuit 60 is interrupted at the switch springs 601 and 603 and the front contacts associated therewith, thereby to cause the relay R790 to restore. Upon restoring, the relay R790 prepares at RA793 and the back contact associated therewith a circuit, traced hereinafter, for energizing the upper winding of the relay R780, the relay R770 being held in its operated position at this time by way of a holding circuit extending from ground at TA811 by way of C861, RA934 and the back contact associated therewith, RA979' and the back contact associated therewith, C862, RA949, C863 and the winding of R770 to battery. After a predetermined time interval, the thermal responsive element of the thermostatic device T964 operates to complete at TA965 the circuit for energizing the upper winding of the relay R780, this circuit extending from ground at RA793 and the back contact associated therewith by way of C855, TA965, C854 and the upper winding of R780 to battery. When energized over the above-traced circuit, the relay R780 operates to complete at RA782 the previously traced path for illuminating the answer and supervisory lamp 654 at the attendant cabinet 40 and to complete at RA781 and the front contact associated therewith the previously traced path for operating the trunk signal buzzer M576 at the attendant cabinet 40. Due to the fact that the above-mentioned paths include the pulse ground lead C1000, the answer and supervisory lamp 564 is flashed and the trunk signal buzzer M576 is intermittently operated. The flashing of the lamp 564 and the operation of the buzzer M576 indicate to the attendant at the attendant cabinet that the call "in waiting" should be answered.

The attendant then recompletes the loop circuit between the attendant cabinet 40 and the relays R900 and R790 in the first trunk circuit 60 by operating the connect switch 600 to its front position, thereby to cause reoperation of the relay R790. Upon operating, the relay R790 interrupts at RA793 and the back contact associated therewith the previously traced circuit for energizing the upper winding of the relay R780, thereby to cause the latter relay to restore. This operation of the connect switch 600 also completes at the switch spring 608 and the front contact associated therewith a path for short-circuiting the thermostatic device T964, this path extending from the upper terminal of the winding of the thermostatic device T964 by way of the winding of T964, C636, the switch spring 608 and the front contact associated therewith and C637 to the upper terminal of the winding of T964, thereby to cause the thermal responsive element of the thermostatic device T964 to be restored. When the thermal responsive element of the thermostatic device T964 restores, a further point in the previously traced circuit for energizing the upper winding of the relay R780 is interrupted. Upon restoring, the relay R780 interrupts at RA782 and at RA781 and the front contact associated therewith, respectively, the previously traced paths for illuminating the answer and supervisory lamp 564 and for operating the trunk signal buzzer M576. The attendant at the attendant cabinet 40 then proceeds to establish a connection between the first trunk circuit 60 and the desired subscriber substation, as described above. In the event the desired subscriber substation is still busy, the call may again be placed "in waiting" or the call may be abandoned by the subscriber at the substation associated with the central exchange 20 in the event the subscriber does not wish to wait any longer.

Temporary direct answering of incoming central exchange calls at authorized substations

The attendant at the attendant cabinet 40 is given a predetermined time interval in which to answer an incoming central exchange call routed thereto by way of the trunk circuits. For example, assuming that an incoming central exchange call is routed by way of the first trunk circuit 60 to the attendant cabinet 40, the attendant at the attendant cabinet is given a predetermined time interval within which to answer this incoming central exchange call. In the event the call is not answered within this predetermined time interval, the thermal responsive element of the thermostatic device T570 at the attendant cabinet 40 is operated, the winding of the thermostatic device T570 being energized by way of the previously traced circuit in series with the lower winding of R780 upon operation of the relay R970 as previously explained. Upon operating, the thermal responsive element of the thermostatic device T570 completes at TA571 a circuit for energizing the relay R550, this circuit extending from ground at RA543 and the back contact associated therewith by way of TA571 and the winding of the relay R550 to battery. When energized over the above-traced circuit, the relay R550 operates to complete at RA553 a circuit for energizing the winding of the relay R700, this circuit extending from ground at RA724 and the back contact associated therewith by way of C628, RA553, C633, RA979, C858 and the winding of R700 to battery, thereby to cause the latter relay to operate. Further, the relay R550 interrupts at RA557 a point in the previously traced circuit for energizing the lower winding of the relay R780, thereby to cause the latter relay to restore. Further, the relay R550 completes at RA555 a circuit for energizing the relay R530, this circuit extending from ground at the switch spring 572 of the night switch 570 and the back contact associated therewith by way of RA542 and the back contact associated therewith, RA555 and the winding of R530 to battery, thereby to cause the relay R530 to operate, and interrupts at RA558 a point in the path for applying ground potential to the transmitter 565 at the attendant cabinet 40. Further, the relay R550 completes at RA556 a holding circuit for itself extending from ground at RA543 and the back contact associated therewith by way of RA556 and the winding of R550 to battery, prepares at RA552 a point in the path for applying ground potential to the start conductor C820 extending to the allotter 50, and prepares at RA551 a point in the circuit for applying battery potential to the control conductor C639 extending to the allotter 50.

Upon restoring, the relay R780 interrupts at RA782 and at RA781 and the front contact associated therewith, respectively, the previously traced circuits for illuminating the answer and supervisory lamp 564 and for operating the trunk signal buzzer M576, thereby to arrest flashing of the lamp and the operation of the buzzer. Upon operating, the relay R700 completes at RA701 the path for applying ground potential to the start conductor C820, this path extending from ground at RA552 by way of C627 and RA701 to the start conductor C820, and completes at

RA702 the path for applying battery potential to the control conductor C639, this path extending from battery at the lower terminal of the upper winding of R750 by way of the upper winding of R750, RA702, C626 and RA551 to the control conductor C639. Finally, the relay R700 completes at RA703 and the front contact associated therewith the previously traced circuit for energizing the relay R710, thereby to cause operation of the latter relay. The application of ground potential to the start conductor C820 completes a circuit for energizing the relay R360 in the allotter 50, thereby to cause operation of this relay. Upon operating, the relay R360 completes at RA361 a path for operating the general incoming trunk signal 387, this path extending from the pulse ground lead C395 by way of RA361 and the winding of the signal 387 to battery. The operation of the general incoming trunk signal 387 indicates to the subscribers at the authorized subscriber substations that an incoming central exchange call is awaiting an answer and that the attendant at the attendant cabinet 40 is not at her position to answer the call.

Upon operating, the relay R710 prepares at RA713 a holding circuit for itself and completes at RA716 a circuit for energizing the lower winding of the relay R940, the latter circuit extending from ground at RA775 by way of C635, RA716, C637 and the lower winding of R940 to battery. When energized over the above-traced circuit, the relay R940 operates to complete at RA941 the previously traced path for connecting the lower winding of the relay R960 across the positive and negative line conductors of the first trunk circuit 60 and interrupts at RA942 and the back contact associated therewith and at RA943 and the back contact associated therewith, respectively, the connections between the positive trunk conductors C836, C1011 and the negative trunk conductors C833, C1010.

