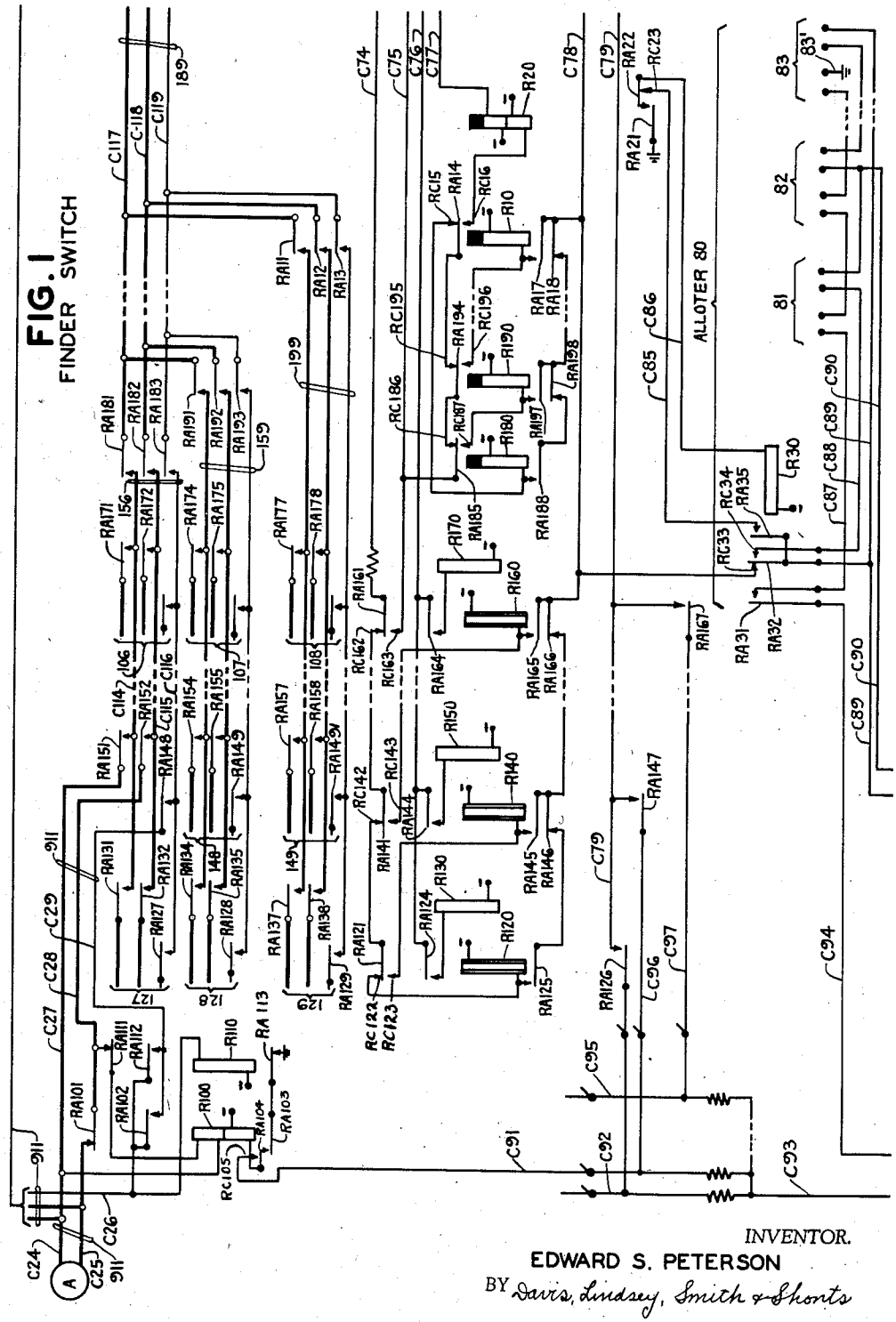
May 16, 1939. E. S. PETERSON 2,158,945

TELEPHONE SYSTEM

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TELEPHONE SYSTEM

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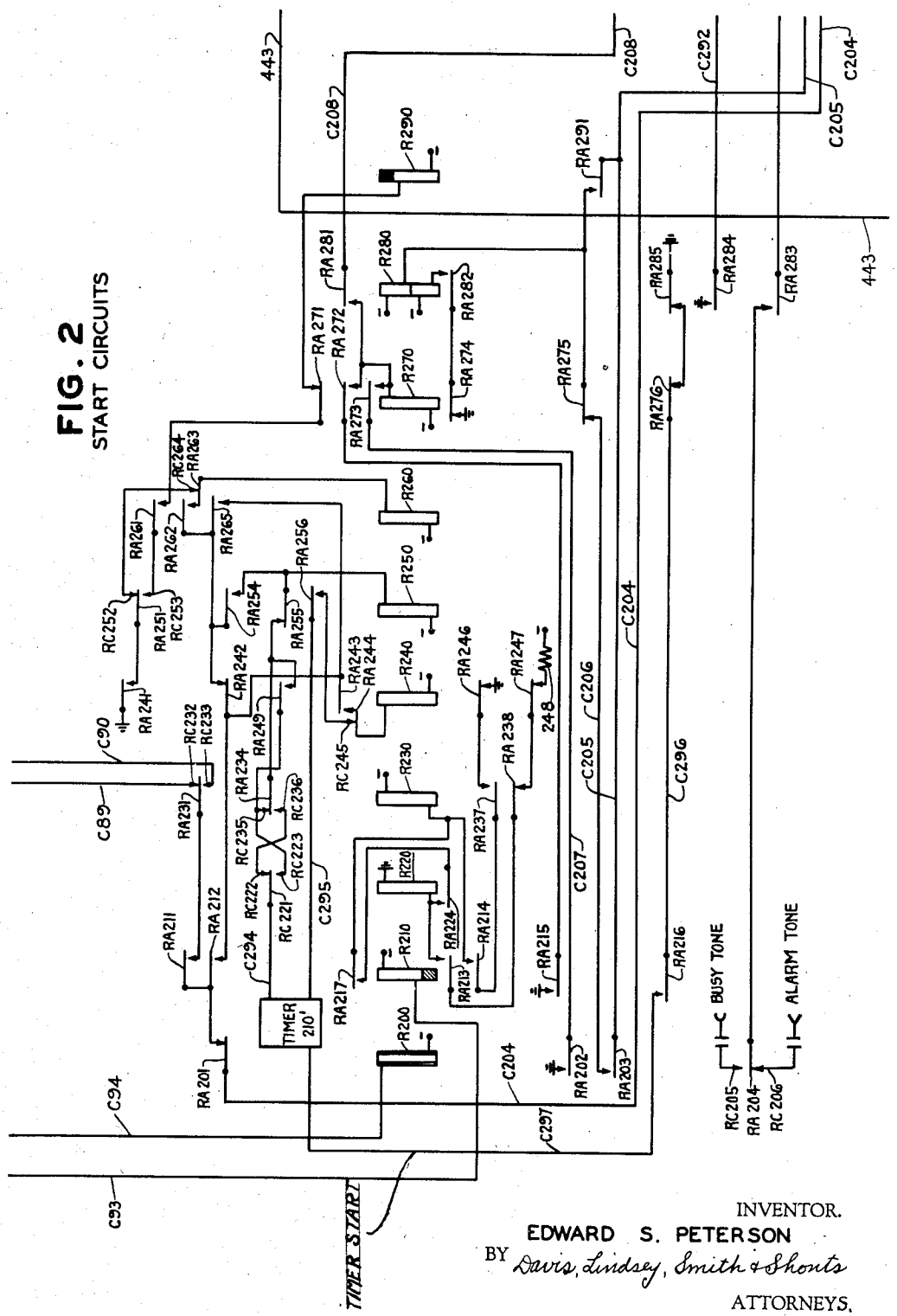


FIG. 2

START CIRCUITS

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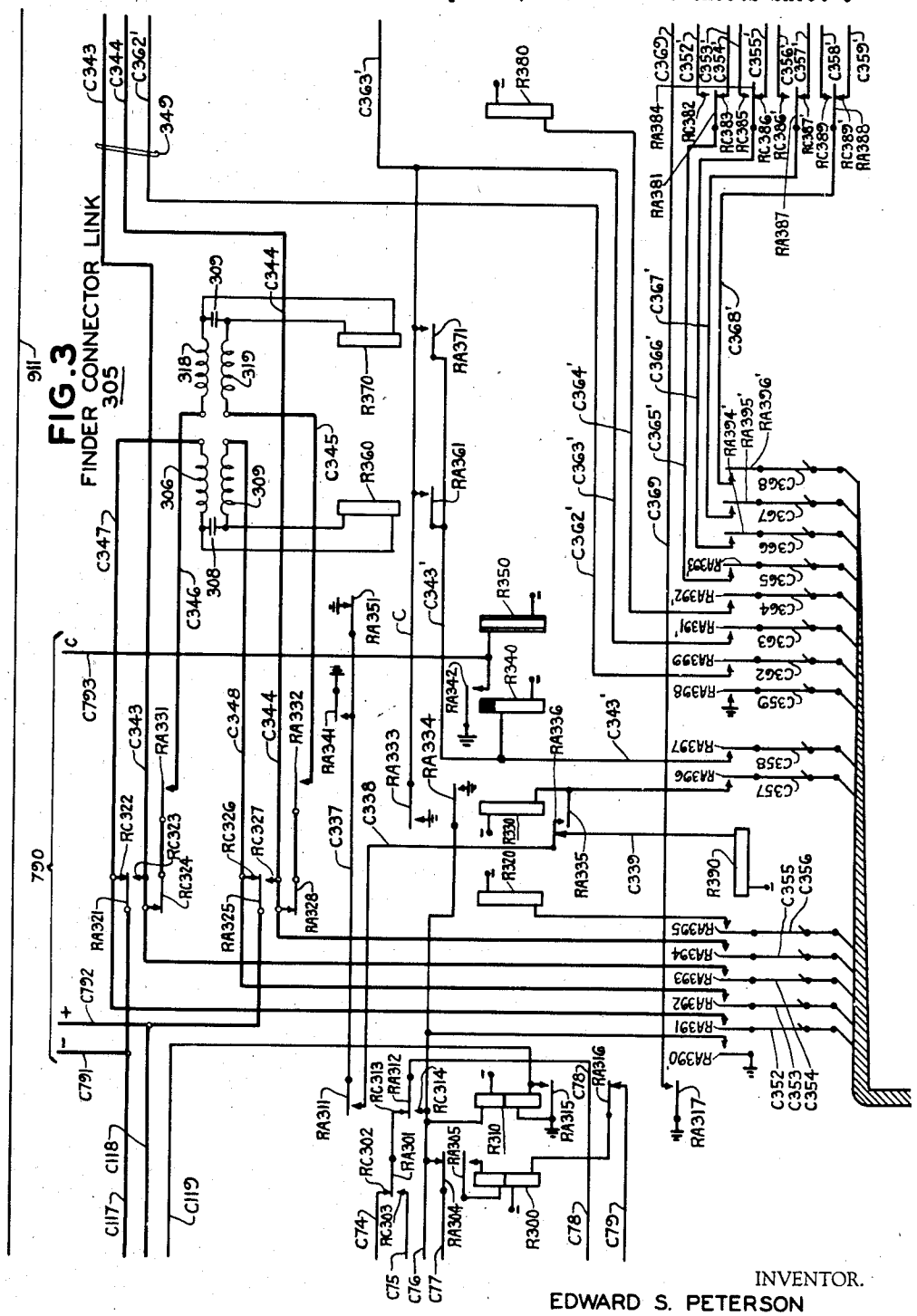
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TELEPHONE SYSTEM

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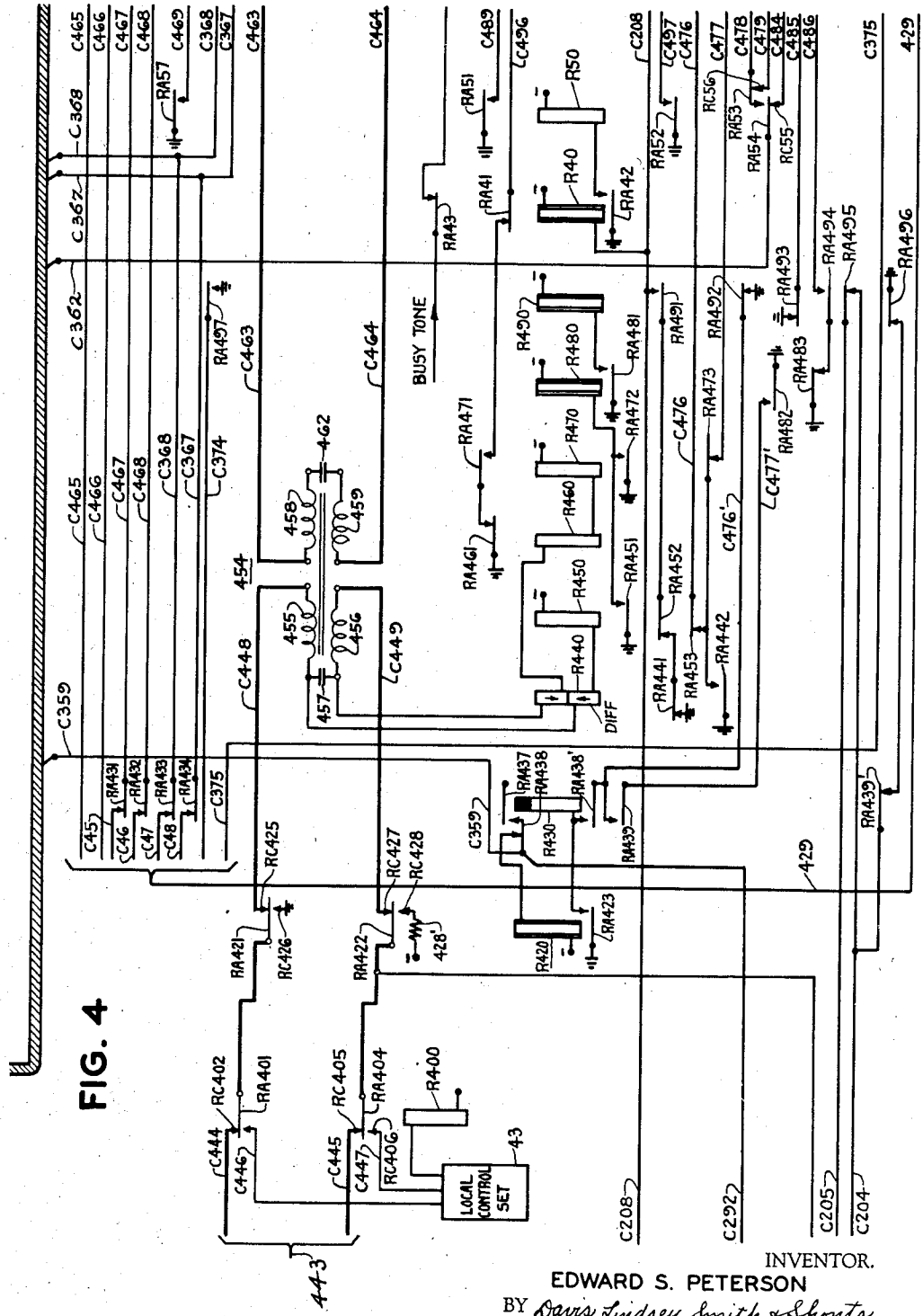


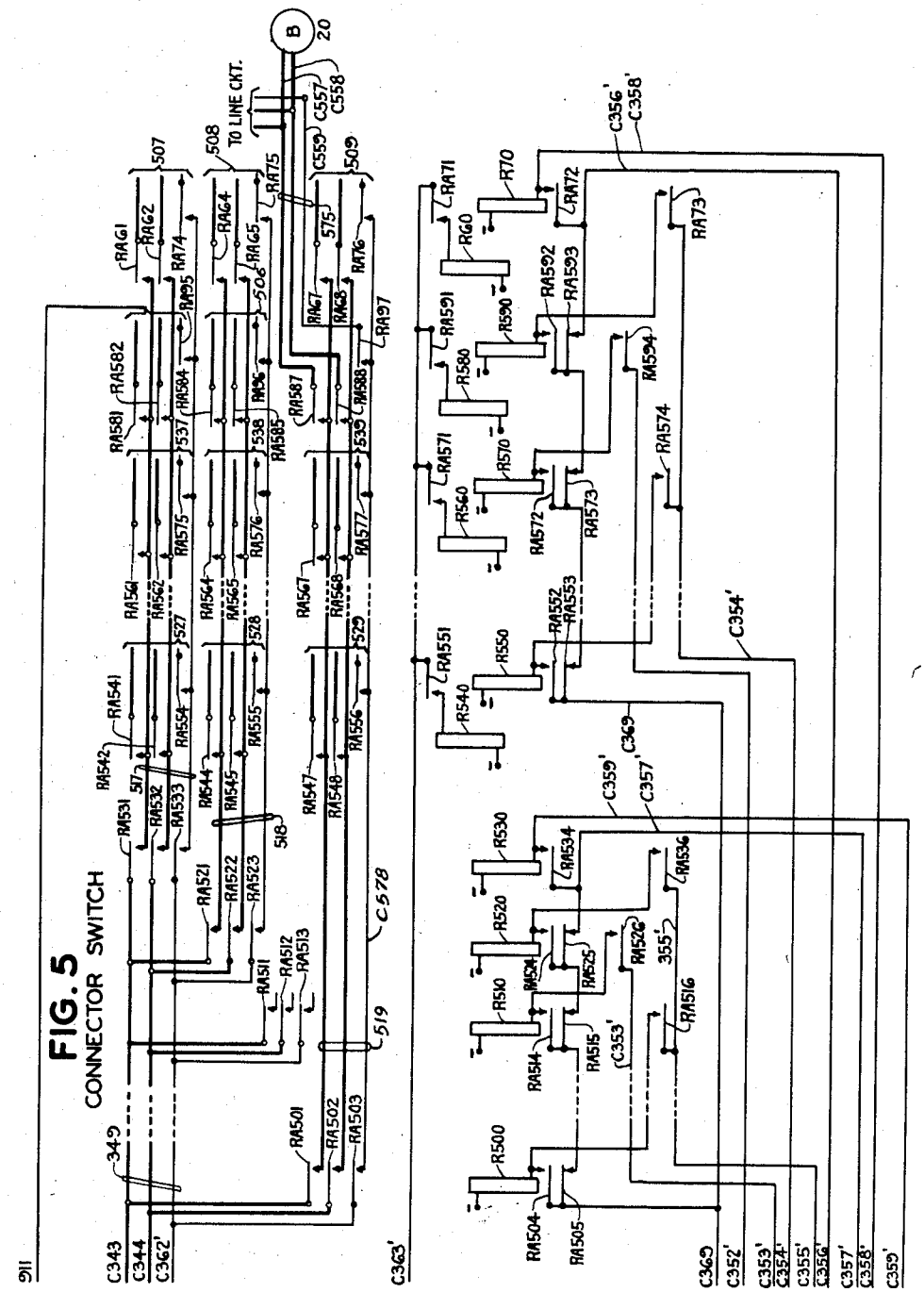
FIG. 4

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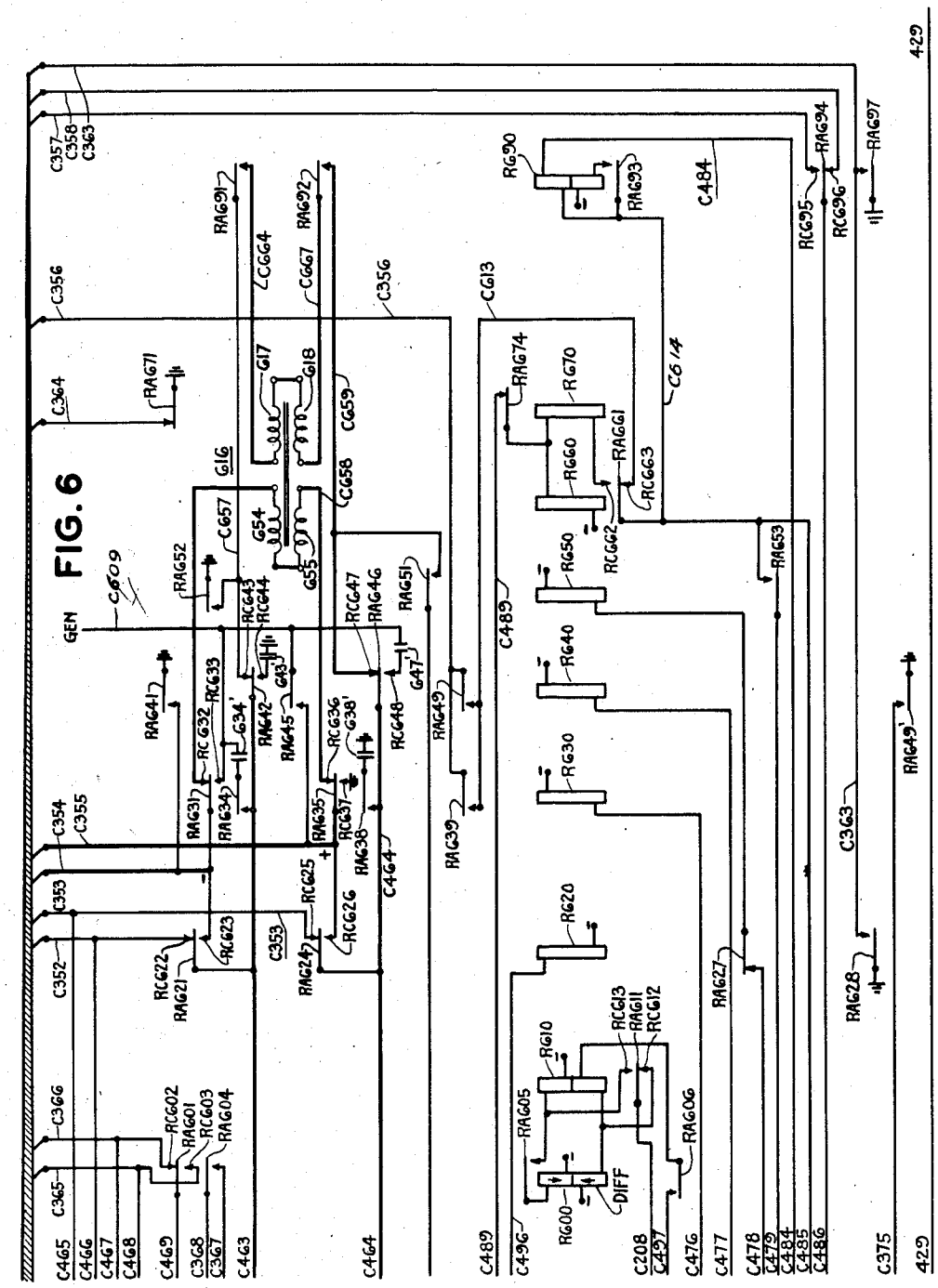


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FIG. 9

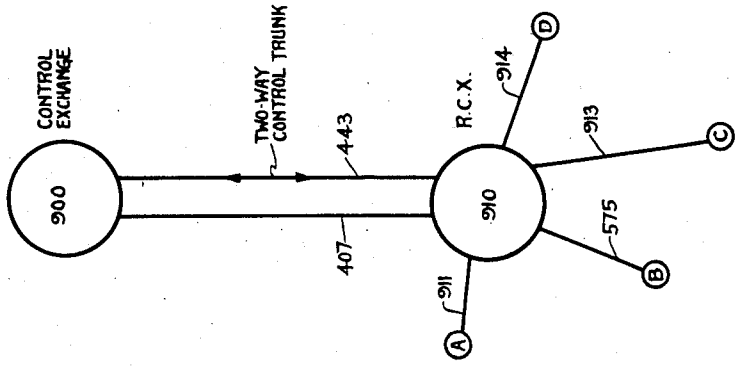
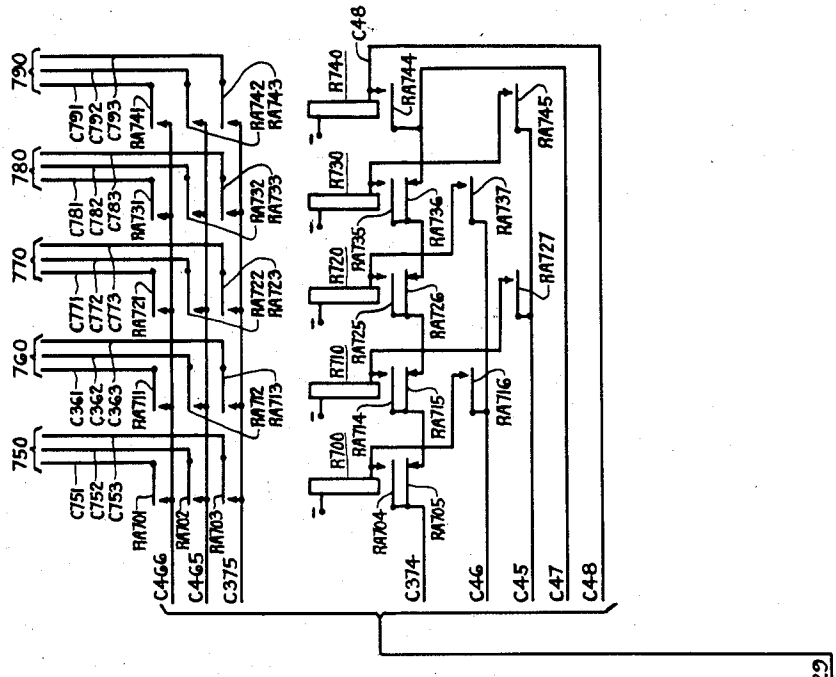


FIG. 7



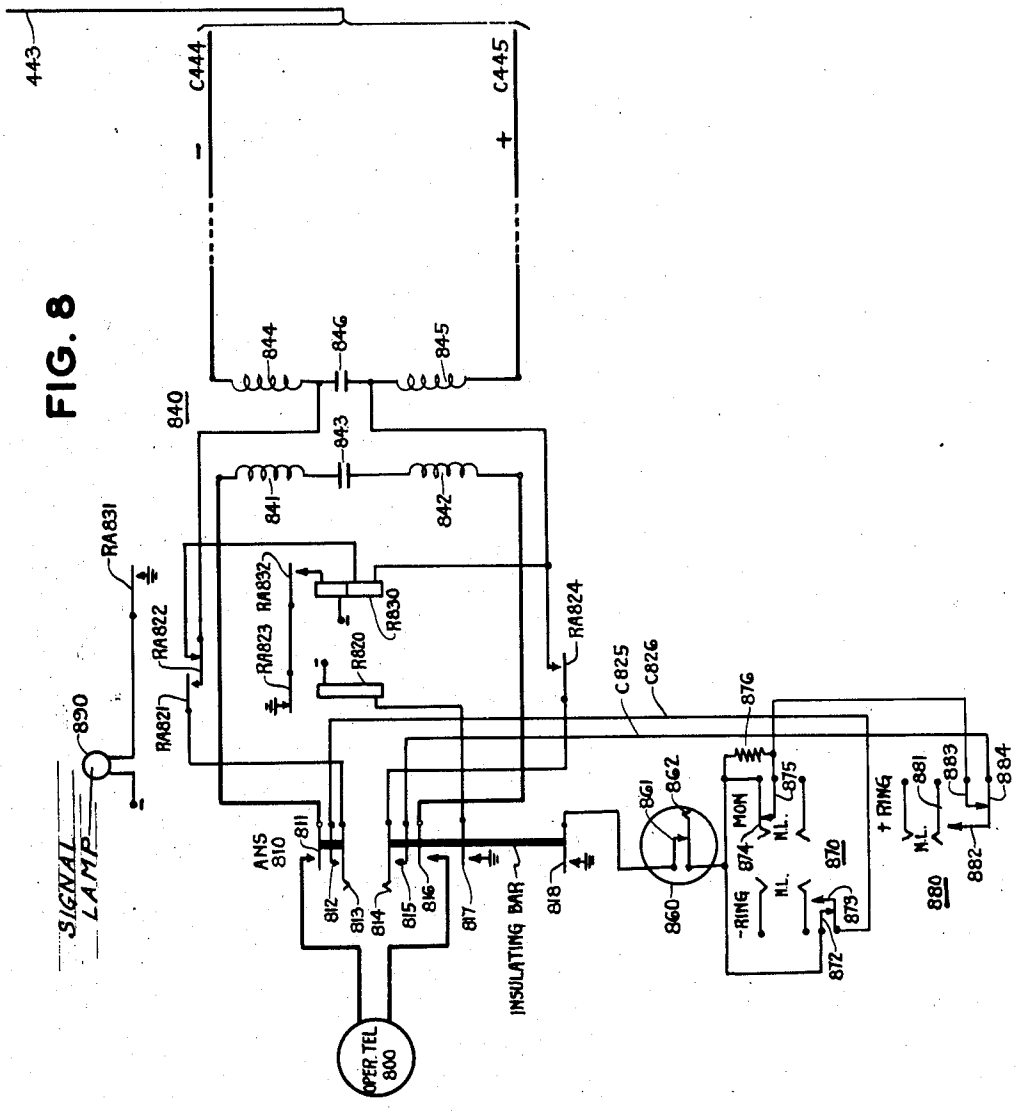
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TELEPHONE SYSTEM

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FIG. 8



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UNITED STATES PATENT OFFICE

2,158,945

TELEPHONE SYSTEM

Edward S. Peterson, Elmwood Park, Ill., assignor to Associated Electric Laboratories, Inc., Chicago, Ill., a corporation of Delaware

Application September 24, 1937, Serial No. 165,472

25 Claims. (Cl. 179—26)

The present invention relates to telephone systems and more particularly to systems adapted to serve a small group of subscribers' lines in a rural community.

In the early history of telephone operations, it was the practice in rural areas to provide a more or less independent telephone exchange for the rendition of telephone service to the small group of subscribers in each small community. These exchanges were of the manual type and each thereof required an operator for setting up desired connections between the various subscribers' lines. In the usual case, the telephone traffic was so small as to take up only a small part of the operator's time and as a consequence, the service was poor and the cost thereof relatively high. In order to obviate the above disadvantages, there has been developed what is known as a semi-automatic system wherein the setting up of connections between the subscribers' lines terminating at a small rural exchange is under the control of an operator located in a larger exchange remote from the small community exchange. By this arrangement it is possible for one operator in the central exchange to perform duties other than the supervision of calls emanating at the small rural exchange, with a consequent decrease in the cost of the service rendered and an increase in the quality of the service. Several forms of this type of system have been devised, one improved form being disclosed in United States Patent No. 2,010,372, granted August 6, 1935, to the present applicant. The system of this patent comprises, in general, a control trunk line interconnecting the control and local exchanges, an operator's station in the control exchange including an operator's telephone and an impulsing device, a plurality of finder-connector links included in the local exchange for setting up conversational connections between the various subscribers' lines terminating at this exchange, and allotter means arranged to assign, in a definite order, the idle finder-connector links to calling subscribers' lines. Control of the finder-connector links to set up the desired connections is achieved by transmitting impulses from the impulsing device at the operator's telephone, by way of the control trunk line, to cause any seized link to perform its line selecting functions and the usual auxiliary functions normally required in an automatic system. Various other features are incorporated in the circuit arrangement of this prior system which are designed to increase the operating efficiency of the equipment in the local exchange and increase the standard of service rendered to the various subscribers.

It is an object of the present invention to provide an improved system of the general character noted which is of simple and economical arrangement, is thoroughly reliable in operation, and requires a minimum of maintenance.

More specifically it is an object of the invention to provide a system of the form described wherein relays are used exclusively in setting up desired connections to the various lines of the system and wherein the arrangement is such that the number of relays required for an exchange of a given line capacity is reduced to a minimum.

In general, the objects as set forth above are attained in accordance with the present invention by providing a system of the form just described wherein all-relay finder-connector links are exclusively utilized in the rural exchange for setting up connections between the various lines terminating at the exchange, and allotter means comprising a plurality of interrelated relays are provided for successively assigning idle ones of the links to successive calling lines. More particularly, the finder switch embodied in each of the finder-connector links comprises a plurality of group select relays so connected and arranged as sequentially to operate in response to the initiation of a call on one of the lines terminating at the exchange to select a group of lines including the calling line, and a plurality of units relays so connected and arranged as sequentially to operate to select the calling line from the selected group of lines. Similarly, the connector end of each link includes a plurality of interrelated relays arranged to operate in a predetermined sequence in accordance with a series of impulses, transmitted from the central exchange operator's impulsing device over the control trunk interconnecting the two exchanges, to select a group of lines including a called line, and a plurality of relays so connected and arranged as sequentially to operate in accordance with another series of impulses transmitted from the impulsing device over the control trunk to select the called line from the selected group of lines. Control of the links in their operation to set up connections between the various lines extending to the rural exchange is achieved by providing control apparatus associated with the control trunk and common to all of the links. In this apparatus are included a pair of impulse responsive relays so connected and arranged that one thereof operates at the beginning of each odd impulse transmitted from the central exchange operator's im-

pulsing device over the control trunk and restores at the beginning of each even impulse. This one relay is arranged to control the operation of the line selecting relays embodied in the connector portion of each link. Also embodied in the common apparatus are means whereby the control operator located in the control or central exchange may monitor any connection following its establishment and may control the application of ringing current to a called subscriber's line to provide selective code ringing of those subscribers' lines which are of the multi-party type. Means under control of the central exchange operator are further provided in the common equipment for performing the usual auxiliary functions of applying ring-back tone current, or busy tone current, depending upon the condition of the called line, to the control trunk and a loop extending to a calling subscriber's line. For the purpose of controlling the operation of the common equipment in the remote exchange, there are provided at the operator's station in the cenral exchange, in addition to the impulsing device noted above, a plurality of key switches, one of which is operable to connect the operator's telephone to the control trunk and two others of which are operable to effect the ringing of a called substation. A signal device is also located at the operator's station for indicating the seizure of the common apparatus during the initiation of a call on one of the subscribers' lines. Means are further provided whereby this signal device is energized when all of the links become busy, or when a fault is present in the apparatus located at the remote exchange which renders this apparatus inoperative. The common control apparatus also includes supervisory equipment whereby the conrol operator in the central exchange may establish a connection to any one of the finder-connector links to determine whether or not it is actually busy, and may release any link thus tested in the event it is found to have been permanently appropriated by the failure of a party to ring off following the use of the link.

The novel features believed to be characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the specification taken in connection with the accompanying drawings, in which Figure 1 illustrates the finder end of a finder-connector link, incorporated in the system of the present invention; Fig. 2 illustrates the link starting apparatus, which, in combination with the allotter means illustrated in Fig. 1, controls the assignment of idle links to the calling lines; Fig. 3 illustrates the link portion of the finder-connector link; Fig. 5 illustrates the connector end of the link; Figs. 4 and 6 illustrate the control apparatus associated with the control trunk and common to all of the finder-connector links embodied in the system; Fig. 7 illustrates the supervisory apparatus referred to above; Fig. 8 illustrates the equipment located at the operator's station in the control exchange; and Fig. 9 is a trunking diagram illustrating the general form of a system having the features of the present invention embodied therein.

Referring now to Fig. 9 of the drawings, there is illustrated in diagrammatic form, a system of the general type described in the opening paragraphs, which diagrammatic illustration is included for the purpose of facilitating an understanding of the features to which the invention more particularly pertain. In brief, the system comprises a central or control exchange **900** which may have a number of subscribers' lines, not shown, extending thereto, and which is interconnected with a second rural community exchange **910**, remote from the exchange **900**, by means of a two-way control trunk line **443**, and a toll trunk line **497**. The second office has extending thereto a small number of subscribers' lines, four of which are indicated at **911**, **575**, **913** and **914**, having connected respectively thereto subscribers' substations A, B, C and D. Although a single substation has been shown as being connected to each of the enumerated subscribers' lines, it will be understood that in an actual installation embodying the features of a system of this character each of these lines will probably be of the party line variety, i. e., each thereof will have more than one substation connected thereto. Embodied in the rural exchange **910** are a plurality of finder-connector links for setting up connections between the various subscribers' lines to establish conversational circuits thereover, allotter means for successively assigning idle ones of the links to successive calling lines, and equipment, under the control of the control exchange operator, for performing the functions incidental to the line switching operations of the finder-connector links during the establishing of desired connections. Included in the central or control exchange **900** is the operator's equipment for controlling, by way of the trunk line **443**, the equipment for performing the above-noted incidental functions.