A subscriber at any one of the authorized subscriber substations may answer the incoming central exchange call by momentarily operating the grounding push button at his substation. For example, the subscriber at the authorized subscriber substation A may answer the call by operating the grounding push button 393 at the substation A, thereby to apply direct ground potential to the negative line conductor C408 of the subscriber line 403. The application of direct ground potential to the negative line conductor C408 of the subscriber line 403 completes the previously traced circuit for energizing the intermediate winding of the relay R390 associated with the subscriber line 403, thereby to cause partial operation of this relay. Upon partially operating, the relay R390 completes at RA393 the previously traced path for applying ground potential to the start lead C419, thereby to complete the previously traced circuit for energizing the winding of the relay R300 in the allotter 50. When the winding of the relay R300 is energized, this relay operates to complete at RA301 the previously traced circuit for energizing the upper winding of the relay R320, thereby to cause this relay to operate as previously explained. Upon operating, the relay R320 completes at RA322 a path for applying ground potential to the control conductor C639 extending to the first trunk circuit, this path extending from ground at RA322 by way of the lower winding of R320, TA326, RA331 and RA363 and the front contact associated therewith to the control conductor C639, and completes at RA325 an obvious path for applying ground potential to the start conductor C417. This application of ground potential to the control conductor C639 completes a circuit for energizing the upper winding of the relay R750 in the first trunk circuit, this circuit extending from the grounded control conductor C639 by way of RA551, C626, RA702 and the upper winding of the relay R750 to battery. The above-traced circuit retains the relay R320 in the allotter 50 in its operated position and causes the relay R750 in the first trunk circuit 60 to operate. Upon operating, the relay R750 completes at RA752 a path for energizing in multiple the winding of the motor M615 and the upper winding of the relay R740, this path extending from the pulse ground lead C179 by way of C831, C616 and RA752 to RA723, one branch of this path extending from RA723 by way of C625 and the winding of M615 to battery and the other branch extending from RA723 by way of C625 and the upper winding of R740 to battery. When energized over the above-traced path, the motor M615 operates intermittently and the relay R740 operates to complete at RA745 an obvious path for short-circuiting the lower winding thereof, thereby to render the relay R740 slow to release in order that the relay R740 will not restore during the impulsing period. Further, the relay R750 completes at RA756 a path for applying battery potential to the wiper 675 of the rotary switch 674 of the trunk finder-connector switch 30, this path extending from battery at the upper terminal of the lower winding of R720 by way of the lower winding of R720, RA756, and C617 to the wiper 675. Further, the relay R750 interrupts at RA753 a point in the connection between the control conductor C639 extending to the first trunk circuit 60 and the control conductor C794 extending to the second trunk circuit, thereby to prevent the relays in the other trunk circuits corresponding to the relay R750 in the first trunk circuit 60 from being operated at this time, and interrupts at RA758 a point in the connection between the control conductor C638 extending to the first trunk circuit 60 and the control conductor C802 extending to the second trunk circuit, thereby to prevent operation of the relays in the other trunk circuits corresponding to the relay R750 in the first trunk circuit 60. Finally, the relay R750 completes at RA755 an obvious path for applying ground potential to the start conductor C822 extending to the allotter 50. The intermittent operation of the motor M615 rotates the wipers of the rotary switches of the trunk finder-connector switch 30 step by step in a counterclockwise direction until the wipers of the rotary switches are rotated to the positions of the contacts in the associated contact banks terminating the conductors of the subscriber line 403 extending to the subscriber substation A. When the wiper 675 of the rotary switch 674 engages the contact in the associated contact bank 676 terminating the control conductor of the subscriber line 403, a circuit is completed for energizing the lower winding of the relay R720, this circuit extending from battery at the upper terminal of the lower winding of R720 by way of the lower winding of R720, RA756, C617, the wiper 675 of the rotary switch 674, the contact in the associated contact bank terminating the control conductor C406 of the subscriber line 403, RA396, and RA395 to the grounded start lead C417.

During the operation of the motor M615 to rotate the wipers of the rotary switches over the

associated contact banks, the relay R740 occupies its operated position, thereby to interrupt at RA741 and at RA742 the connections between the negative trunk conductors C624, C835 and the positive trunk conductors C622, C836, in order to prevent interference with completed connections extending to other of the subscriber substations. When the relay R720 is energized over the above-traced circuit, it operates to complete at RA727 the previously traced path for energizing the upper and intermediate windings thereof in series with the lower winding of the relay R390, thereby to cause the relay R390 to operate as previously explained and to complete a holding circuit for the relay R720. Also, upon operating, the relay R720 interrupts at RA723 the previously traced path for energizing the multiple connected winding of the motor M615 and the upper winding of the relay R740, thereby to arrest further operation of the motor M615 and to cause the relay R740 to restore shortly thereafter. Further, the relay R720 completes at RA725 a holding circuit for the relay R710, this circuit extending from the grounded control conductor C630 by way of RA771, C843, RA765, RA725, RA713 and the winding of R710 to battery, and completes at RA724 and the front contact associated therewith the previously traced circuit for illuminating to its full brilliance the answer and supervisory lamp 564 at the attendant cabinet 40. Further, the relay R720 interrupts at RA724 and the back contact associated therewith the previously traced circuit for energizing the relay R700, thereby to cause the latter relay to restore, and interrupt at RA703 and the front contact associated therewith a point in the previously traced original operating circuit of the relay R710, the latter relay being held in its operated position at this time due to its completed holding circuit. Also, upon restoring, the relay R700 interrupts at RA701 the previously traced circuit for energizing the relay R360 in the allotter 50 and interrupts at RA702 the previously traced circuit for energizing the upper winding of the relay R750 in the first trunk circuit 60 in series with the lower winding of the relay R320 in the alloter 50, thereby to cause these relays to restore. Upon restoring, the relays R360 and R320 in the allotter 50 cause the allotter to be released for further use as previously explained. Finally, the relay R720 completes at RA721 and at RA722 and the front contact associated therewith the previously traced path for projecting ringing current from the interrupted generator lead C801 over the subscriber line 403 to ground at RA762 and the back contact associated therewith, thereby to cause the ringer at the substation A to be operated. The operation of the ringer at the substation A indicates to the subscriber thereat that the trunk circuit having the incoming central exchange call thereon has operated to extend the call to the substation A and that this call may be answered by removing the receiver of the telephone instrument thereat from its hook.

When the subscriber at the substation A answers the call by removing the receiver of the telephone instrument thereat from its hook, the previously traced low resistance circuit is completed for energizing the lower winding of the relay R760, thereby to cause operation thereof. Upon operating, the relay R760 completes at RA766 the previously traced holding circuit thereof, interrupts at RA762 and the back contact associated therewith and at RA763 and the back contact associated therewith the previously traced circuit for projecting ringing current over the subscriber line 403, and completes at RA762 and the front contact associated therewith and at RA763 and the front contact associated therewith a loop circuit between the subscriber substation A and the relays R900 and R790 in the first trunk circuit 60. This loop circuit extends from ground at the upper terminal of the lower winding of R790 by way of the lower winding of R790, C848, the lower winding of R900, C836, RA763 and the front contact associated therewith, RA722 and the front contact associated therewith and C622 to the wiper 683 of the rotary switch 682 and from battery at the lower terminal of the upper winding of R790 by way of the upper winding of R790, C847, the upper winding of R900, C835, RA762 and the front contact associated therewith, C860, RA721 and C624 to the wiper 687 of the rotary switch 686, the rotary switches 682 and 686 being connected by way of the positive and negative line conductors C409 and C408, respectively, to the subscriber substation A and the telephone instrument at this substation being connected across the positive and negative line conductors of the subscriber line 403. Further, the relay R760 interrupts at RA765 a point in the previously traced holding circuit of the relay R710, thereby to cause the latter relay to restore. Upon restoring, the relay R710 interrupts at RA711 a point in the path for short-circuiting the resistor 784, thereby to complete the previously traced alternative circuit including the resistor 784 for illuminating the answer and supervisory lamp 564 at the attendant cabinet 40 in order to cause this lamp to be illuminated dimly. Further, the relay R710 interrupts at RA716 the previously traced circuit for energizing the lower winding of the relay R940, thereby to cause the latter relay to restore.