Neglecting for the present the details of the circuits involved as shown more particularly in Figs. 1 to 8, inclusive, and considering the operation of the system generally, it is pointed out that the establishing of connections between any pair of the various subscribers' lines terminating at the suboffice **910** is entirely under the control of the rural operator located at the central exchange **900**. Thus, on a call from one of the suboffice subscribers' lines to another of the suboffice subscribers' lines, such, for example, as a call from substation A to the substation B, the party at the substation A removes his receiver from its hook, and operates, in a well-known manner, his hand generator to apply ringing current to the line **911**, which current sets in operation an assigned idle finder-connector link to search for and seize the calling line. It will be understood that the allotment of the finder-connector links is under the control of the automatically operating allotter means referred to above and described more specifically hereinafter. When the calling line is seized by the assigned link, it is connected to the two-way control trunk **443** by way of the link, and the signal device at the operator's board is caused to operate to inform the operator that a call awaits attention. The operator may then connect her telephone to the trunk line **443** to establish a conversational circuit extending by way of this trunk line, the seized link, and the calling subscriber's line to the calling subscriber's substation. Following receipt of the information as to the party desired by the calling party, the operator actuates the impulsing device located at her telephone to cause the connector switch of the seized finder-connector link to operate and select the called line. Two series of impulses are required for such selection, the first series causing the connector switch to select a group of lines including the called line, and the second series

causing the switch to select the particular called line from the selected group of lines. Following the selection of the called line, this line is automatically tested to determine its idle or busy condition, and, if found busy, busy tone current is returned to the operator's telephone and the calling subscriber's telephone. The operator or the calling party may then cause the partially established connection to be cleared out. In the event the called line is found to be idle, the operator, by actuating a suitable ringing key, may cause ringing current properly to be applied to the line conductor or conductors of the line extending to the called subscriber's substation, and ring-back tone current to be applied to the loop extending to the calling subscriber's substation. It will be understood that selective code ringing is employed in those instances where the called subscriber's substation is connected to a party line. When the called subscriber answers, a conversational circuit is automatically set up between the calling and called substations. Following this, the operator may remain on the connection to monitor the same, or she may operate a key switch at her board to cause the control trunk and the equipment in the suboffice common to the links to be released for further use.

At the conclusion of the conversation between the calling and called parties, either thereof may actuate the generator located at his substation to cause the release of the link by way of which the connection is established. The projection of ringing current over the loop connecting the two parties causes the sequential operation of relays included in the link to initiate the ultimate release thereof.

Referring now to Figs. 1 to 8, inclusive, of the drawings wherein the circuits of the system described above are shown in considerable detail, and more particularly to Fig. 1, the finder end of the finder-connector link there illustrated includes a circuit network whereby any one of the plurality of subscribers' lines terminating at the suboffice may be connected to the line conductors of the link. Thus, any one of the lines **106**, **107**, **108**, **911**, **127**, **128**, **129**, **148** and **149** may be connected to the conductors forming the link line **189**, through the operation of relays R120, R130, R140, R150, R160, R170, R180, R190, R10 and R20 provided in the link. Of the enumerated relays, R120, R140 and R160 comprise group select relays which are so connected and arranged as sequentially to operate in response to the initiation of a call on one of the lines noted to select a group of these lines including the calling line. Similarly, the relays R180, R190 and R10 are so connected and arranged as sequentially to operate to select a particular calling line from a group of lines selected by one of the group select relays. The relays R130, R150 and R170 are line group switching relays and each thereof corresponds to one of the group select relays. These switching relays are arranged to operate, in the manner described in detail hereafter, only when the corresponding group select relay is operated and following the selection of the calling line. It will be understood that the number of group select relays and the number of units relays will depend entirely upon the number of subscribers' lines to which the link is to have access. In a link having access to one hundred lines, ten group select relays and ten units relays will be required. For the purpose of initiating the operation of the links, each of the subscribers' lines has associated therewith a line relay which operates when a call is initiated on the associated line. This relay for the line **911** is indicated at R100 and, in cooperation with the start conductor C91, functions to cause the allotter means indicated at **80** in Fig. 1 and the starting apparatus shown in Fig. 2 to assign an idle link to the line **911** when a call is initiated on this line, and to mark the group of lines including the line **911** and also the line **911** in the marked group. Each of the subscribers' lines also has associated therewith a cutoff relay for causing the de-energization of the associated line relay immediately upon the seizure of the associated line by a link. This relay is indicated at R110 for the line **911**. In the allotter means **80** there is included a relay corresponding to each of the links included in the suboffice. This relay for the link shown is indicated at R30 and the terminals embodied in three other similar relays are indicated at **81**, **82** and **83**, respectively. In order to control the operation of the above-enumerated relays, there are provided the two relays R300 and R310 shown in Fig. 3 and, as pointed out in detail hereinafter, the first of these relays operates following the completion of the line group selecting operation of the finder switch and initiates the sequential operation of the units relays to search for the calling line in the selected group, and R310 operates when the calling line is found to cause the calling line to be connected to the control trunk **443**. The operation of the allotter relay corresponding to the finder-connector switch illustrated is under the control of R20 and it is noted here that the latter relay operates to cause the assignment of a new link to a calling subscriber's line in the event the link illustrated searches for and fails to find the calling line.

The starting apparatus shown in Fig. 2 is interconnected with the allotter means **80** and includes a plurality of relays R200, R210, R220, R230, R240, R250, R260, R270, R280 and R290, which function to cause a signal to be transmitted to the central exchange operator when all of the links are busy and also to prevent a defective link from twice being assigned to a calling line. This apparatus also includes a timer **210'** which, in combination with certain of the relays noted, initiates the release of a seized link in the event the link fails to find the calling line responsible for its operation within a predetermined time interval following the seizure of the link, and assigns a second link to the calling line. The relays noted further operate in a manner such that, if the second assigned link fails to find the calling line, an alarm signal is transmitted to the operator's station to indicate the condition of the link and all of the apparatus in the rural exchange is prevented from further operation.

Referring now more particularly to Fig. 3 of the drawings, the equipment there shown is individual to the link illustrated, and comprises a repeater **305** at which the line **189**, leading to the finder end of the link, normally terminates, and line conductors adapted to be connected to the line conductors C343 and C344 outgoing to the connector end of the link. The last-mentioned conductors as well as the line conductors of the link line **189** are also adapted to be connected by a gang relay R390 to the control equipment common to all of the links and illustrated in Figs. 4, 6 and 7. The repeater noted includes primary windings **306** and **309**, connected in series across the line conductors C347 and C348 by means comprising a condenser **308**, and secondary windings **318** and **319** connected in series between the line conductors C346 and C345 by means comprising a con-

denser 309. The control equipment in this portion of the link includes, in addition to the relays R300 and R310 already mentioned, the gang relay R390 for associating the link with the common control equipment shown in Figs. 4 and 6, the relay R380 for selectively associating this control equipment with different ones of the control relays embodied in the connector end of the link, the line switching relays R320 and R330, and relays R340, R350, R360 and R370 which operate in the manner described in detail hereinafter to initiate the release of the link.

The connector end of the link as shown in Fig. 5 is somewhat similar to the finder end of the link in that a circuit network is provided whereby any desired called line may be connected to the link line 349 through the operation of group select, units, and group switching relays. Thus, the lines indicated at 527, 528, 529, 537, 538, 539, 911, 506, 575, 507, 508 and 509 may selectively be connected to the link line 349 through the operation of the relays R500, R510, R520, R530, R540, R550, R560, R570, R580, R590, R60 and R70. Of the enumerated relays, R70, R590, R570 and R550 are group select relays which are so connected and arranged as sequentially to operate in the order named and in accordance with the impulses comprising a first series of impulses transmitted over the control trunk 443 from the impulsing device at the central exchange operator's station, to select a group of lines including a desired called line. Similarly, the units relays R530, R520, R510 and R500 are so connected and arranged as sequentially to operate, in the order named and in accordance with a second series of impulses transmitted from the impulsing device noted, to select the called line from the selected group of lines. The relays R60, R580, R560 and R540 are group switching relays, each of which corresponds to one of the group select relays and is operable only in the event its associated group select relay is operated and the called line is found idle.

The control apparatus associated with the control trunk 443 and common to all of the links embodied in the rural exchange is illustrated in Figs. 4 and 6 and includes two repeaters 454 and 616, and control relays R400, R420, R430, R440, R450, R460, R470, R480, R40, R50, R600, R610, R620, R630, R640, R650, R660, R670 and R690 for performing the various functions briefly outlined above and set forth in greater detail hereinafter. Of these relays, the relays R600 and R610 are impulse responsive relays for controlling the operation of the group select and units relays embodied in the connector switch illustrated in Fig. 5. These two relays are so connected and arranged that one thereof, namely R600, operates at the beginning of each odd impulse transmitted from the impulsing device located at the operator's station over the control trunk 443 and restores at the beginning of each even impulse transmitted from this device. The relays R630 and R640 are ringing current control relays and are selectively operative to apply ringing current to either line conductor of a called subscriber's line, thereby to provide a means for selectively ringing the telephones connected to a party line. The relays R560 and R570 are provided for the purpose of controlling the operation of R380, embodied in the link proper, in a manner such that the impulsing relay R600 is successively connected to control the group select and units relays of the connector switch shown in Fig. 5. The relays R650 and R690 are the busy and switching through relays, respectively, and are included in the means for testing the called line to determine its idle or busy condition, for preventing the calling line from being connected to the called line in case the latter is found busy, for transmitting a busy signal to the operator and the calling subscriber in the event the called line is found busy, and for connecting the calling line to the called line in the event the latter is found idle. The relay R620 is a monitor relay which is provided for the purpose of enabling the central exchange operator to set up a connection to a called subscriber's line to the exclusion of a calling subscriber's line. The remaining relays identified above and shown more particularly in Fig. 4, with the exception of R400 and R420, are primarily controlled from the central exchange operator's apparatus and function to control the relays shown in Fig. 6. The relay R420 is operative to signal the central exchange operator when the common equipment is seized, when all of the finder-connector links become busy, or when a fault occurs in the rural exchange which renders the switching equipment therein inoperative.

A local control set 43 is also included in the common equipment, which may be used in emergencies by an operator located in the rural office, to control the establishing of connections between the various lines extending to the rural office independently of the operator in the central exchange. In this connection, it is pointed out that the relay R400 is provided for selectively connecting the common equipment to the control trunk 443 or the emergency operator's apparatus. For the purpose of enabling the central exchange operator to test the condition of the various links located in the rural office, the supervisory apparatus illustrated in Fig. 7 is provided. This apparatus is interconnected with the common equipment, shown in Figs. 4 and 6, and includes relays R700, R710, R720, R730, and R740, which are selectively arranged to be energized, in response to the dialing of predetermined digits at the central exchange operator's station, to connect the operator's telephone with the line conductors of any of the various links included in the suboffice.

Referring now more particularly to Fig. 8 of the drawings, the operator's equipment included in the central exchange and associated with the control trunk 443 is illustrated as comprising an operator's telephone 800, which is adapted to be connected by way of a key switch 810, and a repeater indicated generally at 840 to the trunk noted. Additional key switches 870 and 880 are provided, which are utilized in performing the ringing and monitoring functions noted above and described more particularly hereinafter. This apparatus also includes an impulsing device 860 and control means comprising two relays R820 and R830 which function in the manner pointed out specifically hereinafter in the detailed description of the operation of the system.

Operation of finder switch to find a calling line

Referring now in greater detail to the operation of the apparatus briefly dscribed above to establish a connection between two subscribers' substations, such, for example, as the substations A and B connected to lines terminating at the suboffice, if the substation A is in the calling substation, the call is initiated when the party at this substation actuates his hand generator to apply ringing current to the line 911, thereby to cause the operation of th line relay R100. The path of this current extends from one terminal of

the generator by way of C24, the upper winding of R100 and the elements RA111, RA101, and C25 to the other terminal of the hand generator. In response to such energization R100 operates to complete, at RA103, an obvious circuit for energizing its lower winding, thereby to maintain itself operated independently of its upper winding. At RA101, the relay R100 interrupts a point in the line circuit of the calling subscriber's line and, at RA102, applies battery from the cutoff relay R110 to the control conductor C29, thereby to mark this line in the finder switches to which it extends. Upon operation of RA103, ground is applied from RA113 to the start conductor C91, which ground serves to mark in the finder switches the particular group of lines including the calling line 911 and to start an idle one of the switches searching for the calling line, assuming an idle finder-connector link is available. Thus, when the relay R100 operates, a circuit is completed for energizing the slow-to-release relay R210 included in the starting apparatus shown in Fig. 2. This circuit extends from ground at RA113 by way of the elements RA103, RA104, RC105, C91, C93 and through the winding of R210 to battery. The relay R210, upon operating, completes, at RA211, a circuit for initiating the operation of the group select relays included in the finder switch of Fig. 1, only in the event the control equipment common to the various finder-connector links of the suboffice is idle at the time the call is initiated. At its armatures RA212, RA213, RA214, R215, R216 and RA217, the relay R210 initiates the operation of the starting apparatus shown in Fig. 2 to assign a new idle finder-connector link to the calling line in case the link shown is unsuccessful in finding the line, and to transmit an alarm signal to the central exchange operator in the event the second assigned link also fails to find the calling line; all in the manner described in detail hereinafter.

Assuming the control equipment common to all of the links of this suboffice to be idle, all of the relays illustrated in Figs. 4, 6 and 7 are in their restored positions as shown. When the relay R210 operates, therefore, and assuming that the finder-connector link illustrated is the link assigned to the calling line 911, a circuit is completed upon operation of R210 for energizing the first group select relay R120, this circuit extending from ground at RA496 by way of the elements RA439', C204, RA201, RA211, RA231, C89, RA32, RC33, C78, RA312, RC313, RA301, RC302, C74, RA161, RC162, RA141, RC142, RA121, RC122 and through the winding of R120 to battery. The relay R120, upon operating, completes, at RA125, a holding circuit for itself extending from ground on C78, interrupts at RA121 and RC122 its original operating circuit, completes at RA121 and RC123 a circuit for energizing R140, and prepares at RA124 a circuit, traced hereinafter, for energizing the group switching relay R130. The above-noted circuit for energizing R140 extends from ground on C78 by way of RA312, RC313, RA301, RC302, C74, RA161, RC162, RA141, RC142, RA121, RC123 and through the winding of R140 to battery. At RA126, the relay R120 connects the start conductor C92 to C79, which latter conductor is included in the circuit, traced hereinafter, for energizing the lower winding of R300.

Each of the start conductors C91, C92, etc., corresponds to one group of subscribers' lines and the relays respectively associated with the lines of each group all have circuits controlled thereby for applying ground to the associated group start conductor. In the present case, the group of lines including the calling line is associated with the start conductor C91 and assuming there are no calling lines in the group associated with the conductor C92, so that ground is not present thereon, R300 is not energized upon operation of RA126. As a result, R140 operates to complete, at RA145, a locking circuit for itself, to interrupt, at RA146, the above-noted locking circuit for R120, and to interrupt, at RA141 and RC142, a point in the original circuit for energizing R120. The last-mentioned relay restores after an interval and opens, at RA124, a point in the prepared circuit for energizing the group switching relay R130. Upon the restoration of RA125, a further point is opened in the locking circuit for R120 and, when RA126 falls back, the start conductor C92 is disconnected from C79 included in the circuit for energizing the lower winding of R300. When RA141 is pulled into engagement with RC143, a circuit is completed, extending from ground on C74, for energizing the third group select relay, and when RA144 is operated a circut is prepared for energizing the second group switching relay R150. The sequential operation of the group select relays R120, R140, R160, etc., continues in the exact manner described above until the one of these relays corresponding to the group of lines including the calling line 911 is operated. In the present instance, wherein the calling line is included in the second line group, or that group corresponding to the group select relay R140 and the start conductor C91, a circuit is completed upon operation of R140 for energizing the lower winding of R300. This circuit extends from ground at RA113, by way of the elements RA103, RA104, RC105, C91, C96, RA147, C79, RA316 and through the lower winding of R300 to battery. The relay R300 immediately operates to short-circuit, at RA305, its upper winding, thereby to render itself slightly slow to release. It is noted that both the third group select relay and R300 are energized simultaneously with the operation of R140, but R300 is much faster to operate than any of the group select relays. The energizing circuit for the third group select relay is, therefore, opened at RA301 and RC302 before this relay operates. Hence, the third group select relay remains restored and R140 remains locked up over its holding circuit extending by way of RA166 to ground on C78.

Each time one of the group select relays R120, R140, R160, etc., operates, it prepares testing circuits for determining which line included in the associated group of lines is the calling line. Thus, the relay R140, upon operating RA148, RA149, RA149', etc., prepares testing circuits for the lines 911, 148, 149, etc., included in the group corresponding to the group select relay R140 and the start conductor C91. These prepared testing circuits enable the units relays R180, R190, R10, etc., to select the particular calling line from the selected group of lines including the calling line. In this connection it will be noted that R140 upon operating applies, at RA148, battery from the cutoff relay R110 to C116 of the common link line 156.

Following the operation of the finder switch to select the group of lines including the calling line, the units relays are started into operation to select from this selected group of lines the particular calling line as identified by the extension of battery to the control conductor C116. Thus, when R300 operates, a circuit is completed

for energizing the first units relay R180, this circuit extending from ground on C78 by way of RA312, RC313, RA301, RC303, C75, RA185, RC186, RA194, RC195, RA14, RC15 and the winding of R180 to battery. The relay R180 operates after an interval and completes, at RA188, a locking circuit for itself, which circuit extends from ground on C78 by way of RA18, RA198, RA188, and through the winding of R180 to battery. At RC187, a circuit is completed, extending from ground on C75, for energizing the second units relay R190. At this same armature and its associated contact RC186, the original circuit over which R180 was energized is interrupted, the last-mentioned relay being held operated for an interval over its holding circuit as described above. When R180 operates, it connects, at its armatures RA181, RA182, and RA183, the conductors of the common link line 156 to the conductors of the link line 189 extending to the repeater 305.

Disregarding for the present the operations which follow the operation of the armatures RA181 to RA183, inclusive, and considering further the sequential operation of the units relays, it will be seen that R190 operates shortly after the operation of R180 and prepares, at RA194 and RC196, a circuit for energizing the next succeeding units relay. At its armature RA 197, the relay R190 completes an obvious locking circuit for itself extending from ground on C78 and, at RA198, it opens a point in the above-noted holding circuit for the first units relay R180. The relay R180 immediately restores to complete, at RA185 and RC186, the previously prepared circuit for the units relay next succeeding R190, which latter relay, upon operating, interrupts the holding circuit for R190 and prepares a circuit for energizing the fourth units relay. This operation continues until the particular calling line in the selected group of lines is found.

As noted previously, the finding of the calling line is determined by the presence of battery potential on one of the control conductors, corresponding to C116, included in the common link lines 156, 159, 199, etc. In the present assumed case, wherein the calling line 911 is the first line in the second group of lines, this line is found immediately upon the operation of R180. Thus, when RA183 engages its associated contact, a circuit is completed for energizing the lower winding of R310, this circuit extending from battery at the cut-off relay R110 by way of RA102, C29, RA148, C116, RA183, C119 and through the lower winding of R310 to battery. The relay R310, upon operating, closes its armature RA312 to the associated contact RC314 to complete a locking circuit for itself. This circuit includes the upper winding of R310 and extends from ground on C78 to battery at the lower terminal of this winding. When RA312 is disengaged from RC313, ground is removed from C75 so that there is no longer a circuit prepared for energizing further ones of the units relays R180, R190, R10, etc. Hence, the sequential operation of these relays is interrupted immediately upon the operation of R310. In this connection it is pointed out that the slow-to-operate characteristic of each of the units relays prevents further sequential operation thereof following the finding of the calling line. For example, the relay R310 operates to interrupt the prepared circuit for R190 before sufficient time has elapsed to permit the latter relay to operate. The closure of RA312 to RC314, upon operation of R310, connects C78 to C76, thereby to complete a circuit for energizing the selected one of the group switching relays which, in the present case, is R150 associated with the group select relay R140. This circuit extends from ground on C78 by way of RA312, RC314, C76, RA144 and through the winding of R150 to battery. The relay R150 operates when energized over the above traced circuit and at its armatures RA151 and RA152 connects the conductors C24 and C25 of the subscriber's line 911 through to the line conductors C347 and C348 leading to the control equipment common to all the links and illustrated in Figs. 4, 6 and 7.

The relay R310, upon operating RA315, short-circuits its lower winding to cause the energization of the cut-off relay R110 associated with the calling line 911 over a circuit extending directly from ground at RA315 by way of C119, RA183, C116, RA148, C29, RA102 and through the winding of R110 to battery. At RA317 the relay 310 prepares a circuit, traced hereinafter, for holding the connector switch of Fig. 5 operated independently of the control equipment shown in Figs. 4, 6 and 7. At RA316, the relay R310 interrupts the operating circuit for R300 and at RA311 it completes a circuit, traced hereinafter, for energizing the gang relay R390. When R110 operates RA113, it interrupts the holding circuit for the line relay R100 and removes ground from the start conductor C91. At RA112, the relay R110 shunts the armature RA102 to complete a holding circuit for itself and to maintain ground potential on the control conductor C26, thereby to hold the calling line marked as busy in the relays of the connector switches to which this line extends. At RA111, the relay R110 opens a point in the circuit over which the line relay R100 was originally energized, thereby to prevent the line relay R100 from being energized during the release of the connection. When R100 restores, it opens at RA103 a point in the path for applying ground to the start conductor C91 and a point in the circuit for energizing its lower winding. At RA101, it completes a point in the line circuit extending to the calling subscriber's substation A and, at RA102, it opens the shunt from around the operated armature RA112. When R300 restores shortly following the operation of R310 a circuit is completed at RA304 for energizing the upper winding of R20, this circuit extending from ground on C76 by way of RA304, C77 and the upper winding of R20 to battery. The relay R20, upon operating completes at RA21 and RA22 an obvious circuit for energizing the allotter relay R30 which latter relay operates, in turn, to condition the next succeeding idle finder-connector link to be seized by the next succeeding calling line; all in the manner described in detail hereinafter.

When ground is removed from the start conductor C91 at RA113 of the cut-off relay R110, the above-traced operating circuit for the slow-to-release relay R210 is opened and this relay restores to remove at RA211, ground from the conductor C78. Before this occurs, however, multiple ground is applied to the conductor noted in response to the sequential operation of certain of the relays shown in Figure 3. Thus, immediately upon the operation of R310, a circuit is completed at RA311 for energizing the gang relay R390, this circuit extending from ground to RA351 by way of C337, RA311, C338, RA336, C339, and the winding of R390 to battery. Upon

being energized over the above-traced circuit, R390 operates all of its associated armatures into engagement with their respective associated contacts. This last-mentioned operation results in the application of ground from RA390' to the conductors C76 and C78 thereby to hold R20, R180, R150, R140 and R110 operated independently of the condition of R210 included in the starting apparatus shown in Figure 2. Thus, the finder switch is held operated and the starting and allotter appartus is released for further use.

Extension of the connection to the control exchange operator's telephone.

Simultaneously with the operation of the gang relay R390, circuits are completed for energizing the switching relay R380 and the slow-to-release relay R420. The first of these circuits extends from ground at RA671 by way of C364, RA392', C364', and through the winding of R380 to battery. The second-mentioned circuit, namely, that for energizing R420, extends from ground at RA393 by way of C359, RA438 and the winding of R420 to battery. When the switching relay 380 operates, it prepares circuits, traced hereinafter, for energizing the group select relays R70, R590, R570, R550, etc., in accordance with the impulses transmitted during the first digit dialed at the operator's station in the central exchange. The relay R420, upon operating, completes, at RA423, an obvious circuit for energizing the slow-to-operate relay R430. At its armatures RA421 and RA422 and their respective associated contacts RC426 and RC428, the relay R420 completes a circuit for energizing R830 included in the control apparatus at the central exchange operator's station. The last-mentioned circuit extends from ground at RC426 by way of the elements RA421, RA401, RC402, C444, the repeater winding 844, RA822, the lower winding of R830, the repeater winding 845, C445, RC405, RA404, RA422, RC428, and through the resistor 428' to battery. In response to its energization over the above-traced circuit, R830 operates to complete, at RA831, an obvious circuit for energizing the signal lamp 890. At RA832, the relay R830 completes an obvious locking circuit for itself.

Shortly following the energization and operation of R830, the relay R430 operates to interrupt, at RA437 and RA438, the operating circuit for R420. At its armature RA436', the relay R430 completes a locking circuit for itself extending from ground at RA492 by way of C476' and the winding of R430 to battery. At RA439, this relay prepares an alternative locking circuit for itself extending from ground and held open at RA482. At its armatures RA431 to RA434, inclusive, the relay R430 interrupts points in the impulsing circuits traced hereinafter, for energizing the supervisory relays R700 to R710, inclusive, thereby to prevent these relays from being affected during the transmission of impulses to the selecting relays of the connector switch.

Shortly following the operation of R430 and the consequent interruption of the operating circuit for R420, the latter relay restores further to prepare, at its armaures RA421 and RA422 and their associated contacts RC425 and RC427, respectively, the loop extending between the calling subscriber's substation A and the operator's telephone 800. The operator, upon witnessing the energized condition of the signal lamp 890, is informed that a call is present upon the line 443 which requires her attention. By operating the key switch 810 to its off-normal position, she may complete the talking loop between the telephone 800 and the calling subscriber's substation A, and condition the common control equipment located in the suboffice to be responsive to impulses transmitted thereto from the impulsing device 860. Thus, when this key switch is operated to its off-normal position, an obvious circuit is completed at the switch element 817 for energizing R820, which relay operates RA823 to open a point in the holding circuit for R830. The last-mentioned relay restores its armature RA832, to open a further point in its holding circuit, and its armature RA831, to interrupt the circuit for energizing the signal lamp 890. At its armatures RA821 and RA824, the relay R820, upon operating, completes circuits for energizing the relays R450, R460, and R470 embodied in the control equipment at the distance exchange. The first of these circuits extends from ground at the switching element 818 by way of the impulsing springs 861 and 862, the springs 872 and 873 of the key switch 870, C826, the springs 812 and 813 of the key switch 810, RA821, RA822, the repeater winding 844, C444, RC402, RA401, RA421, RC425, C448, the repeater winding 455, the lower winding of R440 and through the winding of R450 to battery. The second of the above-noted circuits, namely that for energizing R460 and R470 in series, extends from ground at the switch spring 818 of the key switch 810 by way of the impulsing springs 861 and 862, the springs 874 and 875 of the key switch 870, the springs 883 and 884 of the key switch 880, C825, the springs 814 and 815 of the key switch 810, RA824, the repeater winding 845, C445, RC405, RA404, RA422, RC427, C449, the lower repeater winding 456 of the repeater 454, the upper winding of R440, and through the windings of R460 and R470 in series, to battery. Although both of the windings of R440 are energized, this relay does not operate, the two windings being connected in opposition to permit operation of the relay only when one thereof is energized and the other is deenergized.

When the relay R450 operates, following its energization over the above-traced circuit, it completes at RA451 an obvious circuit for energizing the slow-to-release relay R480. At its armature RA452, the relay R450 opens a point in a circuit, traced hereinafter, for energizing the relays R40 and R600 in parallel and, at its armature 453, it opens a point in the circuit for energizing the ringing current control relay R630.

The relay R460, upon operating, interrupts, at RA461, a point in the circuit, traced hereinafter, for energizing the monitor relay 620. When R470 operates in response to its energization in series with R460, it prepares, at its armature RA471, a point in the above-noted circuit for energizing R460, completes, at its armature RA472, a multiple circuit for the slow-to-release relay R480 and interrupts, at its armature RA473, a point in the circuit, traced hereinafter, for energizing the ringing current control relay R640.

Shortly following the operation of R450 to complete a circuit for energizing R480, the last-mentioned relay operates to complete, at RA482, an obvious alternative holding circuit for maintaining R430 energized independently of the slow-to-release relay R490. At its armature RA483, the relay R480 interrupts a point in the circuit, traced hereinafter, for energizing R340 during the release of the finder-connector link by the central exchange operator. At its armature

RA481, the relay R480 completes an obvious circuit for energizing R490, and the latter relay operates, in turn, to prepare, at RA491, a point in the circuits for energizing R40 and R50, to interrupt, at RA492, the original holding circuit for R430, and to prepare, at its armature RA493, a circuit, traced hereinafter, for energizing the switching relay R690, following the selection and testing of the called line. At its armature RA494, the relay R490 prepares a point in the above noted circuit for energizing R340 included in the control equipment of the finder-connector link illustrated in Figures 1, 3, and 5, and at its armature RA495 it opens a point in the circuit, traced hereinafter, for energizing R280 included in the starting apparatus illustrated in Figure 2. At its armature RA497, the relay R490 prepares a circuit, traced hereinafter, for energizing R740 and at RA496 it opens a point in the common portion of the circuits for initially energizing the group and units relays of the finder switches, thereby to prevent a second link from starting to operate before the control equipment common to the links and shown in Figs. 4, 6 and 7 is released. With the control equipment included in the suboffice and common to the links in this condition, it is prepared to respond to impulses transmitted from the impulsing device 860 located at the operator's position in the central exchange thereby to cause the group and units relays of the connector switch to select the called line 575.

Dialing the called line

As pointed out above, immediately upon the operator's actuation of the key switch 810 to its off-normal position, a conversational circuit is established between the operator's telephone 800 and the calling subscriber's substation A. This loop includes the calling subscriber's line 911, the common link line 156, the link line 189, the line conductors C347 and C348, the link conductors C352 and C353, the line conductors C463 and C464, the repeater 454, the control trunk 443, the repeater 840 and the line conductors leading to the operator's telephone. With this circuit completed the operator may converse with the calling party and obtain the necessary information for completing the connection to the desired substation. In the present case, wherein it is assumed that the calling party A desires to converse with a party at the substation B, the central exchange operator manipulates the impulsing device 860 in accordance with the number designating the line 575 to which the substation B is connected, thereby to cause the connector switch shown in Figure 5 to select this line. It will be observed from a consideration of Figure 5 that the telephone number of the called line 575 is 20 since this line is in the tenth line in the second group of ten lines.

At the beginning of the first impulse of the first digit dialed, the previously traced operating circuits for the relays R450, R460 and R470 are interrupted at the impulsing springs 861 and 862 of the impulsing device 860. The relay R460, upon falling back, prepares, at its armature RA461, the above-mentioned circuit for energizing R520, a point in this circuit being simultaneously opened at RA471 of R470. At its armature RA473, the last-mentioned relay prepares a point in the circuit for energizing R640, this circuit being held open at the restored armature RA442 of the differential relay R440. At the two armatures RA451 and RA472, embodied respectively in R450 and R470, the operating circuit for R480 is opened. Due to its slow-to-release characteristic, however, the last-mentioned relay remains operated during impulsing. The relay R450, upon falling back, completes, at its armature RA452, a circuit for energizing the slow-to-release relay R40 and the lower winding of the impulsing relay R600 in parallel, this circuit extending from ground at RA441 by way of RA452 and RA491 to C208, where it divides, one branch extending through the winding of R40 to battery and the other branch extending by way of RA611, RC612 and the lower winding of R600 to battery. Both of the relays R40 and R600 operate, the first thereof to complete, at RA42, an obvious circuit for R50 and the second thereof to prepare, at its armature RA605, a circuit, traced hereinafter, for energizing the upper windings of R600 and R610 in parallel. The impulsing relay R600, upon operating, also prepares, at RA606, a path for short-circuiting the lower winding of R610, this path being completed upon operation of R50 and extending from ground at RA52 by way of C497, RA606, the lower winding of R610, RC612, RA611 back to ground on C208. The relay R50 upon operating also prepares, at its armature RA54, a test circuit, traced hereinafter, for energizing the busy relay R650 in the event the called line ultimately selected is found busy. At its armature RA51, the relay R50 completes a circuit extending by way of C489 and RA674 for energizing R660, which latter relay immediately operates to short-circuit, at RA661 and RC662, the winding of R670. This short-circuiting path extends from ground at RA51 by way of C489, RA674, the winding of R670, RC662, RA661, C485, back to ground at RA493.

In addition to performing the functions described above, the impulse responsive relay R600, upon operating, completes, at RA604, a circuit for energizing the first group select relay R70 included in the connector switch shown in Figure 5. This circuit extends from ground at RA317 by way of C369, RA553, RA573, RA593, C356', RC386', RA387, C367', RA395', C367, RA604, C368, RA396', C368', RA388, RC389, C358' and through the winding of R70 to battery. At its armature RA601 and associated contact RC603, the impulsing relay R600 prepares a circuit, traced hereinafter, for energizing the third group select relay R570, this circuit being held open at the restored armature RA594 of the second group select relay R590. The last-mentioned circuit is further prepared at RA57 upon the operation of R50 at the beginning of the first pulse of the first digit. It will be understood that due to the slow-to-release characteristic of the relay R40, this relay and the relay R50 are held operated during any series of impulses comprising a particular dialed digit. With R40 operated, circuits, traced hereinafter, are opened at RA43 for applying busy tone current to the calling subscriber's line 911 and the control trunk 443.

As noted previously, the two relays R600 and R610 are so connected and arranged that R600 operates at the beginning of each odd impulse, R610 operates at the end of each odd impulse, R600 restores at the beginning of each even impulse, and R610 restores at the end of each even impulse. Thus, and as pointed out above, R600 operates immediately upon the restoration of R450 at the beginning of the first impulse of the first digit. At the end of this pulse, when the impulsing springs 861 and 862 are again closed to cause the reenergization of R450, R460, and

R470, the above-traced short-circuiting path for the lower winding of R610 is interrupted at RA452 permitting this winding to be energized in series with the lower winding of R600. When this occurs, R600 stays operated and R610 operates to prepare, at RA611 and RC613, the above-noted circuit for energizing in parallel the respective upper windings of the two relays R600 and R610. This circuit is completed at the beginning of the second impulse when R450 again restores its armature RA452 and extends from ground at RA441 by way of RA452, RA491, C208, RA611, to RC613, where it divides, one branch extending through the upper winding of R610 to battery and the other branch extending by way of RA605 and the upper winding of R600 to battery. The relay R610 remains operated, but the relay R600, being differentially wound, restores when its upper and lower windings are both energized. When RA605 falls back, the circuit for energizing the upper winding of R600 is opened and when RA606 falls back, a second point is opened in the circuit for energizing the lower winding of R600 and the lower winding of R610 in series. In order to render R600 fast to restore at the beginning of each even impulse, its upper winding is constructed so that the flux produced thereby greatly predominates over that furnished by the lower winding. At the end of the second impulse when R450 again operates, the circuit holding R610 operated is interrupted at RA452 and R610 restores its armature RA611 to restore the two relays R600 and R610 to the condition which prevailed before the first impulse was transmitted thereto. It will of course be understood that the sequential operation and restoration of these two relays as described above are repeated during each succeeding pair of impulses transmitted thereto.

Due to the repeated operation and restoration of R600 in response to the impulses transmitted thereto, the group select relays R70, R590, R570, and R550 are caused successively to energize and restore in accordance with these impulses. Thus, it was pointed out above that R70 was energized and operated at the beginning of the first impulse of the first digit dialed. This relay, upon operating, prepares, at RA71, a circuit for energizing the group switching relay R60, the latter relay not being energized at this time due to the fact that ground is withheld from C363' at the restored armatures RA628 and RA697. At its armature RA72, the relay R70, upon operating, completes a locking circuit for itself extending from ground at RA317 by way of C369, RA553, RA573, RA593, RA72 and the winding of R70 to battery. At its armature RA73, the relay R70, upon operating prepares a circuit for energizing the second group select relay R590, this circuit being completed upon the restoration of the impulsing relay R600 at the beginning of the second impulse and extending from ground at RA57 by way of C469, RA601, RC602, C366, RA394', C366', RA384, RC385, C354', RA73 and the winding of R590 to battery.

The second group select relay, upon operating, interrupts, at RA593, the above-traced holding circuit for R70, causing this latter relay to restore to interrupt at RA71 the previously prepared point in the circuit for energizing R60 and to interrupt, at RA73, the original circuit over which R590 is energized. At RA72, the relay R70 interrupts a further point in its locking circuit as traced above. Before R70 falls back and immediately upon operation of R590, a holding circuit is completed for the latter, which circuit extends from ground at RA317, by way of C369, RA553, RA573, RA592 and the winding of R590 to battery. At RA591, the relay R590 prepares a circuit for energizing R580 from ground on C363' and, at RA594, it prepares a circuit for energizing the third group select relay R570.

At the beginning of the third impulse, when the impulsing relay R600 again operates, the last-mentioned circuit is completed at RA601 and RC603 and extends from ground at RA57 by way of C469, RA601, RC603, C365, RA393', C365', RA381, RC382, C352', RA594 and the winding of R570 to battery. The relay R570, upon operating, completes, at RA572, an obvious locking circuit for itself, interrupts, at RA573, the locking circuit for the preceding group select relay R590, prepares, at RA571, a circuit for energizing the group switching relay R560, and prepares, at RA574, a circuit for energizing the next succeeding group select relay.