When the above-traced loop circuit is completed, the relay R790 operates to interrupt at RA792 the previously traced circuit for energizing the upper winding of the relay R970, thereby to cause the latter relay to restore, interrupts at RA793 and the back contact associated therewith a point in the previously traced circuit for energizing the lower winding of the relay R950, thereby to cause the latter relay to restore, and completes at RA793 and the front contact associated therewith the previously traced holding circuit for the relay R770. Upon restoring the relay R940 connects at RA942 and the back contact associated therewith and at RA943 and the back contact associated therewith the relay R920 across the positive and negative trunk conductors C1011 and C1010 respectively, thereby to cause the relay R920 to give answer supervision to the operator in the central exchange 20 and, in the event the central exchange is of the manual common battery type, to cause the relay R920 to operate. Upon operating, the relay R920 completes at RA921 and at RA923 the previously traced connection between the loop circuit extending between the subscriber substation A and the relays R900 and R790 in the first trunk circuit 60 and the loop circuit extending between the relay R920 and the central exchange 20, thereby to complete an established connection between the subscriber substation A and the subscriber substation associated with the exchange 20 for two-way communication therebetween.

The release of this established connection between the subscriber substation A and the sub-

scriber substation associated with the central exchange 20 is the same as the release of the established connection therebetween previously described except that the relays R550 and R530 at the attendant cabinet 40 remain operated. Accordingly, this temporary direct answering of incoming central exchange calls remains in force and the next incoming call from the central exchange 20 will cause operation of the general trunk signal 387 in the manner previously described. This temporary direct answering of incoming central exchange calls remains in force, and these calls are answered directly at the authorized subscriber substations until the attendant returns to the attendant cabinet 40 and assumes control by answering an incoming central exchange call. When the attendant answers an incoming central exchange call, the connect switch 600 is operated to its front position, thereby to complete at the switch spring 609 and front contact associated therewith the previously traced circuit for energizing the relay R540. When energized, the relay R540 operates to interrupt at RA543 and the back contact associated therewith the previously traced circuit for energizing the relay R550 and interrupts at RA542 and the back contact associated therewith the previously traced circuit for energizing the relay R530, thereby to cause the relay R550 to restore immediately and to cause the relay R530 to restore shortly thereafter, the latter relay being of the slow-to-release type. The restoration of the relays R530 and R550 arrest further temporary direct answering of incoming central exchange calls. However, this service may again be instituted in the event an incoming central exchange call is not answered within a predetermined time interval after it is extended to the attendant cabinet 40 as previously explained.

While temporary direct answering service is in force, incoming central exchange calls have preference over outgoing trunk calls, due to the fact that, when an incoming central exchange call is extended to the P. A. B. X., the relay R360 in the allotter 50 operates to interrupt at RA363 and the back contact associated therewith a point in the path for applying ground potential to the control conductor C638 extending to the first trunk circuit 60 and prepares at RA363 and the front contact associated therewith a point in the path for applying ground potential to the control conductor C639 extending to the first trunk circuit 60. As previously noted, the operation of the grounding push button at one of the authorized subscriber substations to apply direct ground potential to the negative control conductor thereof is effective to cause the relay R320 in the allotter 50 to operate in order to apply ground potential to either the control conductor C638 or the control conductor C639, the application of ground potential to the control conductor C638 being effective to initiate an outgoing central exchange call while the application of ground potential to the control conductor C639 is effective to initiate the answering of an incoming central exchange call. Accordingly, when temporary direct answering service is in force, the operation of the grounding push button at one of the authorized subscriber substations is effective to cause the call to be answered rather than to cause an outgoing central exchange call to be initiated.

It is noted that this temporary direct answering service is automatically instituted on any one of the trunk lines incoming to the P. A. B. X. when an incoming call to the P. A. B. X. thereo from the central exchange 20 has a predeter mined delayed answering time interval, and n preliminary act of the attendant at the attendar cabinet 40 is required to cause this service to b instituted.

Night service

When the attendant at the attendant cabine is ready to go off duty, she institutes night serv ice, this being accomplished by operating th common night switch 570 to its front position This operation of the common night switch in terrupts at the switch spring 571 and the back contact associated therewith and at the switch spring 574 and the back contact associated therewith points in the respective paths for illuminating the answer and supervisory lamp 564 and for operating the trunk signal M576 at the attendant cabinet 40. Also, the paths for illuminating the answer and supervisory lamps associated with the other trunk circuits are similarly interrupted in order to prevent illumination of these lamps while the attendant is off duty. Further, this operation of the common night switch 570 completes at the switch spring 572 and the front contact associated therewith and at the switch spring 573 and the front contact associated therewith obvious circuits for respectively energizing the relays R540 and R550, thereby to cause operation thereof. Upon operating, the relay R540 prepares at RA541 a circuit, traced hereinafter, for energizing the relay R420 associated with the authorized subscriber substation A, this subscriber substation being selected as one of the subscriber substations which is to be directly signalled when an incoming central exchange call is extended, when night service is in force. Upon operating, the relay R550 prepares at RA554 a further point in the previously mentioned circuit for energizing the relay R420, prepares at RA551 a point in the connection between the control conductor C639 extending to the first trunk circuit 60 and the control conductor C794 extending to the second trunk circuit, prepares at RA553 a point in the previously traced circuit for energizing the winding of the relay R700 in the first trunk circuit 60, this circuit being completed at the armature RA979 of the relay R970 upon operation of the latter relay incident to the extension of an incoming central exchange call to the first trunk circuit 60 in the manner previously described.