In view of the foregoing description, it will be apparent that each group select relay is energized at the beginning of the impulse to which it corresponds. For example, R70 is energized and operates at the beginning of the first impulse, R590 at the beginning of the second impulse, R570 at the beginning of the third impulse, etc. Each of these relays upon operating causes the restoration of the preceding group select relay and prepares a circuit for energizing the corresponding group switching relay and the next succeeding group select relay. Each of the group select relays further functions to prepare testing circuits for each of the lines in the group to which it corresponds. For example, the first group select relay R70 upon being energized prepares at its armatures RA74, RA75, RA76, etc., testing circuits for the lines 507, 508, 509, etc., included in the first group. Similarly the second group select relay R590, upon operating, prepares at its armatures RA95, RA96, RA97, etc., circuits for determining the idle or busy condition of the lines 911, 506, 575, etc., included in the second group of lines corresponding to this group select relay. It will be understood that in a finder-connector link, wherein the lines extending thereto are divided into ten groups, ten group select relays will be utilized which successively operate in accordance with a first digit of from 1 to 0 to select a group of lines including a desired calling line. In the present instance, wherein the called line 575 is included in the second group and the first digit comprises only two impulses, the group select relay R590 will be energized at the end of the digit so that a circuit is prepared for energizing the corresponding group switching relay R580. Since the digit comprises an even number of impulses, the two relays R600 and R610 are both restored.

At the end of the series of impulses comprising the first digit, the impulsing springs 861 and 862 are again closed to cause the reoperation of R450, R460 and R470 and remain closed for a sufficient period of time to permit the sequential restoration of R40 and R50. Thus, when R450 operates, it interrupts, at RA452, the above-traced circuit over which R40 is energized. After an interval, R40 falls back, to interrupt, at RA42, the operating circuit for R50. The relay R50, upon restoring, opens at RA51, the shunt across the winding of R670 and, at RA52, interrupts a point in the circuit for energizing the respective lower windings of R600 and R610 in series. At RA57, the relay R50 opens a point in the common por-

tion of the circuits over which the group select relays are initially energized, thereby to prevent a false operation of one of these relays following the restoration of R600 and R610, in case the two latter relays are in an energized condition at the end of a particular series of impulses. At RA54 and RC55, the relay R50, upon restoring, prepares a circuit for energizing the line switching relay R690.

When the short-circuiting path for the winding of R670 is interrupted at RA51, the two relays R660 and R670 are energized in series over a path extending from ground at RA493 by way of C485, RA661, RC662, the winding of R670 and the winding of R660 to battery. The relay R670 operates, when energized in series with R660, and at RA674, interrupts the above-traced circuit over which R660 was initially energized. At its armature RA671, the relay R670 interrupts a point in the above-traced circuit for the pulse switching relay R380. This last-mentioned relay, upon restoring its armatures, prepares circuits, traced hereinafter, for successively energizing the units relays R530, R520, R510, R500, etc., in accordance with the impulses comprising the second digit dialed at the impulsing device 860.

At the beginning of the first impulse of the second digit, when the above-described operating circuits for the relays R450, R460 and R470 are again interrupted at the impulsing springs 861 and 862, these relays restore to cause the reoperation of R40, R50 and the impulsing relay R600. In view of the foregoing description it will be understood that, during the impulses comprising the second digit, the two relays R600 and R610 follow the sequence of operations outlined above; that is, R600 operates at the beginning of each odd impulse, R610 operates at the end of each odd impulse, R600 restores at the beginning of each even impulse and R610 restores at the end of each even impulse.

At the beginning of the first impulse of the second digit when R600 operates, a circuit is completed at RA604 for energizing the first units relay R530, this circuit extending from ground at RA317 by way of C369, RA505, RA515, RA525, C357', RC387', RA387', C367', RA395', C367', RA604, C368', RA396', C368', RA388, RC389', C359' and the winding of R530 to battery. At its armature RA534, the relay R530, upon operating, completes a locking circuit for itself extending from ground at RA317 and including an obvious portion of the circuit traced immediately above. At its armatures RA531, RA532, and RA533, the relay R530 connects the link line 349 to the common link line 517 to prepare a testing circuit for the calling line 911. At RA536, the relay R530 prepares a circuit for energizing the second units relay R520, this circuit being completed at the beginning of the second impulse of the second digit, when R600 restores in response to its differential energization in the manner described above. This last-mentioned circuit extends from ground at RA57 by way of C469, RA601, RC602, C366', RA394', C366', RA384', RC386', C355', RA536, and the winding of R520 to battery. The relay R520, upon operating, interrupts at RA525 a point in the previously noted holding circuit for the first units relay R530 and, at its armature RA524, completes an obvious holding circuit for itself. The relay R530 thereupon restores all of its armatures to interrupt, at RA536, the original operating circuit for the second units relay R520 and to disconnect the common link line 517 from the link line 349. With the units relay R520 operated, a circuit is prepared for testing the condition of the subscriber's line 506.

At the beginning of the third impulse, when the impulse responsive relay R600 again operates, the above-noted circuit for energizing the third units relay R510 is completed, this circuit extending from ground at RA57 by way of C469, RA601, RC603, C365, RA393', C365', RA381', RC383, C353', RA526 and the winding of R510 to battery. The relay R510, upon operating, immediately interrupts, at its armature RA515, the holding circuit for the second units relay R520 and completes, at RA514, a holding circuit for itself. At its armatures RA511, RA512, and RA513, this third units relay prepares a circuit for testing the condition of the third line of the second group and, at its armature RA516, it prepares a circuit for energizing the fourth units relay.

In view of the immediately preceding description, it will be understood that the units relays are successively energized in accordance with the impulses of the second digit and that, at the end of this digit, only the one of these relays corresponding to the number of the last impulse in the second digit is energized. In the present assumed case, wherein the called line 575 is the tenth line in the second group of lines, the second digit, as has been pointed out, will comprise ten impulses so that, at the conclusion of this digit, the tenth units relay R509 is energized and the control conductor C559 of the called line 575 is connected by way of the armatures RA597 and RA503 to the control conductor C362' of the link line 349. It will be observed that the operated group select relay R590 and the operated units relay R500 are locked up over holding circuits including the common portion extending from ground at RA317, which circuits are held completed independently of the control equipment common to all of the links.

At the conclusion of the second digit, the relays R450, R460 and R470 re-operate and the relays R40 and R50 and the impulse responsive relays R600 and R610, if operated, restore; all in the manner described above in connection with the operations which occur following the dialing of the first digit at the central exchange operator's station. The sequence of operations which occur from this point on depend upon the condition of the called line as identified by the potential existing on the control conductor thereof. As noted in an earlier portion of the description, in connection with the operation of the finder switch shown in Figure 1, if the called line is busy, its control conductor is marked with ground potential whereas, if the line is idle, battery potential is present thereon, this potential being applied to the control conductor from the cut-off relay associated with the line and corresponding to the relay R110 associated with the calling line 911.

The operations resulting when the called line is idle

Assuming the called line to be idle, the relays R40 and R50, upon restoring, shortly following the end of the second digit, complete a circuit for energizing the upper winding of the switching relay R690, this circuit extending from battery at the cutoff relay associated with the called line 575 by way of C559, RA597, C578, RA503, C362', RA399, C362, RA54, RC55, C484, the upper winding of R690, C614 and C485 to ground at RA493. In response to the energization of its upper wind-

ing over the above-traced circuit, R590 operates to complete, at RA693, a locking circuit for itself, which circuit extends from ground at RA493 by way of C485, C514, RA693 and the lower winding of R690 to battery. At RA691 and RA692, the relay R690 prepares a talking loop, including the repeaters 616 and 305, between the calling and called lines, and a talking loop, including the repeaters 454 and 616, between the operator's telephone 800 and the called line. At its armature RA694 and RC696, the relay R690 opens a further point in the circuit, traced hereinafter, for energizing R340 and, at this same armature and RC695, it prepares a point in the circuit for energizing R330. At its armature RA697, the relay R690 closes ground to C353 to complete a circuit for energizing the selected group switching relay R580. This circuit extends from ground at RA697 by way of C363, RA391', C363', RA591 and the winding of R580 to battery. When the group switching relay R580 operates, it connects, at its armatures RA581 to RA588, inclusive, the line conductors of the lines 911, 506, 575, etc., comprising the group selected, to the common lines 517, 518, 519, etc. This operation causes the called line 575 to be connected to the link line 349 to complete conversational circuits between the calling and called telephones and the central exchange operator's telephone 800. With the system in this condition the operator may listen in to determine whether or not the called line is being used by two parties each having his telephone conected thereto. If the called line is busy the operator may hold the connection until the previously established connection is cleared out, break in on the ensuing conversation, or release the connection in the manner described hereinafter. If, on the other hand, the called line is idle, the operator may proceed to ring the desired one of the substations connected thereto.

Ringing the called substation

To this end and as pointed out above, provisions are made whereby ringing current may be transmitted over either line conductor of the line extending to the called subscriber's substation to a grounded ringing device connected thereto, or over both line conductors to a bridged ringer connected across the conductors of the line. Thus, if the signal device at the called substation B is connected between the positive line conductor C558 and ground, or is bridged across the two line conductors C557 and C558, the operator may transmit the proper coded ring by repeated actuations of the key switch 880 to its off-normal ringing position. Each time the springs 883 and 884 of this key switch are opened, ground at the spring 818 is removed from the positive trunk line conductor C445 to open the operating circuit for the relays R460 and R470, thereby to cause the deenergization of these relays and the upper winding of the differential relay R440. As a consequence, R440 operates to interrupt, at RA441, a point in the circuit for energizing R40 and R600 in parallel, and to prepare, at RA442, a circuit extending by way of C477 for energizing the ringing relay R640. The last-mentioned circuit is completed at RA473 upon the restoration of R470. The relay R640 upon operating prepares, at RA649, a circuit, held open at RA661 and RC663, for energizing the relay R320. At RA641 and RA645, the ringing relay R640 completes a path for applying ringing current to the line conductors of the called line. If the ringing device at the substation B is connected between the positive line conductor and ground, the path of this current is from one terminal of the ringing current generator by way of C609, RA645, C355, RA394, C344, RA502, RA503, C558 and through the ringing device to ground. If, on the other hand, the ringing device at the called substation B is bridged across the line conductors C557 and C558, this path instead of extending to ground at the ringing device is returned to the grounded side of the ringing current generator at RA641, by way of C557, RA587, RA501, C343, RA393 and C354.

At its armatures RA642 and RA646 and their respective associated contacts RC644 and RC648, the ringing relay R640, upon operating, completes obvious paths for by-passing portions of the ringing current through the condensers 647' and 643' to the receiver of the operator's telephone and the receiver of the calling party's telephone, thereby to indicate that the called substation is being rung. It will be understood that the ringing relay R640 is energized and deenergized repeatedly in accordance with the coded ring identifying the called subscriber's substation B and that the above-outlined operations take place during each interval when R640 is energized.

At the conclusion of the ringing operation as described above, the non-locking ringing key or switch 880 is restored to its normal position, thereby to re-complete the circuit for energizing the upper winding of R440 and the relays R460 and R470 in series. There results the restoration of the ringing relay R640, thereby permanently to disconnect the ringing current generator from the called line and to re-establish the above-referred to conversational circuits between the operator's telephone, the calling subscriber's substation and the call subscriber's substation.

In the event the ringing device at the called substation B is bridged between the negative line conductor of the called line 575 and ground, this device may be energized by the operator's actuation of the ringing key 870 in accordance with the coded ring identifying the called substation B. Each time this switch is operated to its off-normal position, the above-traced circuit extending from ground at the spring 818 is interrupted at the switch springs 872 and 873, thereby to cause the deenergization of R450 and the lower winding of the differential relay R440. With its lower winding deenergized, R440 operates in the exact manner noted above to prepare, at RA442, a circuit for energizing the ringing relay R630, this circuit being completed at RA453, upon the restoration of R450 and extending from ground at RA442 by way of RA 453, C476, and the winding of R630 to battery. When R630 operates, it prepares, at its armature RA639, a circuit for energizing R320 and, at its armatures RA631 and RA635 and their respective associated contacts RC633 and RC637, applies ringing current to the called subscriber's line, thereby to energize a signal device bridged across the line conductors C557 and C558 or between the negative line conductor C557 and ground. If the ringing device is bridged across the line conductors, the path of the ringing current is exactly the same as that traced above and completed in response to the energization of the ringing relay R640. If, on the other hand, this path is bridged between the negative line conductor C557 and ground, the path of this current extends from

one terminal of the ringing current generator by way of C609, RC633, RA631, C354, RA393, C343, RA501, RA587, C557 and through the ringing device at the substation B to ground. A portion of this current is by-passed through the condensers 634 and 638 by way of the loop extending to the operator's telephone and the receiver of this telephone to indicate to the operator that the called substation is being rung. At the end of the ringing operation, when the key switch 870 is restored to normal, the circuit, traced above, for energizing the lower winding of R440 and the winding of R450 in series is re-completed. When R440 and R450 operate, the operating circuit for R630 is interrupted and the latter relay restores, permanently to disconnect the ringing current generator from the line conductors leading to the called subscriber's substation, and to re-establish the talking loops referred to above extending between the calling and called substations and the operator's telephone.

With the system in this condition, the operator may, by simply retaining her apparatus in the condition which prevails at the conclusion of the ringing operation, maintain her telephone connected to the connection existing between the calling and called lines to monitor the conversation which ensues after the called substation is answered. Alternatively, she may operate the key or switch 870 to the monitoring position, thereby to establish a conversational circuit between her telephone and the called telephone to the exclusion of the calling party. As a further alternative, she may operate the key switch 810 to its normal position, thereby to cause the release of the equipment common to all of the links and prepare the same for further use in connection with other calls initiated on lines terminating at the suboffice 910.

Monitoring

In the event the operator desires to converse with the called party to the exclusion of the calling party, she may operate the switch 870 to the monitoring position immediately following the conclusion of the ringing operation. In response to this operation, the springs 874 and 875 are opened to insert the resistor 876 in the above-traced circuit for energizing the upper winding of R440 and the windings of R460 and R470 in series. The resistor 476 is so proportioned that, when inserted in this circuit, only the marginal relay R460 is affected, the differential relay R440 remaining restored and R470 remaining operated. The marginal relay R460, however, restores to complete, at RA461, a circuit for energizing the monitoring relay R620, this circuit extending from ground at RA461 by way of RA471, RA41, C496 and the winding of R620 to battery. When energized over the above-traced circuit, R620 operates to open, at RA627, a point in the circuit, traced hereinafter, for energizing the busy relay R650 and to apply, at RA628, multiple ground to the conductor C363. At its armatures RA621 and RA624 and their respective associated contacts RC622 and RC625, the relay R620 disconnects the telephone located at the calling substation A from the loop extending between the operator's telephone and the called subscriber's substation. At these same armatures and their respective associated contacts RC623 and RC626, a direct metallic circuit is completed between the line conductors C463 and C464 and the line conductors C558 and C557, respectively, of the called subscriber's line. Thus, the operator may converse with the called party without the calling party overhearing the conversation.

In order to re-establish the connection between the calling and called lines following energization of the monitoring relay R620 to exclude the calling party from the connection, it is only necessary for the operator to restore the key switch 870 to its normal position, thereby to short-circuit, at the springs 874 and 875, the resistor 876 and effect the re-operation of the marginal relay R460 and the restoration of the relay R620.

Release of the common control equipment

In the usual operation of the system, the operator in the central exchange causes the equipment common to the links and located in the suboffice 910 to be restored to normal immediately upon ascertaining that the call is answered. To this end, the operator simply restores the key switch 810 to its normal position, thereby to cause the deenergization of R320. When this relay restores its armatures RA821 and RA824, the above-traced operating circuits for the relays R450, R460, and R470 are interrupted. The latter relays, upon restoring, open the operating circuit for the slow-to-release relay R480 which restores, after an interval, to interrupt the operating circuit for R490.

When R480 restores its armature RA482, the holding circuit for R430 is interrupted, permitting the last-mentioned relay to restore and interrupt, at RA438, a further point in its holding circuit. At RA483, the relay R480, upon restoring, completes a circuit for energizing R330, this circuit extending from ground at RA483 by way of RA494, C486, RA694, RC695, C357, RA396 and the winding of R330 to battery.

The relay R330, upon operating, immediately completes, at RA335 and RA336, a holding circuit for itself, which circuit extends from ground at RA351 by way of C337, RA311, C338, RA336, RA335 and the winding of R330 to battery. At RA333, the relay R330 prepares a circuit for energizing the link release relay R340 and completes a circuit for holding the group switching relays R580 operated independently of the relays included in the equipment common to the links. At RA331 and RA332, the relays R330 completes an obvious talking loop between the calling and called substations, which loop is independent of that referred to above extending into the common equipment illustrated in Figs. 4 and 6 and includes the repeater 305. At its armature RA334, the relay R330 applies ground to C76, thereby to maintain closed the holding circuits for the operated relays in the finder switch shown in Figure 1. At RA336, the relay R330, upon operating, interrupts the operating circuit for the gang relay R390, which latter relay restores all of its armatures to disconnect the control equipment associated with the illustrated link from the control equipment common to all of the links and shown in Figs. 4, 6 and 7. The gang relay R390, upon restoring, removes, at RA390, multiple ground from C76, interrupts, at RA395, a point in the operating circuit for R320, and interrupts, at its armatures RA391 to RA396, inclusive, points in the control circuits for the relays included in the connector switch of Fig. 5.

As pointed out above, the relay R320, upon restoring its armatures, completes an alternative loop between the calling and called substations, and with the system in this condition, the con-

trol equipment included in the operated finder-connector link is entirely divorced from the equipment common to all of the links and shown in Figs. 4, 6 and 7. In this regard, it is pointed out that the operated relays of the finder switch are maintained energized over holding circuits starting from ground at RA334, and the operated relays in the connector switch are held energized over holding circuits starting from ground at RA317 and RA333.

When the gang relay R390 restores RA398, the previously traced circuit over which R420 was initially energized is opened to prevent the re-operation of this relay when R430 restores shortly following the restoration of R480. Shortly following the restoration of R480, the relay R490 falls back to interrupt the momentarily completed operating circuit for R40 and R609, permitting these two relays to restore. At RA492, the relay R490 reprepares the holding circuit for R430, this circuit now being held open at RA438'. At RA494, the relay R490 opens a point in the circuit, traced above, over which R330 was initially energized and at RA493 it opens the circuit holding the two relays R660 and R670 operated, permitting these two relays to restore. The restoration of RA493 also opens a point in the locking circuit for the switching relay R690, causing this relay to restore. At RA495 and RA496, circuits are prepared for conditioning the starting apparatus shown in Fig. 2 and the allotter 80 to permit the common equipment to be assigned to the next succeeding calling line. With the equipment in this condition, a talking loop is established between the calling and called parties, and the common control equipment is in readiness for use in connection with another call.

The operations resulting when the called line is found busy

Before describing the release of the operated finder-connector link, it will be assumed that at the time the called line 575 is tested, this line is busy in connection with another call so that ground is present on the control conductor C559. It will be recalled that the two relays R40 and R50 remain operated for a short time interval following the end of the second digit. Upon the operation of R500, therefore, a circuit is completed for energizing the busy relay R650, this circuit extending from ground on C559 by way of RA97, RA503, C362', RA399, C362, RA54, RA53, C478, RA627 and through the winding of R650 to battery. Shortly following the energization of the busy relay, R50 restores to complete, at RA53 and RC56, a holding circuit for R650. This circuit extends from ground at RA493 by way of C485, RA653, C479, RC56, RA53, C478, RA627 and through the winding of R650 to battery. Since ground is present on the control conductor C559 of the called line, the upper winding of the switching relay R690 is short-circuited upon the restoration of R50 and this relay remains in its restored position. The busy relay R650, upon operating, prepares, at RA652 and RA651, circuits for conducting busy tone current by way of the control trunk 443 to the operator's telephone, and by way of the finder switch and the calling subscriber's line to the calling party's telephone. These circuits are completed at RA43, shortly following the operation of R650 and upon the restoration of R40. Thereupon, the operator may either hold the connection to the calling line and monitor the previously established connection to the called line, or initiate the release of the operated finder switch and the control equipment common to the finder-connector links, as desired.

In order to monitor the previously established connection to the called party, it is only necessary for the operator to operate the key or switch 870 to the monitoring position, thereby to cause the operation of the monitor relay R620 in the exact manner described above. When the monitor relay operates it interrupts, at RA627, the operating circuit for the busy relay R650, causing the latter relay to restore and disconnect busy tone current from the circuits extending to the operator's telephone and the calling subscriber's telephone. When the busy relay R650 restores, its previously traced locking circuit is opened at RA653 so that the busy relay cannot thereafter be energized upon deenergization of the monitor relay R620. When the monitor relay R620 operates it completes, at RA628, the above-traced circuit for energizing the group switching relay R580 and, at its armatures RA621 and RA626, it prepares a talking loop between the operator's telephone and the called substation. This loop is completed at RA587 and RA588 when the group switching relay R580 operates shortly following the operation of R620.

When the previously established connection to the called substation B is finally cleared out, ground is removed from the control conductor C559 thereof and is replaced by battery potential. This battery potential is extended over the circuit, traced previously, for energizing the upper winding of the switching relay R690, which latter relay immediately operates its armature RA693 to complete its previously traced locking circuit. The operator may now proceed to ring the called substation B in the exact manner described above.

If the operator does not desire to hold the connection until such time as the earlier established connection to the called line is cleared out, she may initiate the release of the operated finder-connector link by restoring the key of the switch 810 to normal. There results the de-energization and restoration of R540, R460, R470, R480 and R490, all in the manner described above, followed by the restoration of R660 and R670. During this sequence of operations and when R480 restores to interrupt, at RA481, the energizing circuit for R490, a circuit is completed for energizing R340. This circuit extends from ground at RA483 by way of RA494, C486, RA694, RC696, C358, RA397, C343' and through the winding of R340 to battery. When R340 operates, it completes, at RA341, a multiple circuit for holding R390 operated and, at RA342, a circuit for energizing R350. When R350 operates it interrupts, at RA351, the multiple circuit for R390; the circuit for the latter relay being completely opened when R340 restores immediately following the restoration of R490 to interrupt, at RA494, the operating circuit for R340. When R390 restores its armatures, the holding circuit for R310 and the other operated relays R140, R150, R10, R20 and R180, included in the finder switch of Figure 1, is interrupted at RA390', permitting these relays to restore. The relay R310, upon falling back, interrupts, at RA311, the circuit over which R390 was initially energized, so that the last-mentioned relay cannot be re-energized when R350 restores RA351, shortly following the restoration of RA311. At RA317, the relay R310, upon restoring, removes holding ground from C369, thereby to interrupt a point in the holding circuits for the operated

relays R500 and R580 included in the connector switch. When R390 restores, the holding circuit for R580 is broken at RA391', causing the last-mentioned relay to restore. The relay R20, upon restoring, opens, at RA21, the operating circuit for the allotter relay R30, causing the latter relay to restore and prepare at RA32 and RC33 the start circuit for starting the illustrated finder switch in operation to search for the next succeeding calling line. At RA31 a point is opened in the chain circuit for energizing the all-links busy relay R200 and at RA32 and RC34 a point is opened in the start circuit extending to the next assigned finder-connector link. Thus, the finder-connector link is released and ready for use in connection with other calls. When R490 falls back, following the restoration of R480, it not only performs the functions described previously in connection with the release of the common equipment following the completion of a connection to an idle called line, but interrupts, at RA493, a point in the holding circuit, traced above, over which the busy relay R650 is held energized. Thus, the equipment common to the finder-connector links is restored to normal and in condition for further use.

Release of established connection

In the event a connection is once established between the calling and called lines and it is desired to clear out the connection at the end of the conversation, either party may initiate the release of the operated finder-connector link by actuating the hand generator at his substation to cause current to be transmitted to one or the other of the alternating current relays R360 and R370. When either of these two relays is energized it operates to complete a circuit for energizing the slow-to-operate relay R340, this circuit extending from ground at RA333 by way of RA361 or RA371, C343' and the winding of R340 to battery. The relay R340, upon operating, completes, at RA342, an obvious circuit for energizing R350 and applies, at RA341, multiple ground to C337 included in the holding circuit for R330. When R350 operates, it opens, at RA351, the multiple holding circuit for R330, so that when R340 restores, at the conclusion of the ringing operation and when its circuit is interrupted at RA361 or RA371, the remaining holding circuit for R330 is interrupted at RA341. The relay R330, upon restoring RA335, opens a further point in its holding circuit and at RA336 reprepares the circuit for energizing the gang relay R390. At RA334, the relay R330 removes holding ground from C76, thereby to cause the restoration of the operated relays R310, R140, R150, R110, R20 and R180, all included in the finder switch, and at RA333 it removes holding ground from C363' to open the operating circuit for the group switching relay R580, causing this relay to restore. When R310 restores, it interrupts, at RA311, the initial operating circuit for R390, so that, when R350 falls back after an interval, this circuit is not completed. At RA317, the relay R310 removes ground from C369 to interrupt the holding circuits for R500 and R590 included in the connector switch of Fig. 5, permitting these relays to restore. The relay R20, upon restoring, opens at RA21 the operating circuit for the allotter relay R30, causing the latter relay to restore and prepare at RA32 and RC33 the start circuit for starting the illustrated finder switch in operation to search for the next succeeding calling line. At RA31 a point is opened in the chain circuit for energizing the all-links busy relay R200 and at RA32 and RC34 a point is interrupted in the start circuit extending to another of the finder-connector links. Thus, the finder-connector link illustrated is entirely released and is ready for further use.

Operation of the allotter and starting apparatus

Referring now more particularly to the operation of the allotter means 80 and the starting apparatus shown in Fig. 2, it is pointed out above that each time one of the finder-connector links in the suboffice is seized, the allotter relay corresponding to this link is energized. Thus, during the sequence of operations just described, the allotter relay R30 operates following the energization of R20 and shortly following the seizure of the link. This allotter relay remains operated until such time as the connection involving the link is cleared out. The relay R30 upon operating, completes at RA31 a point in the chain circuit for energizing R200. At RA32 and RC34 the allotter relay R30 connects C89 to C88, thereby to cause the assignment of the next succeeding idle finder-connector link to the next succeeding calling line. Each allotter relay, corresponding to the terminals 81, 82 and 83, is energized as the link corresponding thereto is seized, so that C89 is successively associated with the control circuits of the respective links as the individual ones thereof are assigned for operation. As pointed out above, following the release of a connection involving any of these links, the allotter relay corresponding thereto is deenergized, so that the link is conditioned to be used again. Thus, if it be assumed that the first three links, corresponding respectively to R30 and the allotter relays embodying the terminals 81 and 82, are busy, so that the start conductor C89 is connected through to the allotter relay associated with the fourth link, and the first link corresponding to R30 is released, R30 immediately restores to reconnect at RA32 and RC33 the start conductor C89 to C78, and to open, at the same armature and RC34, the connection from the start conductor to the conductor in the fourth link corresponding to C78, whereby the link illustrated is assigned to the next calling line.

In the event all of the links included in the suboffice become busy at the same time, a chain circuit is completed for energizing the slow-to-release relay R200, this chain circuit extending from battery at the lower terminal of the winding of R200 by way of C94, RA31, C87, the armatures, corresponding to RA31, of the relays having the terminals 81, 82, 83, etc., to ground at 83'. The relay R200 operates when energized over the above-traced circuit, to interrupt at RA201 a point in the common portion of the start circuits for the various links. At RA202, the relay R200 prepares a point in the holding circuit for R270, and at RA203 it completes a circuit for energizing the upper winding of R280, this circuit extending from ground at RA496 by way of RA439', C204, RA495, C205, RA203, C206, RA275, and through the upper winding of R280 to battery. At RA204 and RC205, the relay R200 prepares a point in the circuit for applying busy tone current to the control trunk 443 leading to the operator's telephone. When R280 is energized over the circuit traced above, it operates to complete at RA282 an obvious holding circuit for itself, and to prepare at RA281 a circuit traced hereinafter for energizing R270. At RA284 it completes a circuit extending by way of C292 for

energizing R420, and, at RA283, it completes the previously prepared circuit for applying busy tone current to the control trunk extending to the operator's telephone in the central exchange.

When R420 operates, it completes at RA421 and RA422, the previously traced circuit for energizing R830 included in the control apparatus located at the central exchange operator's station. At RA423, the relay R420 completes an obvious circuit for energizing R430, which latter relay operates, in turn, to interrupt at RA438 the operating circuit for R420. When R430 operates it completes at RA438' the previously traced locking circuit extending from ground at RA492 and prepares the previously traced alternative locking circuit which extends from ground at RA482. Thus, R430 is held energized and R420 deenergized. The relay R830 upon operating, completes a circuit for energizing the signal lamp 890, thereby to indicate to the operator that a condition prevails which requires her attention. The operator, upon manipulating the key switch 810 to connect the telephone 800 to the control trunk 443, receives busy tone over the control trunk and is informed thereby that all of the links in the suboffice are busy. She may then challenge, in the manner described hereinafter, the connections extending by way of the various links, to determine whether the links are actually busy, or have been permanently appropriated by the failure of a subscriber to ring off following the termination of a conversation.

It is noted that when the operator actuates the answer key 810 to its off-normal position, the previously traced circuits for energizing R450, R460, R470, are completed at the springs 814, 815, 811 and 812. Following the operation of these relays, R480 and R490 are successively operated. The relay R490, upon operating, prepares at RA491 a further point in the circuit for energizing R270, this circuit being held open at RA452.

In order to establish the desired connections for challenging the various connections responsible for the all-links busy condition, the operator first actuates the answer key to its normal position, thereby to interrupt the operating circuits for R450, R460 and R470, which relays restore to cause the restoration of R480 and R490. Immediately R450 restores and before R490 falls back a circuit is completed at RA452 for energizing R40, R200 and R270. Since under the conditions assumed, the common control equipment shown in Figs. 4, 6 and 7, is not operatively associated with any of the links, the resulting operation of R200, R40 and R50 is without effect. The above-noted circuit for energizing R270 extends from ground at RA441, by way of RA452, RA491, C208, and through the winding of R270 to battery. The relay R270, upon operating, completes, at RA273, a holding circuit for itself, which circuit extends from ground at RA202 by way of C207, RA273 and the winding of R270 to battery. At RA274, this relay interrupts the holding circuit for R280 including the lower winding thereof, and at RA275 it interrupts a point in the circuit for enargizing the upper winding of R280. As a consequence, R280 restores to interrupt, at RA281, a point in the original circuit over which R270 was energized, to disconnect, at RA283, the busy-tone current source from the control trunk extending to the operator's telephone, and to interrupt at RA284, a point in the circuit over which R420 was initially energized. Shortly following the deenergization of R280, the relay R480 restores to interrupt the above noted alternative holding circuit for R430. The relay R430 immediately restores to open at RA438 a point in both of its holding circuits so that it cannot reoperate when R490 restores shortly thereafter. With R430 restored, circuits are prepared at the armatures RA431 to RA434, inclusive, for controlling the relays included in the supervisory apparatus shown in Fig. 7. The operator may now proceed to challenge the condition of any or all of the links in the manner described hereinafter. It is pointed out that R270 is held energized over the holding circuit extending from ground at RA202 until such time as the all-link busy condition is terminated to cause the restoration of R200. It will be apparent that immediately upon the restoration of R200, the relay R270 restores and the common portion of the starting circuit for the various links is recompleted at RA201.

In the event two calls are initiated simultaneously on two different lines, the relay R210 is energized over circuits extending from the line relays associated with each of these calling lines, and remains operated until such time as a finder-connector link is assigned to each of the two calling lines. Obviously, however, the same link can not be assigned to both of the lines. With the arrangement shown the line included in the group having the smallest number will take precedence in the matter of link assignment. Thus, if one of the lines is included in the No. 2 group of lines, corresponding to the relay R140, and the other of the lines is included in the No. 6 group of lines, corresponding to the sixth group select relay, the first-mentioned line will be assigned a link first. If, on the other hand, the two calling lines are included in the same group, the one of these lines having the smallest number will be assigned a link first. For example, if both of the calling lines are included in the No. 4 group, one thereof corresponds to the No. 2 units relay and the other thereof corresponds to the No. 6 units relay, the one corresponding to the No. 2 units relay will be assigned an idle link first. In this connection it is pointed out that the line which is assigned a link first is the first to seize the common control equipment by way of which the desired connection is ultimately established. Thus, immediately upon the seizure of the calling line and following operation of the gang relay R390, the relay R430 operates to interrupt at RA439' a point in the common portion of the start circuits over which the group select and units relays of all the links are energized. Since R430 is held operated until such time as the common control equipment is again idle, no one of the finder switches included in the various links may be set in operation to search for the second of the two calling lines until this equipment is released.

As pointed out above, provisions are made, whereby in the event a link is assigned to a calling line, and the finder switch thereof fails to find the line, a second link is assigned thereto and if the second link also fails to find the line, an alarm is transmitted to the central exchange operator to indicate that certain of the apparatus in the remote exchange is out of order. Thus, in the sequence of operations just described, wherein the link illustrated is assigned to the calling line 911, immediately upon the operation of R210, circuits are completed for energizing R220 and for starting the timer 210' in operation, the first of these circuits extending from battery at the

resistor 248 by way of RA247, RA238, RA213 and through winding of R220 to ground and the second thereof extending from ground at RA285 by way of RA276, C296, and RA216 to the timer start conductor C297. The relay R220, upon operating, short-circuits, at RA224, the winding of R230, this path starting from battery at the upper terminal of R230 by way of the winding of R230, RA217, RA224, RA213, RA238 back to battery at RA247. At RA221 and RC223, the relay R220 prepares a point in the circuit for energizing R250 from ground in the timer 210'. This timer, which is started in operation upon the application of ground to C297, may be of any standard construction and is connected and arranged to transmit ground pulses over C294 and C295, at definitely spaced time intervals, each of which is somewhat greater than the time interval required for two finder switches sequentially to operate to find a calling line. Shortly following the operation of R220, the timer 210' momentarily connects ground to C294, thereby to complete a circuit extending by way of RA221, RC223, RC235, RA234 and RA255 for energizing R250. The relay R250 upon operating, completes at RA254 a holding circuit for itself, which circuit extends from ground on C204, by way of RA201, RA212, RA242, RA254, and the winding of R250 to battery. At RA255, the relay R250 interrupts a point in its original operating circuit and at RA251, it opens a point in the circuit, traced hereinafter, for energizing R260 and prepares a point in the circuit for energizing R290. In the event the calling line 911 is found by the finder switch shown in Fig. 1 and the common equipment illustrated in Figs. 4, 6 and 7 is seized, the circuit for energizing R210 is interrupted at RA113 of the cut-off relay R110. The relay R210 upon restoring, opens the operating circuits for R220, R250 and the timer 210'. Thus, the equipment shown in Fig. 2 is restored to normal.

If, on the other hand, the finder switch shown in Fig. 1 fails to find the calling line 911, R210 remains energized and R430 included in the common control equipment is not energized. Hence, R250 remains energized. After an interval sufficient for two finder switches successively to operate to find the calling line, ground is momentarily connected to C295 in the timer 210', thereby to complete the circuit extending by way of RA256, RC245, and RA244 for energizing R240. The relay R240, upon operating, completes at RA243 and RA244 a holding circuit for itself extending by way of RA201 and RA212 to ground on C204, and at RA247 interrupts a point in the path short-circuiting the winding of R230. At RA242, the relay RA240 interrupts the holding circuit for R250, and at RA241, it prepares a point in the circuit for energizing R260. At RA246, the relay R240 opens a point in an obvious alternative operating circuit for R230, and, at RA249, it prepares a new circuit for energizing R250.

The relay R250 upon restoring, reprepares, at RA255, a point in its original energizing circuit, interrupts at RA254 a further point in its holding circuit, and completes at RA251 and RC252 a circuit for energizing R260. The last-mentioned circuit extends from ground at RA241, by way of RA251, RC252, RC264, RA263, and the winding of R260 to battery. The relay R260, upon operating, completes at RA262 and RA265 a holding circuit for itself, which circuit extends from ground on C204 by way of RA201, RA212, RA265, RA262, RA263, and the winding of R260 to battery. At RA261, the relay R260 prepares a point in the circuit, traced hereinafter, for energizing R290, this circuit being held open at the restored armature RA251 of R250.

When the short-circuiting path is removed from the winding of R230, this relay is energized in series with R220, and operates to prepare at RA237 the above-noted alternative operating circuit for itself. At RA231 and RC233, the relay R230 connects C204 by way of C90 to the conductor, corresponding to C78, in the third finder-connector link, or to the link corresponding to the allotter relay including the terminals 82. Thus, this second assigned link is started in operation to search for the calling line.

If the second assigned link finds the calling line, R210 is caused to restore in the exact manner described previously. When R210 restores, it interrupts the operating circuits for the timer 210' and for R220, R230, R240 and R260, thereby to stop the timer and cause the enumerated relays to restore. Thus, the starting apparatus shown in Fig. 2 is restored to normal.