At this time, when night service is in force, the routing of an incoming central exchange call from the central exchange 20 to the P. A. B. X. by way of the first trunk circuit 60 causes the relay R970 to operate as previously explained, this relay being energized by the ringing current projected over the trunk line 1005. Upon operating, the relay R970 completes at RA979 a circuit for energizing the relay R700, this circuit extending from ground at RA724 by way of C628, RA553, C633, RA979, C858 and the winding of R700 to battery. When energized over the above-traced circuit, the relay R700 operates to complete at RA701 the previously traced circuit for applying ground potential to the start conductor C820 extending to the allotter 50, thereby to cause the relay R360 in the allotter 50 to operate. Upon operating, the relay R360 completes at RA361 the previously traced circuit for causing operation of the general incoming trunk signal 387, and completes at RA362 a path for energizing the relay R420, this path extending from the pulse ground lead C640 by way of RA541,

RA654, C629, RA362, C421 and the winding of R420 to battery. Relatively short and long pulses are transmitted by way of the above-traced circuit for causing the relay R420 intermittently to operate, this relay alternately operating and restoring and remaining operated during successive relatively short and long periods. Upon operating, the relay R420 completes at RA421 a path for applying ground potential to the control conductor C425, one branch extending therefrom by way of the winding of R430 to the control conductor C407 of the subscriber line 403. Also, another branch of this path extends by way of the control conductor C425' to the winding of a relay corresponding to R430 and associated with another authorized subscriber substation. This path is intermittently completed at the armature RA421 of the relay R420. This application of ground potential to the control conductor C407 of the subscriber line 403 is of no effect in the event this subscriber line is busy, as ground potential already appears upon the control conductor C407. Accordingly, the relay R430 is short-circuited in an obvious manner. On the other hand, this application of ground potential to the control conductor C407 completes a circuit for energizing the relay R430 in series with the lower winding of the relay R390 in the event the subscriber line 403 is idle at this time, this circuit extending from ground at RA421 by way of the winding of R430 and the lower winding of R390 to battery. When the lower winding of the relay R390 and the winding of the relay R430 are thus energized, the relay R390 does not operate; however, the relay R430 does operate. Upon operating, the relay R430 completes at RA431 and the front contact associated therewith and at RA432 and the front contact associated therewith a path for operating the ringer at the subscriber substation A, this path extending from the direct generator lead C394 by way of RA431 and the front contact associated therewith, the positive conductor C409 of the subscriber line 403, the bridge including the ringer and the condenser connected across the positive and negative line conductors C409 and C408, respectively, of the subscriber line 403, the negative line conductor C408 and RA432 and the front contact associated therewith to ground. The above-traced path is intermittently completed in accordance with the operation of the relay R420, thereby to cause the ringer at the substation A to operate and produce audible long and short sounds. In a similar manner, the ringer at the other authorized subscriber substation is operated, in the event the subscriber line extending thereto is idle. This operation of the ringer at the substation A indicates to the subscriber thereat that an incoming central exchange call is awaiting an answer. The subscriber at the substation A may answer the incoming central exchange call by momentarily operating the grounding push button 393 thereat, thereby to apply direct ground potential to the negative line conductor C408 of the subscriber line 403. This application of direct ground potential to the control conductor C408 completes the previously traced circuit for energizing the intermediate winding of the relay R390, when the relay R430 is restored, thereby to cause the relay R390 to operate. Upon operating, the relay R390 closes its "X" contacts associated with its armatures RA393 and RA394, thereby to complete at RA393 the previously traced circuit for energizing the upper winding of R390 in series with the winding of the relay R300 in the allotter 50. The relay R300 operates to complete the circuit for energizing the upper winding of the relay R320, thereby to cause the latter relay to operate. Upon operating, the relay R320 completes at RA323 a path for applying multiple ground potential to the start conductor C419, thereby to complete a circuit for energizing in series the upper and intermediate windings of the relay R390, this circuit extending from ground at RA323 by way of RA332, RA352, the start lead C419, RA393 and the upper and intermediate windings of R390 to battery. The relay R390 is held in its operated position at this time over the above-traced circuit independently of the positions of the grounding push button 393 and the relay R430. Accordingly, subsequent operations of the relay R430 do not cause the relay R390 to restore. Also, upon operating, the relay R320 completes at RA325 a path for applying ground potential by way of the control conductor C406 of the subscriber line 403 to the contact in the contact bank 676 of the rotary switch 674 terminating this control conductor.

Also, upon operating, the relay R700 completes at RA702 the previously traced circuit for energizing the upper winding of the relay R750 in the first trunk circuit 60 in series with the lower winding of the relay R320 in the allotter 50, this circuit extending from ground at RA322 to battery at the lower terminal of the upper winding of R750 as previously noted. When energized over the above-traced circuit, the relay R750 is operated and the relay R320 is held in its operated position. Upon operating, the relay R750 completes at RA752 the previously traced circuit for intermittently energizing in multiple the winding of the motor M615 and the upper winding of the relay R740. The apparatus in the first trunk circuit 60 then operates, as previously explained, thereby to cause the wipers of the rotary switches of the trunk finder-connector switch 30 to be rotated in a counterclockwise direction until these wipers engage the contacts in the associated contact banks terminating the conductors of the subscriber line 403. When the wiper 675 of the rotary switch 674 engages the contact in the contact bank 676 terminating the control conductor C406 of the subscriber line 403, the relay R720 is operated as previously explained, thereby to cause the relay R740 to restore shortly thereafter and to arrest further operation of the motor M615. Upon operating, the relay R720 completes at RA726 the previously traced circuit for energizing the multiple connected upper and intermediate windings thereof in series with the lower winding of the relay R390, the latter relay being associated with the subscriber line 403 in the manner previously described. When the above-mentioned circuit is completed, ground through a relatively low resistance is applied to the control conductor C407 of the subscriber line 403, thereby to complete an obvious path for short-circuiting the winding of the relay R430, causing the latter relay to restore. Upon restoring, the relay R430 interrupts at RA431 and the front contact associated therewith and at RA432 and the front contact associated therewith the previously traced path for projecting ringing current under the control of the relay R420 over the positive and negative line conductors C409 and C408 of the subscriber line 403, thereby to arrest operation of the ringer at the subscriber substation A. Further, the relay R430 connects at RA431 and the back contact associated there-

with and at RA432 and the back contact associated therewith the positive and negative line conductors of the subscriber line 403 to the rotary switches 682 and 686 of the trunk finder-connector switch 30, and the apparatus in the first trunk circuit 60 operates to cause ringing current to be projected over the subscriber line 403 in order to operate the ringer at the subscriber substation A in the previously described manner.

The ringer at the subscriber substation A is operated at this time in the regular manner, thereby to indicate to the subscriber thereat that the incoming central exchange call has been extended to the substation A. The subscriber at the substation A then answers the incoming central exchange call in the usual manner by removing the receiver of the telephone instrument thereat from its hook, thereby to cause the equipment in the first trunk circuit 60 to operate to complete an established two-way communication connection between the subscriber substation A and the subscriber substation associated with the central exchange 20 and to release the equipment in the allotter 50 for further use, as previously described.

In the event an incoming central exchange call is not answered by the subscriber at the authorized subscriber substation A or at one of the other authorized subscriber substations within a predetermined time interval, the thermal responsive element of the thermostatic device T810 is operated to interrupt at TA811 the circuit for energizing in series the winding of the relay R770 and the winding of T810. This circuit normally extends from ground at TA811 by way of C861, RA934 and the back contact associated therewith, RA979', and the front contact associated therewith, C860, the winding of T810, RA767 and the back contact associated therewith, C778 and the winding of R770 to battery. In the event the call is answered at the subscriber substation A within a predetermined time interval, a loop circuit is completed between the subscriber substation A and the relays R900 and R790 in the first trunk circuit 60 as previously described, thereby to cause the relay R790 to operate. Upon operating, the relay R790 completes at RA793 and the front contact associated therewith an obvious holding circuit for the relay R770 independent of the armature TA811 of the thermostatic device T810. Further, it is noted that this operation of the relay R790 completes, at RA793 and the front contact associated therewith, a path for short-circuiting the winding of the thermostatic device T810, this path extending from ground at RA793 and the front contact associated therewith by way of C778, RA767 and the back contact associated therewith, the winding of T810, C860, RA979' and the front contact associated therewith, RA934, C861 and TA811 to ground. The operated relay R770 retains the apparatus in the first trunk circuit 60 is operated position. The release of the first trunk circuit 60 is accomplished by causing the relay R770 to restore, as previously noted. Accordingly, in the event the incoming centrol exchange call, routed by way of the first trunk circuit 60 to the P. A. B. X., is not answered by a subscriber at an authorized subscriber substation within the predetermined time interval, mentioned, the relay R770 is caused to restore, thereby to cause the release of the first trunk circuit in the previously described manner.

It is noted that the operation of the apparatus to signal directly the authorized subscriber substation A and the other authorized subscriber substation to which the control conductor C425' extends, in the manner described above, when night service is in force, is independent of the particular trunk line on which the incoming call to the P. A. B. X. is routed from the central exchange 20.

Breakdown of trunk circuits for incoming toll calls to the P. A. B. X. from the central exchange

Each trunk circuit is provided with an arrangement under the control of a toll operator at the central exchange 20 for breaking down and for forcing the release of an established connection between an authorized or semi-authorized subscriber substation and a subscriber substation associated with the central exchange, which may be utilized when a toll call is to be extended from the central exchange to the P. A. B. X. while all of the trunk circuits are busy. For example, an established connection routed between the subscriber substation A and a subscriber substation associated with the central exchange 20 by way of the first trunk circuit 60 may be broken down by a toll operator in the central exchange, this being accomplished by the operation of apparatus in the central exchange to cause alternating current to be projected over the positive and negative line conductors of the trunk line 1005 included in the previously mentioned established connection. This projection of alternating current over the positive and negative line conductors of the trunk line 1005 completes a path for energizing the lower winding of the relay R970, this path extending from the positive line conductor C1004 by way of RA982 and the back contact associated therewith, the condenser 978, the lower winding of R970 and RA981 and the back contact associated therewith to the negative line conductor C1003. When energized over the above-traced path, the relay R970 operates to complete a holding circuit for itself, the particular path of this holding circuit depending upon the condition of the connection routed between the subscriber substation A and the subscriber substation associated with the central exchange 20. In the event the above-mentioned connection is completely established, the relay R950 occupies its restored position, in which event a holding circuit is completed at RA976' for the upper winding of the relay R970, this circuit extending from ground at RA976' by way of RA955 and the back contact associated therewith and the upper winding of R970 to battery. In the event the above-mentioned connection is not completely established, a holding circuit is completed at RA975 for the upper winding of R970, this circuit extending from the grounded control conductor C630 by way of RA771, C843, RA792, C842, RA975 and the upper winding of R970 to battery.

Also, upon operating, the relay R970 completes at RA973 a path for short-circuiting the intermediate winding of the relay R720, this path extending from C619 by way of the intermediate winding of R720, C839, RA973 and RA944 to C619, and interrupts at RA976 a point in the circuit for energizing the upper winding of the relay R720, thereby to cause the latter relay to restore. Upon restoring, the relay R720 interrupts at RA721 and at RA722 and the front contact associated therewith the loop circuit extending between the subscriber substation A and the relays R900 and R790 in the first trunk circuit 60 and completes at RA723 the previously traced path for energizing in multiple the winding of the motor M615 and the upper winding of the relay R740, this

path extending from the pulse ground lead C179 by way of C831, C616, the wiper 671 of the rotary switch 670 of the trunk finder-connector switch 30, the multiple connected contacts in the associated contact bank 672, C615, RA931, C837, and RA712 and the back contact associated therewith to RA723, one path extending from RA723 by way of C625 and the winding of M615 to battery and the other path extending from RA723 by way of C625 and the upper winding of R740 to battery. The motor M615 and the upper winding of the relay R740 are intermittently energized over the above-traced path in order to cause the trunk finder-connector switch 30 to be restored to its home position and to prevent completed calls to other subscriber substations from being interfered with, as previously explained. The release of the remainder of the equipment in the first trunk circuit 60 incident to the restoration of the relay R720 and the operation of the trunk finder switch 30 to its home position are the same as previously described.

Further, the relay R970 completes at RA972 a path for illuminating the answer and supervisory lamp 564 at the attendant cabinet, this path extending from the pulse ground lead C1001 by way of RA972, C825, C641, the switch spring 571 of the common night switch 570 and the back contact associated therewith and the lamp 564 to battery. The ground pulses on the pulse ground lead C1001 cause the lamp 564 to flash. Further, the relay R970 completes at RA978 the previously traced circuit for energizing in series the lower winding of the relay R780 and the winding of the thermostatic device T570. When thus energized, the relay R780 operates to complete at RA781 the previously traced path for energizing the trunk signal buzzer M576 at the attendant cabinet 40 from the pulse ground lead C1000, thereby to cause operation of this buzzer. The flashing of the answer and supervisory lamp 564 and the operation of the trunk signal buzzer M576 at the attendant cabinet 40 indicate to the attendant thereat that an incoming central exchange call is awaiting an answer. The attendant then answers the incoming central exchange call and extends it to the desired subscriber substation in the previously described manner.

Selection of first choice local links

An arrangement is provided in the allotter 50 for rearranging the sequence of selecting the local links for use in completing substation to substation calls. As previously noted, a call which is to be extended from the substation A to the substation B is initiated at the substation A by removing the receiver of the telephone instrument at the substation A from its hook, thereby to complete a path for applying battery potential at the intermediate winding of the relay R390 associated with the subscriber line 403 to the start conductor C418. At this time, if the first local link 21 is idle, the application of battery potential to the start conductor C418 completes a circuit for energizing the winding of the relay R340 in the allotter 50 in series with the intermediate winding of the relay R390 from ground potential in the first local link 21, this circuit extending from ground at the armature RA156 and the back contact associated therewith of the relay R150 in the first local link 21 by way of C204, RA324, the winding of R340, C418, RA391, RA431, C409, the bridge connection including the telephone instrument at the substation A between C409 and C408, C408, RA432, RA392 and the intermediate winding of R390 to battery. When energized over the above-traced circuit, the relay R340 operates to complete at RA341 an obvious circuit for energizing the relay R350, thereby to cause the latter relay to operate. Upon operating, the relay R350 completes at RA351 a path for applying ground potential to the start conductor C416. The application of ground potential to the start conductor C416 completes a circuit for energizing in multiple the winding of the thermostatic device T160 and the upper winding of the relay R130, this circuit extending from the grounded start conductor C416 by way of the switch springs 308 and 307 of the chain switch 306 to C210, one branch extending from C210 by way of the winding of the thermostatic device T160 to battery and the other branch extending from C210 by way of C228, the twenty-fifth or home contact in the contact bank 246 of the rotary switch 244, the associated wiper 245, C226, RA114, RA143 and the back contact associated therewith, the resistor 179 and the upper winding of R130 to battery. When energized over the above-traced circuit, the relay R130 operates to cause the finder switch 22 of the local link 21 to hunt for the calling subscriber line 403 in the previously described manner.