If the second assigned finder switch fails to find the calling line, however, the timer 210' continues to operate and a second ground pulse is applied to C294 to cause the reoperation of R250 over a circuit extending from ground on C294, by way of RA221, RC223, RA249, RA255 and the winding of R250 to battery. The relay R250 upon operating, completes at RA254 a holding circuit for itself, which circuit extends from ground on C204 by way of RA201, RA212, RA265, RA254, and the winding of R250 to battery. At RA255, the relay R250 interrupts its original energizing circuit, and at RA251, it completes the previously prepared circuit for energizing R290. The last-mentioned circuit extends from ground at RA241, by way of RA251, RA253, RA261, RA271, and the winding of R290 to battery. The relay R290 upon operating, completes at RA291, a circuit for energizing the upper winding of R280, this circuit extending from ground at RA496 by way of RA439', C204, RA495, C205, RA291 and the upper winding of R280 to battery. At RA282, the relay R280, upon operating, completes its holding circuit for itself, and at RA281, it prepares the previously traced circuit for energizing R270. At RA285, the relay R280 opens a point in the operating circuit for the timer 210', thereby to interrupt the operation of this device. At RA283, the relay R280, upon operating, completes a path for applying alarm tone current to the control trunk 443 leading to the central exchange operator's telephone, and at RA284 it completes the circuit for energizing R420, this circuit extending by way of C292, RA438, and the winding of R420 to battery. When R420 operates, it completes, at RA421 and RA422, the previously described circuit for energizing R830 included in the aparatus at the operator's station in the central exchange. The last-mentioned relay upon operating, completes the above-noted circuit for energizing the signal lamp 890, thereby to indicate to the operator that a situation prevails which requires her attention. The relay R420 upon operating, also completes at RA423 a circuit for energizing R430, and the later relay operates after an interval to interrupt at RA438 the operating circuit for R420. At RA438' the relay R430 completes the holding circuit for itself extending from ground at RA492 and at RA439 it prepares the alternative holding circuit for itself extending from ground at RA482. When the relay R430

operates, it interrupts, at RA439', a point in the common portion of the holding circuits for the relays R240, R250 and R260, causing these relays to restore and interrupt the operating circuit for R290. The relay R290, upon restoring, interrupts at RA291 the original operating circuit for R280, but the latter relay is held energized over its holding circuit extending from ground at RA274. At RA246, the relay R240, upon restoring, short-circuits, over an obvious path, the winding of R220, causing the later relay to restore. The relay R230 is, however, held operated over the above-noted alternative operating circuit which extends from ground at RA246 by way of RA237, RA214, and the winding of R230 to battery.

When the relay R420 restores, shortly following the operation of R430, it reconnects at RA421 and RA422, and their respective associated contacts RC425 and RC427, the conductors of the trunk line 443 to the line conductors leading to the repeater 484.

The operator, upon observing the illuminated condition of the signal lamp 890 and upon operating the answer key switch 810 to its off-normal position to connect the telephone 800 to the control trunk 443, hears the alarm tone and is informed that the apparatus located in the remote exchange is out of order. She may then cause a service man to be sent to the remote exchange to locate the faulty condition responsible for the inoperativeness of the apparatus and to repair the apparatus.

It is pointed out that the central exchange operator, upon actuating the answer key switch 810 to its off-normal position, causes the sequential operation of the relays R450, R460, R470, R480 and R490 in the exact manner described above. Thereafter, and when the operator restores the answer key switch 810 to its normal position to release her telephone for further use, these relays are caused to restore. Since R480 is deenergized and restores its armatures before R490, the two holding circuits for R430 are momentarily opened at the same time, permitting the last-mentioned relay to restore and recomplete, at RA439', the common portion of the start circuits for the various finder switches located in the remote exchange. The relay R450, upon restoring, completes, at RA452, a circuit for energizing R270, this circuit extending from ground at RA441 by way of RA452, RA491, C208, RA281 and the winding of R270 to battery. Upon being energized over the above-traced circuit, R270 operates to complete, at RA272, a holding circuit for itself extending from ground at RA215. At its armature RA276, the relay R270 opens a further point in the start circuit for the timer 210' and at RA274 it opens a point in the holding circuit for R280. The operation of the remaining armatures embodied in the relay R270 is without effect at this time. Shortly following the operation of R270, the relay R280 restores to interrupt, at RA284, a point in the original circuit for energizing R420, and to interrupt, at RA283, a point in the circuit for applying alarm tone current to the control trunk extending to the central exchange. At its armature RA285, this relay prepares a point in the start circuit for the timer 210' and, at RA281, it opens a point in the circuit over which R270 was originally energized.

Since the line relay R100 is held operated over a holding circuit extending from ground at RA113 and the cut-off relay R110 is not operated during the above described sequence of operations to interrupt the operating circuit for R100, the relay R210, included in the starting apparatus, is maintained in its energized condition until the fault causing the inoperativeness of the switching apparatus is located and repaired. In addition to the two relays noted, the relays R230 and R270 are held operated over previously traced circuits until the faulty condition of the apparatus is rectified. When the fault is cleared out the line relay R100 is caused to restore, thereby to interrupt the operating circuit for R210, which latter relay in turn restores RA214 and RA215 to open the holding circuits for R230 and R270. Thus the starting apparatus illustrated in Fig. 2 is returned to its normal condition and is in readiness for further use.

As pointed out previously, the arrangement is such that if a fault occurs in one of the finder switches proper, the apparatus just described does not operate to send an alarm to the central exchange since a second link is immediately assigned to search for the calling line. Thus, assume that the link illustrated is started in operation, but because of a fault in one of the testing circuits fails to find the calling line 911. It will be apparent in view of the previous description that if this occurs, all of the group select relays and units relays, as shown in Fig. 2, will be caused sequentially to operate. When the last units relay, namely R10, operates it completes at RA14 and RC16 a circuit for energizing R20, this circuit extending from ground on C74 or C75 by way of RA185, RC186, RA194, RC195, RA14, RC16 and through the lower winding of R20 to battery. The relay R20, upon operating, completes a circuit, traced previously, for energizing the allotter relay R30 and the latter relay operates, in turn, to assign a second link to the calling line 911. When R30 operates, it prepares at RA35 a holding circuit for itself and opens, at RA32 and RC33 the operating circuits for R160, R10 and R20, causing these relays to restore and return the link illustrated to its normal condition. The holding circuit noted is completed immediately upon the restoration of R20 and extends from ground on C89 by way of RA35, C85, RC23, RA22, C86 and through the winding of R30 to battery. Thus, the relay R30 is held operated until the start relay R210 is restored to break the above-traced circuit at RA211.

Assuming that the second assigned link is successful in finding the calling line, the connection from this line to the control trunk 443 is established in the exact manner described previously. During the time interval this second assigned link is hunting for the calling line 911, a ground pulse is applied by the timer 210' to C294 causing the operation of R250. Before the second ground pulse, as described above, is applied to C295, however, the finder switch of the second assigned link has sufficient time in which fully to operate in search of the calling line. If the line is found, the cut-off relay R110 operates and causes the sequential restoration of R100 and R210 in the exact manner described previously. The relay R210 upon restoring its armatures RA211 and RA212 opens points in the holding circuits for R30 and R250 causing these relays to restore. At RA213 it interrupts the operating circuit for R220 causing this relay to restore and at RA216 it interrupts the operating circuit for the timer 210' to stop the operation thereof. At RA217, the relay R210 opens a point in the circuit for energizing the two relays R220 and R230 in series,

thereby to prevent these relays from being held operated. The allotter relay R30 upon restoring again conditions the apparatus for seizure of the link illustrated on the next succeeding call.

If the second assigned finder-connector switch fails to find the calling line, a third link, if any third link is idle, is assigned to the calling line in the exact manner just described and this successive assignment of links continues until the starting apparatus illustrated in Fig. 2 has had sufficient time in which completely to operate to send in an alarm to the central exchange operator. The operations resulting thereafter are set forth above and need not be repeated.

From the description in the immediately preceding paragraphs it will be apparent that two safeguards are provided for preventing defective apparatus from rendering any subscriber's line inoperative. Thus, if a calling line seizes a defective link, a second link is assigned almost immediately. If, on the other hand, certain of the apparatus is so defective that the cut-off relay associated with a calling line is not caused to operate within a given time interval, the starting apparatus of Fig. 2 operates to signal the central exchange operator.

Operation of the supervisory apparatus

As explained above, the supervisory apparatus illustrated in Fig. 7 is provided for the purpose of enabling the central exchange operator selectively to challenge the condition of the various finder-connector links to determine whether or not these links are actually in use or have been permanently appropriated by the failure of a calling or called party to ring off at the conclusion of a conversation. This is usually performed following the receipt of busy tone at the operator's telephone, indicating an all-busy condition of the various links located at the remote exchange. As was pointed out above, when this condition occurs, the relay R830 is energized and operates to energize the signal lamp 890. Simultaneously, busy tone current is applied to the control trunk 443 to signal the operator when the answer key switch 810 is actuated to its off-normal position. Further in accordance with the description appearing above, this answer key is momentarily restored upon receipt of busy tone to cause the locking up of R270 included in the starting apparatus illustrated in Fig. 2. Following this momentary restoration of the key switch 810 to its normal position, this switch is again actuated to its off-normal position to cause the energization of the relays R450, R460, R470, R480 and R490 in the manner described previously. With the system in this condition, R430 is deenergized so that impulsing circuits are prepared for causing the sequential operation of the supervisory relays illustrated in Fig. 7. The operator may now establish a connection between the telephone 890 and the established connection involving any desired one of the links by dialing a predetermined digit at the impulsing device 860. Thus, assuming that the operator desires to challenge the condition of the finder-connector link illustrated, she may establish a connection between her telephone and the line conductors of this link by dialing a single digit comprising a single impulse. At the beginning of the impulse of this digit, the relay R450 restores to complete at RA452, the previously traced circuit for energizing R40 and R600 in parallel, thereby to cause operation of these two relays and the relay R50. When R600 operates, it completes, at RA604, a circuit for energizing R740 included in the supervisory apparatus illustrated in Fig. 7. The circuit noted extends from ground at RA497 by way of C374, RA705, RA715, RA726, RA736, C47, RA433, C368, RA604, C367, RA434, C48, and through the winding of R740 to battery. The relay R740 upon operating completes at its armature RA744 a locking circuit for itself which extends from ground on C374, and prepares, at RA745, a circuit for energizing the supervisory relay R730, corresponding to the second of the finder-connector links, this circuit being held open at the operated armature RA601 of RA600. At its armature RA741, the relay R740, upon operating, connects the line conductor C463, included in the equipment common to all of the links, to the line conductor C117 embodied in the link illustrated, the path of this connection extending from C463 by way of RA621, RC622, C466, RA741, C791 to C117. Similarly, the line conductor C464 included in the common equipment is connected to the line conductor C118 of the link illustrated, the path of the last-mentioned connection being by way of RA624, RC625, C465, RA742 and C792. At its armature RA743 the relay R740 prepares a circuit for energizing the slow-to-release relay R350 shown in Fig. 3, this circuit being held open at RA649'.

At the conclusion of the single impulse dialed at the operator's station when the relays R40 and R50 restore in the manner described previously, R600 and R610 also restore. It is pointed out that since R50 restores RA57 before the armatures of R600 fall back, the circuit for energizing the second supervisory relay R730 is not completed. Thus, the first supervisory relay R740 is held operated over its locking circuit as traced above. With the system in this condition, that is, with the line conductors C117 and C118 connected, respectively, to C463 and C464, an obvious talking loop is completed between the operator's telephone and the established connection involving the finder-connector link shown. If, upon challenging the last-mentioned connection, the operator ascertains that the link is actually busy, she may cause her telephone to be disconnected therefrom by operation of the answer key switch 810 to its normal position, thereby to cause the sequential restoration of R450, R460, R470, R480 and R490. The relay R490 upon restoring RA497, interrupts the previously traced holding circuit R740 causing the last-mentioned relay to restore. Thus, the equipment is restored to normal and the operator may proceed to challenge the condition of the second link included in the apparatus located at the remote exchange.

If, on the other hand, the operator upon challenging the connection ascertains that it is not in fact being used, she may proceed to cause the release of the connection by operating the ringing key switch 870 to its off-normal position, thereby to cause the operation of R440, the restoration of R470, and the operation of the ringing relay R640, all in the manner described previously. It will be recalled that, if the link illustrated is being held in its operated condition, the relays R310 and R330 are operated, together with certain of the group select, group switching and units relays included in the finder switch of Fig. 1 and the connector switch of Fig. 5. When, however, the ringing relay R640 is energized, it completes, at RA649', a circuit for energizing R350, this circuit extending from ground at RA649' by way of C375, RA743, C793, and through the winding of R350 to battery. The relay RA350, upon operat-

ing RA351, interrupts the holding circuit for R330, causing the last-mentioned relay to restore. When RA333 is restored, the previously traced holding circuit for the operated one of the group switching relays included in the connector switch shown in Fig. 5 is interrupted, causing this relay to restore. At RA334, the relay R330, upon restoring, interrupts the holding circuits for R310 and the operated ones of the group select, group switching and units relays included in the finder switch shown in Fig. 1. When R310 restores, it interrupts, at RA311, a point in the original circuit for energizing R330, and, at RA317, the holding circuit for the operated ones of the group select and units relays included in the connector switch shown in Fig. 5. The restoration of RA334 also opens the holding circuit for R20, causing this relay to restore and interrupt, at RA21, the circuit holding the allotter relay R30 operated. Thus, the last-mentioned relay is caused to restore to mark the finder-connector link illustrated as idle and to prepare this link for seizure by the next succeeding calling line.

Following the release of the link in the manner described above, the operator may condition the common control equipment for challenging the connection involving the second finder-connector link by the same expedient of restoring the key switch 880 and the answer key switch 810 to their respective normal positions, thereby to cause the restoration of R440, R450, R480, R490 and the ringing relay R640. When R640 restores RA549', the above-traced operating circuit for R350 is interrupted, causing this relay to restore. During this sequence of operations, the holding circuit for R740 is interrupted upon the restoration of RA497 in the exact manner described above.

The method by which each of the remaining links is challenged is quite similar to that described above and differs therefrom only in regard to the operation of the impulse responsive relays R600 and R610 to cause the operation of the desired one of the supervisory relays R700 to R740 included in the supervisory apparatus illustrated in Fig. 7. The one of these supervisory relays which is energized depends upon the impulses comprising the digit dialed at the operator's station. If this digit comprises two impulses, for example, the relay R730 is caused to operate; if the digit comprises three impulses, R720 is caused to operate; and so on. It will be understood that the impulse responsive relays R600 and R610 follow the sequence of operations described previously; that is, R600 operates at the beginning of each odd impulse, R610 operates at the end of each odd impulse, R600 restores at the beginning of each even impulse, and R610 restores at the end of each even impulse. Hence, if the operator desires to challenge the condition of the second operated finder-connector link, she may do so by dialing a digit comprising two impulses. At the beginning of the second impulse of this digit when R600 restores RA601, a circuit is completed for energizing R730, this circuit extending from ground at RA57 by way of C469, RA691, RC602, C467, RA431, C45, RA 745, and through the winding of RA730 to battery. The relay R730, upon operating, completes at RA735 a locking circuit for itself extending from ground on C338, and interrupts, at RA736, the locking circuit for the first supervisory relay R740. At its armatures RA731 and RA732, the relay R730 completes a connection between the operator's telephone and the line conductors of the second link. At its armature RA737, the relay R730 prepares a circuit for energizing the third supervisory relay R720 in the event the digit dialed comprises three impulses instead of two. The relay R740 restores immediately upon the operation of R730, further to interrupt, at RA744, its own locking circuit, and, at RA745, a point in the operating circuit for R730. At its armatures RA741 and RA742, the relay R740 disconnects the line conductors of the first link illustrated in Figs. 1, 3 and 5 from the operator's telephone, and, at its armature RA743, it opens a point in the circuit, traced above, for energizing R350.

In the event the digit dialed comprises three impulses instead of two, R600 is caused to reoperate at the beginning of the third impulse to complete, at RA601 and RC603, a circuit for energizing the third supervisory relay R720, corresponding to the third finder-connector link included in the remote exchange. The circuit noted extends from ground, at RA57, by way of C469, RA691, RC603, C468, RA432, C46, RA737, and through the winding of R720 to battery. The relay R720, upon operating, completes a holding circuit for itself, interrupts the holding circuit for the preceding supervisory relay R730, prepares a circuit for energizing the succeeding relay R710, and connects the operator's telephone 800 to the line conductors embodied in the third finder-connector link. From the immediately preceding description, it will be apparent that the operator may successively challenge each of the finder-connector links included in the remote exchange by successively dialing the digits corresponding to these links. It is believed that the operations occurring upon the dialing of digits having more than three impulses will be apparent from the above description and, accordingly, a description thereof is omitted.

Reverting calls

As pointed out previously, reverting calls, or calls in which a party on one line desires to converse with a party having a substation connected to the same line, may be completed with or without the assistance of the central exchange operator. Obviously, if all of the substations connected to any given line include signal devices bridged across the conductors of the associated line, any party having a telephone connected to this line may ring any other party by operating the hand generator at his substation to project over the line ringing current corresponding to the called subscriber's coded ring. If, on the other hand, the calling subscriber does not know the coded ring of the substation it is desired to call, or the signal devices included in the various substations connected to the line are bridged between one line conductor and ground, the call can not be completed without the assistance of the central exchange operator. In any case, the application of ringing current to a calling line terminating at the remote exchange results in the seizure of a finder-connector link which operates to prepare a connection to the operator's telephone in the central exchange and to signal the operator thereat, assuming, of course, that an idle finder-connector link is available and the equipment common to all of the links is not in use. If the call is completed by the calling party's operation of his hand generator to signal the called party directly, the central exchange operator will ascertain this fact upon operation of the answer key switch 810 to its off-normal position to establish a connection, described previously, between her telephone 800 and the calling substation

connected to the calling line. The operator may then initiate the release of the seized finder-connector link in the manner described more particularly hereinafter.

If, on the other hand, the assistance of the central exchange operator is required to complete the connection to the called party's substation, the calling party may transmit the desired information to the central exchange operator when the central exchange operator answers the call and challenges the connection. Following this, the operator instructs the calling party to hang up for a few moments and proceeds to ring the desired substation connected to the calling line. The last-mentioned operation is performed by actuating the correct one of the ringing keys 870 or 880 to its off-normal position, thereby to transmit ringing current back over the calling line to cause the energization of the signal device embodied in the called subscriber's substation. In the present case, wherein no dialing operations are performed by the central operator, the two relays R660 and R670 are not energized. Hence, when either of the two ringing relays R630 and R640 is energized and operates, a circuit is completed for energizing R320, or the relay corresponding thereto in the seized finder-connector link. Assuming the link illustrated is the one involved in the connection, the above-noted circuit extends from ground at RA493 by way of C485, RA661, RC663, C613, one or the other of the armatures RA639 and RA649, C356, RA395, and the winding of R320 to battery. The relay R320, upon operating, connects, at its armatures RA321 and RA325 and their respective associated contacts RC323 and RC327, the link line conductors C117 and C118 to the line conductors C354 and C355, respectively, thereby to apply ringing current directly to the calling line; this ringing current being applied to the line conductors C354 and C355 at the armatures RA641 and RA645 or the armatures RA631 and RA635, depending upon which of the two ringing relays R630 or R640 is energized. This ringing current is obviously applied also to the line conductors C343 and C344 leading to the connector switch illustrated in Fig. 5, but since the last-mentioned conductors are not connected to a subscriber's line, the application of ringing current thereto is without effect. Obviously, each time either of the ringing keys 870 and 880 is restored to its normal position to cause the restoration of ringing relays R630 and R640, the operating circuit for R320 is interrupted so that this relay restores to re-complete the connection between the calling subscriber's line and the operator's telephone.