In the event the finder switch 22 finds the calling subscriber line 403 within a predetermined time interval, the previously traced circuit for energizing the relay R150 is completed, thereby to cause this relay to operate and interrupt, at RA156, the previously traced circuit for energizing the relay R340 in the allotter 50 in order to cause the latter relay to restore. Upon restoring, the relay R340 interrupts at RA341 the circuit for energizing the relay R350, thereby to cause the latter relay to restore and remove at RA351 the application of ground potential to the start conductor C416. However, in the event the finder 22 does not find the calling subscriber line 403 within the predetermined time interval mentioned, the thermal responsive element of the thermostatic device T160 operates to complete at TA161 a path for applying ground potential to the conductor C423 extending to the second local link, this path extending from ground at RA351 by way of the start lead C416, the switch springs 308 and 307 of the chain switch 306, C210, TA161, C211 and the switch springs 305 and 303 of the chain switch 302 to the conductor C423 extending to the second local link. This application of ground potential to the conductor C423 extending to the second local link causes operation of the apparatus therein in order to cause the finder switch thereof to hunt for the calling subscriber line 403 in the manner previously described. Also, it is noted that, when the finder switch 22 of the first local link finds the calling subscriber line 403, the relay R150 is caused to operate. Upon operating, the relay R150 causes the relay R140 to operate as previously explained. Upon operating, the relay R140 completes at RA144 a path for connecting the start lead C416 to the conductor C423 extending to the second local link, this path extending from the start lead C416 by way of the switch springs 308 and 307 of the chain switch 306, C210, RA144, C211 and the switch springs 305 and 303 of the chain switch 302 to the conductor C423 extending to the second local link. Thus, when the first local link becomes busy, the second local link is assigned to the use of the next substation to substation call initiated at one of the

apparatus at said operator station for causing the operation of said second signal.

6. In a telephone system, a private exchange including an operator station and at least one subscriber substation, a plurality of trunk lines extending to said private exchange, a first signal associated with said operator station, a second signal associated with said subscriber substation, normally effective apparatus at said operator station operative to answer an incoming call to said private exchange on any one of said trunk lines, normally ineffective apparatus at said subscriber substation operative to answer an incoming call to said private exchange on any one of said trunk lines, means responsive to the extension of an incoming call to said private exchange on any one of said trunk lines for causing the operation of said first signal, and automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval by the operation of the apparatus at said operator station for causing the operation of said second signal and for rendering effective the apparatus at said subscriber substation.

7. In a telephone system, a private exchange including an operator station and at least one subscriber substation, a plurality of trunk lines extending to said private exchange, normally effective apparatus at said operator station operative to answer an incoming call to said private exchange on any one of said trunk lines, normally ineffective apparatus at said subscriber substation operative to answer an incoming call to said private exchange on any one of said trunk lines, and automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval by the operation of the apparatus at said operator station for rendering effective the apparatus at said subscriber substation.

8. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a trunk line extending to said private exchange, normally effective apparatus at said operator station operative to answer an incoming call to said private exchange on said trunk line, normally ineffective apparatus at each of said subscriber substations operative to answer an incoming call to said private exchange on said trunk line, and automatic means operative in the event an incoming call to said private exchange on said trunk line is not answered within a predetermined time interval by the operation of the apparatus at said operator station for rendering effective the apparatus at each of said subscriber substations.

9. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, normally effective apparatus at said operator station operative to answer an incoming call to said private exchange on any one of said trunk lines, normally ineffective apparatus at each of said subscriber substations operative to answer an incoming call to said private exchange on any one of said trunk lines, and automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval by the operation of the apparatus at said operator station for rendering effective the apparatus at each of said subscriber substations.

10. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, normally effective apparatus at said operator station operative to answer an incoming call to said private exchange on any one of said trunk lines, normally ineffective apparatus at each of said subscriber substations operative to answer an incoming call to said private exchange on any one of said trunk lines, automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval by the operation of the apparatus at said operator station for rendering effective the apparatus at each of said subscriber substations, and means responsive to the operation of the apparatus at said operator station to answer an incoming call to said private exchange on any one of said trunk lines for rendering inoperative said automatic means.

11. In a telephone system, a private exchange including an operator station and at least one subscriber substation, a plurality of trunk lines extending to said private exchange, apparatus at said operator station operative to answer an incoming call to said private exchange on any one of said trunk lines, a device at said subscriber substation, normally effective means responsive to the operation of said device for causing an idle one of said trunk lines to be associated with said subscriber substation, thereby to initiate the extension of an outgoing call from said private exchange on the trunk line associated with said subscriber substation, and automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval by the operation of the apparatus at said operator station for rendering ineffective said last-mentioned means.

12. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, apparatus at said operator station operative to answer an incoming call to said private exchange on any one of said trunk lines, a device at each of said subscriber substations, normally effective means responsive to the operation of the device at any one of said subscriber substations for causing an idle one of said trunk lines to be associated with the one subscriber substation, thereby to initiate the extension of an outgoing call from said private exchange on the trunk line associated with the one subscriber substation, and automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval by the operation of the apparatus at said operator station for rendering ineffective said last-mentioned means.

13. In a telephone system, a private exchange including an operator station and at least one subscriber substation, a plurality of trunk lines extending to said private exchange, apparatus at said operator station operative to answer an incoming call to said private exchange on any one of said trunk lines, a device at said subscriber substation, normally effective means responsive to the operation of said device for causing an idle one of said trunk lines to be associated with said subscriber substation, thereby to

initiate the extension of an outgoing call from said private exchange on the trunk line associated with said subscriber substation, normally ineffective means responsive to the operation of said device for causing one of said trunk lines having an incoming call to said private exchange thereon to be associated with said subscriber substation, thereby to initiate the answering of the incoming call to said private exchange on the trunk line associated with said subscriber substation, and automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval by the operation of the apparatus at said operator station for rendering ineffective said first-mentioned means and for rendering effective said last-mentioned means.

14. In a telephone system, a private exchange including an operator station and at least one subscriber substation, a plurality of trunk lines extending to said private exchange, apparatus at said operator station operative to answer an incoming call to said private exchange on any one of said trunk lines, a device at said subscriber substation, normally effective means responsive to the operation of said device for causing an idle one of said trunk lines to be associated with said subscriber substation, thereby to initiate the extension of an outgoing call from said private exchange on the trunk line associated with said subscriber substation, normally ineffective means responsive to the operation of said device for causing one of said trunk lines having an incoming call to said private exchange thereon to be associated with said subscriber substation, thereby to initiate the answering of the incoming call to said private exchange on the trunk line associated with said subscriber substation, automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval by the operation of the apparatus at said operator station for rendering ineffective said first-mentioned means and for rendering effective said last-mentioned means, and means responsive to the operation of the apparatus at said operator station to answer an incoming call to said private exchange on any one of said trunk lines for rendering inoperative said automatic means.

15. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, apparatus at said operator station operating to answer an incoming call to said private exchange on any one of said trunk lines, a device at each of said subscriber substations, normally effective means responsive to the operation of the device at any one of said subscriber substations for causing an idle one of said trunk lines to be associated with the one subscriber substation, thereby to initiate the extension of an outgoing call from said private exchange on the trunk line associated with the one subscriber substation, normally ineffective means responsive to the operation of the device at any one of said subscriber substations for causing one of said trunk lines having an incoming call to said private exchange thereon to be associated with the one subscriber substation, thereby to initiate the answering of the incoming call to said private exchange on the trunk line associated with the one subscriber substation, and automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval by the operation of the apparatus at said operator station for rendering ineffective said first-mentioned means and for rendering effective said last-mentioned means.

16. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, apparatus at said operator station operating to answer an incoming call to said private exchange on any one of said trunk lines, a device at each of said subscriber substations, normally effective means responsive to the operation of the device at any one of said subscriber substations for causing an idle one of said trunk lines to be associated with the one subscriber substation, thereby to initiate the extension of an outgoing call from said private exchange on the trunk line associated with the one subscriber substation, normally ineffective means responsive to the operation of the device at any one of said subscriber substations for causing one of said trunk lines having an incoming call to said private exchange thereon to be associated with the one subscriber substation, thereby to initiate the answering of the incoming call to said private exchange on the trunk line associated with the one subscriber substation, automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval by the operation of the apparatus at said operator station for rendering ineffective said first-mentioned means and for rendering effective said last-mentioned means, and means responsive to the operation of the apparatus at said operator station to answer an incoming call to said private exchange on any one of said trunk lines for rendering inoperative said automatic means.

17. In a telephone system, a private exchange including an operator station and at least one subscriber substation, a plurality of trunk lines extending to said private exchange, a subscriber line extending to said subscriber substation, automatic switching means for setting up connections between said trunk lines and said subscriber line, a switch operative between normal and off-normal positions, means for assigning an idle one of said trunk lines to be included in a connection to be set up when said switch occupies its normal position and for assigning one of said trunk lines having an incoming call to said private exchange thereon to be included in a connection to be set up when said switch occupies its off-normal position, a device at said subscriber substation operative to cause said switching means to set up a connection between said subscriber line and an assigned trunk line, apparatus at said operator station for answering an incoming call to said private exchange on any one of said trunk lines, and automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval at said operator station for causing said switch to be operated from its normal to its off-normal position.

18. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, a plurality of subscriber lines individually extending to said subscriber substations, automatic switching means operative to set up connections between said trunk lines and said subscriber lines, a switch

operative between normal and off-normal positions, means for assigning an idle one of said trunk lines to be included in a connection to be set up when said switch occupies its normal position and for assigning one of said trunk lines having an incoming call to said private exchange thereon to be included in a connection to be set up when said switch occupies its off-normal position, a device at each of said subscriber substations operative to cause said switching means to set up a connection between the subscriber line individually extending to the associated subscriber substation and an assigned trunk line, apparatus at said operator station for answering an incoming call to said private exchange on any one of said trunk lines, and automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval at said operator station for causing said switch to be operated from its normal to its off-normal position.

19. In a telephone system, a private exchange including an operator station and at least one subscriber substation, a plurality of trunk lines extending to said private exchange, a subscriber line extending to said subscriber substation, automatic switching means for setting up connections between said trunk lines and said subscriber line, a switch operative between first and second positions, means for causing said switch to occupy its first position when no unanswered incoming call to said private exchange is on any one of said trunk lines when a predetermined service is in force and when said predetermined service is not in force and for causing said switch to occupy its second position when an unanswered incoming call to said private exchange is on any one of said trunk lines when said predetermined service is in force, means for assigning an idle one of said trunk lines to be included in a connection to be set up when said switch occupies its first position and for assigning one of said trunk lines having an incoming call to said private exchange thereon to be included in a connection to be set up when said switch occupies its second position, a device at said subscriber substation operative to cause said switching means to set up a connection between said subscriber line and an assigned trunk line, apparatus at said operator station for answering an incoming call to said private exchange on any one of said trunk lines, and automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval at said operator station for causing said predetermined service to be enforced.

20. In a telephone system, a private exchange including an operator station and at least one subscriber substation, a plurality of trunk lines extending to said private exchange, a subscriber line extending to said subscriber substation, automatic switching means for setting up connections between said trunk lines and said subscriber line, a switch operative between first and second positions, means for causing said switch to occupy its first position when no unanswered incoming call to said private exchange is on any one of said trunk lines when a predetermined service is in force and when said predetermined service is not in force and for causing said switch to occupy its second position when an unanswered incoming call to said private exchange is on any one of said trunk lines when said predetermined service is in force, means for assigning an idle one of said trunk lines to be included in a connection to be set up when said switch occupies its first position and for assigning one of said trunk lines having an incoming call to said private exchange thereon to be included in a connection to be set up when said switch occupies its second position, a device at said subscriber substation operative to cause said switching means to set up a connection between said subscriber line and an assigned trunk line, apparatus at said operator station for answering an incoming call to said private exchange on any one of said trunk lines, automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval at said operator station for causing said predetermined service to be enforced, and means responsive to the answering of an incoming call to said private exchange on any one of said trunk lines at said operator station for causing said predetermined service to be discontinued.

21. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, normally effective apparatus at said operator station operative to answer an incoming call to said private exchange on any one of said trunk lines, normally ineffective apparatus at each of said subscriber substations operative to answer an incoming call to said private exchange on any one of said trunk lines, and a device at said operator station operative to render effective the apparatus at each of said subscriber substations.

22. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, a plurality of subscriber lines individually extending to said subscriber substations, automatic switching means operative to set up connections between said trunk lines and said subscriber lines, a switch operative between normal and off-normal positions, means for assigning an idle one of said trunk lines to be included in a connection to be set up when said switch occupies its normal position and for assigning one of said trunk lines having an incoming call to said private exchange thereon to be included in a connection to be set up when said switch occupies its off-normal position, a device at each of said subscriber substations, means responsive to the operation of the device at any one of said subscriber substations for causing said switching means to set up a connection between the subscriber line individually extending to the one subscriber substation and an assigned trunk line, a device at said operator station, and means controlled jointly by the operation of said last-mentioned device and the extension of an incoming call to said private exchange on any one of said trunk lines for causing operation of said switch from its normal to its off-normal position.

23. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, a plurality of subscriber lines individually extending to said subscriber substations, automatic switching means operative to set up connections between said trunk lines and said subscriber lines, a switch operative between normal and off-normal positions, means for assigning an idle one of said

trunk lines to be included in a connection to be set up when said switch occupies its normal position and for assigning one of said trunk lines having an incoming call to said private exchange thereon to be included in a connection to be set up when said switch occupies its off-normal position, a device at each of said subscriber substations, means responsive to the operation of the device at any one of said subscriber substations for causing said switching means to set up a connection between the subscriber line individually extending to the one subscriber substation and an assigned trunk line, a relay, a circuit for said relay, a device at said operator station operative to prepare said circuit, means responsive to the extension of an incoming call to said private exchange on any one of said trunk lines for completing said circuit, and means controlled by the operation of said relay for operating said switch from its normal to its off-normal position.

24. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, a signal associated with each of said subscriber substations, normally effective apparatus at said operator station operative to answer an incoming call to said private exchange on any one of said trunk lines, normally ineffective apparatus at each of said subscriber substations operative to answer an incoming call to said private exchange on any one of said trunk lines, a device at said operator station operative to condition said signal to be operated and to render effective the apparatus at each of said subscriber substations, and means responsive to the extension of an incoming call to said private exchange on any one of said trunk lines for causing the operation of said signal.

25. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, a plurality of subscriber lines individually extending to said subscriber substations, normally ineffective apparatus at each of said subscriber substations operative to answer an incoming call to private exchange on any one of said trunk lines, a device at said operator station operative to render effective the apparatus at each of said subscriber substations, a signal at each of said subscriber substations associated with the subscriber line individually extending thereto, and means responsive to the extension of an incoming call to said private exchange on any one of said trunk lines for causing ringing current to be projected over at least a number of said subscriber lines.

26. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, a plurality of subscriber lines individually extending to said subscriber substations, automatic switching means operative to set up connections between said trunk lines and said subscriber lines, a switch operative between normal and off-normal positions, means for assigning an idle one of said trunk lines to be included in a connection to be set up when said switch occupies its normal position and for assigning one of said trunk lines having an incoming call to said private exchange thereon to be included in a connection to be set up when said switch occupies its off-normal position, a device at each of said subscriber substations operative to cause said switching means to set up a connection between the subscriber line individually extending to the associated subscriber substation and an assigned trunk line, a signal at each of said subscriber substations associated with the subscriber line individually extending thereto, a device at said operator station, and means controlled jointly by the operation of said last-mentioned device and the extension of an incoming call to said private exchange on any one of said trunk lines for causing operation of said switch from its normal to its off-normal position and for causing ringing current to be projected over at least a number of said subscriber lines.

27. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, a plurality of subscriber lines individually extending to said subscriber substations, automatic switching means operative to set up connections between said trunk lines and said subscriber lines, a signal at each of said subscriber substations associated with the subscriber line individually extending thereto, normally ineffective means operative to assign one of said trunk lines having an incoming call to said private exchange thereon to be included in a connection to be set up, a device at said operator station operative to render effective said assigning means, means responsive to the extension of an incoming call to said private exchange on any one of said trunk lines for causing said assigning means to operate and assign said one trunk line to be included in a connection to be set up and for causing ringing current to be projected over at least a number of said subscriber lines, a device at each of said subscriber substations, and means responsive to the operation of the device at any one of said subscriber substations for causing said switching means to set up a connection between said one trunk line and the one of said subscriber lines individually extending to the one subscriber substation.

28. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, a plurality of subscriber lines individually extending to said subscriber substations, automatic switching means operative to set up connections between said trunk lines and said subscriber lines, a signal at each of said subscriber substations associated with the subscriber line individually extending thereto, normally ineffective means operative to assign one of said trunk lines having an incoming call to said private exchange thereon to be included in a connection to be set up, a device at said operator station operative to render effective said assigning means, means responsive to the extension of an incoming call to said private exchange on any one of said trunk lines for causing said assigning means to operate and assign said one trunk line to be included in a connection to be set up and for causing ringing current to be projected over idle ones of at least a selected number of said subscriber lines, a device at each of said subscriber substations, and means responsive to the operation of the device at any one of said subscriber substations for causing said switching means to set up a connection between said one trunk line and the one of said subscriber lines individually extending to the one subscriber substation.

29. In a telephone system, a private exchange

including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, a plurality of subscriber lines individually extending to said subscriber substations, automatic switching means operative to set up connections between said trunk lines and said subscriber lines, a signal at each of said subscriber substations associated with the subscriber line individually extending thereto, normally ineffective means operative to assign one of said trunk lines having an incoming call to said private exchange thereon to be included in a connection to be set up, a device at said operator station operative to render effective said assigning means, means responsive to the extension of an incoming call to said private exchange on any one of said trunk lines for causing said assigning means to operate and assign said one trunk line to be included in a connection to be set up and for causing one type of ringing current to be projected over at least a number of said subscriber lines, a device at each of said subscriber substations, means responsive to the operation of the device at any one of said subscriber substations for causing said switching means to set up a connection between said one trunk line and the one of said subscriber lines individually extending to the one subscriber substation, and means responsive to the setting up of the connection between said one trunk line and said one subscriber line for causing the projection of said one type of ringing current over the number of said subscriber lines to be interrupted and for causing another type of ring current to be projected over said one subscriber line.

30. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, normally effective apparatus at said operator station operative to answer an incoming call to said private exchange on any one of said trunk lines, normally ineffective apparatus at each of said subscriber substations operative to answer an incoming call to said private exchange on any one of said trunk lines, a device at said operator station operative to render effective the apparatus at each of said subscriber substations, and automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval by the operation of the apparatus at said operator station for rendering effective the apparatus at each of said subscriber substations.

31. In a telephone system, a central exchange, a private exchange including an operator station and at least one subscriber substation, a trunk line extending between said central exchange and said private exchange, means at said operator station operative to extend an outgoing call from said private exchange on said trunk line to said central exchange, normally effective apparatus at said operator station operative to answer an incoming call to said private exchange on said trunk line from said central exchange, means at said subscriber substation operative to extend an outgoing call from said private exchange on said trunk line to said central exchange, normally ineffective apparatus at said subscriber substation operative to answer an incoming call to said private exchange on said trunk line from said central exchange, and automatic means operative in the event an incoming call to said private exchange on said trunk line from said central exchange is not answered within a predetermined time interval by the operation of the apparatus at said operator station for rendering effective the apparatus at said subscriber substation.

32. In a telephone system, a private exchange including an operator station and at least one subscriber substation, a plurality of trunk lines extending to said private exchange, means at said operator station operative to extend an outgoing call from said private exchange on any one of said trunk lines, normally effective apparatus at said operator station operative to answer an incoming call to said private exchange on any one of said trunk lines, means at said subscriber substation operative to extend an outgoing call from said private exchange on any one of said trunk lines, normally ineffective apparatus at said subscriber substation operative to answer an incoming call to said private exchange on any one of said trunk lines, and automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval by the operation of the apparatus at said operator station for rendering effective the apparatus at said subscriber substation.

33. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a trunk line extending to said private exchange, means at said operator station operative to extend an outgoing call from said private exchange on said trunk line, normally effective apparatus at said operator station operative to answer an incoming call to said private exchange on said trunk line, means at each of the said subscriber substations operative to extend an outgoing call from said private exchange on said trunk line, normally ineffective apparatus at each of said subscriber substations operative to answer an incoming call to said private exchange on said trunk line, and automatic means operative in the event an incoming call to said private exchange on said trunk line is not answered within a predetermined time interval by the operation of the apparatus at said operator station for rendering effective the apparatus at each of said subscriber substations.

34. In a telephone system, a private exchange including an operator station and a plurality of subscriber substations, a plurality of trunk lines extending to said private exchange, means at said operator station operative to extend an outgoing call from said private exchange on any one of said trunk lines, normally effective apparatus at said operator station operative to answer an incoming call to said private exchange on any one of said trunk lines, means at each of said subscriber substations operative to extend an outgoing call from said private exchange on any one of said trunk lines, normally ineffective apparatus at each of said subscriber substations operative to answer an incoming call to said private exchange on any one of said trunk lines, and automatic means operative in the event an incoming call to said private exchange on any one of said trunk lines is not answered within a predetermined time interval by the operation of the apparatus at said operator station for rendering effective the apparatus at each of said subscriber substations.

JOHN H. VOSS.