Assuming that the call is answered and that the desired connection is established between the calling and called parties, or that the operator's assistance in completing the call is not required, the operator may proceed to release the operated finder-connector link by restoring the answer key switch 810 to its normal position, thereby to cause the restoration of the relays R450, R460, R470, R480, and R490 in the exact manner described previously. During this sequence of operations and when R480 restores shortly before the restoration of R490, a circuit is completed at RA483 for energizing R340 embodied in the operated finder-connector link. This circuit extends from ground at RA483 by way of RA494, C486, RA694, RC696, C358, RA397, C343', and through the winding of R340 to battery. The relay R340, upon operating, completes, at RA342, an obvious circuit for energizing the slow-to-release relay R350. At its armature RA341, the relay R340 completes a multiple holding circuit for the operated relay R390. The relay R350, upon operating, interrupts, at RA351, the original locking circuit for R390, and shortly thereafter, when R490 restores, to interrupt the operating circuit for R340, the remaining operating circuit for R390 is interrupted at RA341. When R390 restores, it initiates the release of the link by opening, at RA390', a point in the holding circuit for R310. When R310 restores, the operated relays embodied in the finder switch of Fig. 1 are deenergized and restore. Thus, the finder-connector link and the common control equipment are restored to normal and the apparatus is in readiness for further use.

Although the operation of the system has been described with particular reference to the control exchange operator's apparatus, as illustrated in Fig. 8, it will be understood that the apparatus may also be controlled from the local control set 43 shown in Fig. 4 of the drawings. The apparatus embodied in this control set is identical with that illustrated in Fig. 8 and the method of operating the same is the same as that just described. In order to associate the apparatus of this set with the line switching equipment illustrated, a control switch is included in the set for completing a circuit for energizing R400. With this relay operated, the control trunk 443 is disconnected from the common equipment shown in Fig. 4 and this equipment is connected to be controlled by the apparatus embodied in the local control set.

It will further be understood that a toll trunk may be provided which interconnects the two exchanges 900 and 910 in the manner of the line 907 illustrated in Fig. 9, which toll trunk is used on calls requiring a line between the two exchanges for completion. The details of the equipment terminating this trunk may be as disclosed, for example, in applicant's previously referred to Patent No. 2,010,372. Since such details form no part of the present invention and the general character thereof is adequately described in the above-noted patent, a detailed description thereof is deemed to be unnecessary.

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

I claim:

1. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, said lines being divided into groups, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, and a finder-connector link for interconnecting said lines to establish conversational circuits thereover, said link comprising; means responsive to the initiation of a call on one of said plurality of lines for selecting the calling line and for establishing a connection between said calling line and said trunk line, a plurality of group select relays individually corresponding to said groups of said lines and so connected and arranged as sequentially to operate in accordance with the impulses comprising a series of impulses transmitted from said impulsing device over said trunk line to select

a group of lines including a called one of said plurality of lines, and a plurality of units relays individually corresponding to the lines of each of said groups and so connected and arranged as sequentially to operate in accordance with the impulses comprising another series of impulses transmitted from said impulsing device over said trunk line to select said called line from said selected group of lines.

2. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, and a finder-connector link for interconnecting said lines to establish conversational circuits thereover, said link comprising; a plurality of group select relays so connected and arranged at sequentially to operate in response to the initiation of a call on one of said plurality of lines to select a group of said lines including the calling line, a plurality of units relays so connected and arranged as sequentially to operate to select said calling line from said selected group of lines, a pair of relays operative in response to the selection of said calling line to connect said calling line to said trunk line, and means comprising the connector portion of the link for selecting a called one of said plurality of lines and for establishing a connection between said calling and called lines, said last-mentioned means comprising means operative in accordance with impulses transmitted from said impulsing device over said trunk line for selecting said called line from said plurality of lines.

3. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, and a finder-connector link for interconnecting said lines to establish conversational circuits thereover, said link comprising; a plurality of group select relays so connected and arranged as sequentially to operate in response to the initiation of a call on one of said lines to select a group of said plurality of lines including the calling line, a plurality of units relays so connected and arranged as sequentially to operate to select said calling line from said selected group of lines, a pair of relays operative in response to the selection of said calling line to connect said calling line to said trunk line, a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising a series of impulses transmitted from said impulsing device over said trunk line to select a group of said plurality of lines including a called line, and a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising another series of impulses transmitted from said impulsing device over said trunk line to select said called line from said last-mentioned selected group of lines.

4. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, and a finder-connector link for interconnecting said lines to establish conversational circuits thereover, said link comprising; a plurality of group select relays so connected and arranged as sequentially to operate in response to the initiation of a call on one of said plurality of lines to select a group of lines including the calling line, a plurality of units relays so connected and arranged as sequentially to operate to select said calling line from said selected group of lines, a pair of relays operative in response to the selection of said calling line to connect said calling line to said trunk line, a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising a series of impulses transmitted from said impulsing device over said trunk line to select a group of said plurality of lines including a called line, a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising another series of impulses transmitted from said impulsing device over said trunk line to select said called line from said last-mentioned selected group of lines, and means for connecting said called line to said calling line only in the event said called line is idle.

5. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, and a finder-connector link for interconnecting said lines to establish conversational circuits thereover, said link comprising; a plurality of group select relays so connected and arranged as sequentially to operate in response to the initiation of a call on one of said lines to select a group of said plurality of lines including said calling lines, a plurality of units relays so connected and arranged as sequentially to operate to select the calling line from said selected group of lines, a pair of relays operative in response to the selection of said calling line to connect said calling line to said trunk line, a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising a series of impulses transmitted from said impulsing device over said trunk line to select a group of said plurality of lines including a called line, a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising another series of impulses transmitted from said impulsing device over said trunk line to select said called line from said last-mentioned selected group of lines, means for testing said called line to determine the idle or busy condition thereof, means for connecting said calling line to said called line in the event the latter is found idle, and means for preventing the connection of said calling line to said called line and for applying busy tone current to said calling line and said trunk line in the event said called line is busy.

6. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a line relay associated with each of said lines, each of said relays being operative in response to the initiation of a call on the associated line, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station,

and a finder-connector link for interconnecting said lines to establish conversational circuits thereover, said link comprising; a first relay, a circuit for said first relay arranged to be prepared upon the operation of one of said line relays, a second relay, a circuit for said second relay also arranged to be prepared upon operation of said one line relay, a plurality of group select relays sequentially operative in response to the operation of said one line relay until said first-mentioned circuit is completed, thereby to select a group of said plurality of lines including the calling line and to cause the operation of said first relay, a plurality of units relays sequentially operative in response to the operation of said first relay until said second-mentioned circuit is completed, thereby to select said calling line from said selected group of lines and to cause the operation of said second relay, a third relay arranged to operate in response to the operation of said second relay and operative to connect said calling line to said trunk line, and means comprising the connector portion of said link for selecting a called one of said plurality of lines and for establishing a connection between said calling and called lines, said last-mentioned means comprising means operative in accordance with impulses transmitted from said impulsing device over said trunk line for selecting said called line from said plurality of lines.

7. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a line relay associated with each of said lines, each of said relays being operative in response to the initiation of a call on the associated line, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, and a finder-connector link for interconnecting said lines to establish conversational circuits thereover, said link comprising; a first relay, a circuit for said first relay arranged to be prepared upon operation of one of said line relays, a second relay, a circuit for said second relay also arranged to be prepared upon operation of said one line relay, a plurality of group select relays sequentially operative in response to the operation of said one line relay until said first-mentioned circuit is completed, thereby to select a group of said plurality of lines including the calling line and to cause the operation of said first relay, a plurality of units relays sequentially operative in response to the operation of said first relay until said second-mentioned circuit is completed, thereby to select said calling line from said selected group of lines and to cause the operation of said second relay, a third relay arranged to operate in response to the operation of said second relay and operative to connect said calling line to said trunk line, a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising a series of impulses transmitted from said impulsing device over said trunk line to select a group of said plurality of lines including a called line, and a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising another series of impulses transmitted from said impulsing device over said trunk line to select said called line from said last-mentioned selected group of lines.

8. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, said lines being divided into groups, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange for interconnecting said lines to establish conversational circuits thereover, and allotter means comprising a plurality of relays so connected and arranged as successively to assign idle ones of said links to successive calling lines, each of said links comprising; finder means responsive to the initiation of a call on one of said plurality of lines for selecting the calling line and for establishing a connection between said calling line and said trunk line, a plurality of group select relays individually corresponding to said groups of lines and so connected and arranged as sequentially to operate in accordance with the impulses comprising a series of impulses transmitted from said impulsing device over said trunk line to select a group of said plurality of lines including a called line, and a plurality of units relays individually corresponding to the lines of each of said groups and so connected and arranged as sequentially to operate in accordance with the impulses comprising another series of impulses transmitted from said impulsing device over said trunk line to select said called line from said selected group of lines.

9. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange for interconnecting said lines to establish conversational circuits thereover, and allotter means comprising a plurality of relays so connected and arranged as successively to assign idle ones of said links to successive calling lines, each of said links comprising; a plurality of group select relays so connected and arranged as sequentially to operate in response to the initiation of a call on one of said plurality of lines to select a group of said lines including the calling line, a plurality of units relays so connected and arranged as sequentially to operate to select said calling line from said selected group of lines, a pair of relays operative in response to the selection of said calling line to connect said calling line to said trunk line, and means comprising the connector portion of the link for selecting a called one of said plurality of lines and for establishing a connection between said calling and called lines, said last-mentioned means comprising means operative in accordance with impulses transmitted from said impulsing device over said trunk line for selecting said called line.

10. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange for interconnecting said lines to establish conversational circuits thereover, and allotter means comprising a plurality of relays

so connected and arranged as successively to assign idle ones of said links to successive calling lines, each of said links comprising; a plurality of group select relays connected and arranged as sequentially to operate in response to the initiation of a call on one of said plurality of lines to select a group of said lines including the calling line, a plurality of units relays so connected and arranged as sequentially to operate to select said calling line from said selected group of lines, a pair of relays operative in response to the selection of said calling line to connect said calling line to said trunk line, a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising a series of impulses transmitted from said impulsing device over said trunk line to select a group of said plurality of lines including a called line, and a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising another series of impulses transmitted from said impulsing device over said trunk line to select said called line from said last-mentioned selected group of lines.

11. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange, allotter means for successive assigning idle ones of said links to successive calling lines, and control apparatus associated with said trunk line and common to said links for causing said links to operate and interconnect said lines to establish conversational circuits thereover, said apparatus comprising a pair of impulse responsive relays so connected and arranged that one thereof operates at the beginning of each odd impulse transmitted from said impulsing device over said trunk line and restores at the beginning of each even impulse, each of said links comprising; finder means operative in response to the initiation of a call on one of said plurality of lines to seize the calling line and said apparatus and to establish a connection between said calling line and said trunk line, and a plurality of relays operable in response to the operation and restoration of said one impulse responsive relay to select a called line from said plurality of lines.

12. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange, allotter means for successively assigning idle ones of said links to successive calling lines, and control apparatus associated with said trunk line and common to said links for causing said links to operate and interconnect said lines to establish conversational circuits thereover, said apparatus comprising a pair of impulse responsive relays so connected and arranged that one thereof operates at the beginning of each odd impulse transmitted from said impulsing device over said trunk line and restores at the beginning of each even impulse, each of said links comprising; finder means operative in response to the initiation of a call on one of said plurality of lines to seize said calling line and said apparatus and to establish a connection between said calling line and said trunk line, a plurality of relays so connected and arranged as sequentially to operate in response to the operation and restoration of said one impulse responsive relay during the transmission of one series of impulses from said impulsing device to select a group of said plurality of lines including a called line, and a plurality of relays so connected and arranged as sequentially to operate in response to the operation and restoration of said one impulse responsive relay during the transmission of another series of impulses from said impulsing device to select said called line from said selected group of lines.

13. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange, allotter means for successively assigning idle ones of said links to successive calling lines, and control apparatus associated with said trunk line and common to said links for causing said links to operate and interconnect said lines to establish conversational circuits thereover, said apparatus comprising a pair of impulse responsive relays so connected and arranged that one thereof operates at the beginning of each odd impulse transmitted from said impulsing device over said trunk line and restores at the beginning of each even impulse, each of said links comprising a plurality of group select relays so connected and arranged as sequentially to operate in response to the initiation of a call on one of said plurality of lines to select a group of said lines including the calling line, a plurality of units relays so connected and arranged as sequentially to operate to select said calling line from said selected group of lines, a pair of relays operative in response to the selection of said calling line to seize said apparatus and connect said calling line to said trunk line, a plurality of relays so connected and arranged as sequentially to operate in response to the operation and restoration of said one impulse responsive relay during the transmission of one series of impulses from said impulsing device to select a group of said plurality of lines including a called line, and a plurality of relays so connected and arranged as sequentially to operate in response to the operation and restoration of said one impulse responsive relay during the transmission of another series of impulses from said impulsing device to select said called line from said selected group of lines.

14. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange, allotter means for successively assigning idle ones of said links to successive calling lines, and control apparatus associated with said trunk line and common to said links for causing said links to operate and interconnect said lines to establish conversational circuits thereover, said apparatus comprising a pair of impulse-responsive relays so connected and ar-

ranged that one thereof operates at the beginning of each odd impulse transmitted from said impulsing device over said trunk line and restores at the beginning of each even impulse, each of said links comprising; finder means operative in response to the initiation of a call on one of said plurality of lines to seize the calling line and said apparatus and to establish a connection between said calling line and said trunk line, and a plurality of relays operable in response to the operation and restoration of said one impulse-responsive relay to select a called line from said plurality of lines; and means for preventing said finder means from operating in the event said common apparatus is busy at the time said call is initiated.

15. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange, allotter means for successively assigning idle ones of said links to successive calling lines, and control apparatus associated with said trunk line and common to said links for causing said links to operate and interconnect said lines to establish conversational circuits thereover, said apparatus comprising a pair of impulse-responsive relays so connected and arranged that one thereof operates at the beginning of each odd impulse transmitted from said impulsing device over said trunk line and restores at the beginning of each even impulse, each of said links comprising; a plurality of group select relays so connected and arranged as sequentially to operate in response to the initiation of a call on one of said plurality of lines to select a group of said lines including the calling line, a plurality of units relays so connected and arranged as sequentially to operate to select said calling line from said selected group of lines, a pair of relays operative in response to the selection of said calling line to seize said apparatus and connect said calling line to said trunk line, a plurality of relays so connected and arranged as sequentially to operate in response to the operation and restoration of said one impulse responsive relay during the transmission of one series of impulses from said impulsing device to select a group of said plurality of lines including a called line, and a plurality of relays so connected and arranged as sequentially to operate in response to the operation and restoration of said one impulse-responsive relay during the transmission of another series of impulses from said impulsing device to select said called line from said selected group of lines; and means included in said common apparatus for preventing said first named plurality of relays from operating in the event said common apparatus is busy at the time said call is initiated.

16. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange, allotter means for successively assigning idle ones of said links to successive calling lines, and control apparatus associated with said trunk line and common to said links for causing said links to operate and interconnect said lines to establish conversational circuits thereover, said apparatus comprising a pair of impulse-responsive relays so connected and arranged that one thereof operates at the beginning of each odd impulse transmitted from said impulsing device over said trunk line and restores at the beginning of each even impulse, each of said links comprising; finder means operative in response to the initiation of a call on one of said plurality of lines to seize the calling line and said apparatus and to establish a connection between said calling line and said trunk line, and a plurality of relays operable in response to the operation and restoration of said one impulse responsive relay to select a called line from said plurality of lines; a switch at said operator's station, and means responsive to the operation of said switch for applying ringing current to said called line.

17. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange, allotter means for successively assigning idle ones of said links to successive calling lines, and control apparatus associated with said trunk line and common to said links for causing said links to operate and interconnect said lines to establish conversational circuits thereover, said apparatus comprising a pair of impulse-responsive relays so connected and arranged that one thereof operates at the beginning of each odd impulse transmitted from said impulsing device over said trunk line and restores at the beginning of each even impulse, each of said links comprising; finder means operative in response to the initiation of a call on one of said plurality of lines to seize the calling line and said apparatus and to establish a connection between said calling line and said trunk line, and a plurality of relays operable in response to the operation and restoration of said one impulse responsive relay to select a called line from said plurality of lines; a switch at said operator's station, and means responsive to the operation of said switch for applying ringing current to said called line.

18. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said con-

trol exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange, allotter means for successively assigning idle ones of said links to successive calling lines, and control apparatus associated with said trunk line and common to said links for causing said links to operate and interconnect said lines to establish conversational circuits thereover, said apparatus comprising a pair of impulse-responsive relays so connected and arranged that one thereof operates at the beginning of each odd impulse transmitted from said impulsing device over said trunk line and restores at the beginning of each even impulse, each of said links comprising; a plurality of group select relays so connected and arranged as sequentially to operate in response to the initiation of a call on one of said lines to select a group of said plurality of lines including the calling line, a plurality of units relays so connected and arranged as to select said calling line from said selected group of lines, a pair of relays operative in response to the selection of said calling line to seize said apparatus and connect said calling line to said trunk line, a plurality of relays so connected and arranged as sequentially to operate in response to the operation and restoration of said one impulse responsive relay during the transmission of one series of impulses from said impulsing device to select a group of said plurality of lines including a called line, and a plurality of relays so connected and arranged as sequentially to operate in response to the operation and restoration of said one impulse-responsive relay during the transmission of another series of impulses from said impulsing device to select said called line from said last-mentioned selected group of lines; a switch at said operator's station operable from one position to a second position to connect said operator's telephone to said trunk line and to condition said common apparatus for the transmission of impulses to said impulse-responsive relays, and means operative following the connection of said called line to said calling line and in response to the operation of said switch from said second position to said one position for releasing said common apparatus without breaking the connection between said calling and called lines.

19. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange for interconnecting said lines to establish conversational circuits thereover, and allotter means comprising a plurality of relays so connected and arranged as successively to assign idle ones of said links to successive calling lines, each of said links comprising; a plurality of group select relays so connected and arranged as sequentially to operate in response to the initiation of a call on one of said plurality of lines to select a group of said lines including the calling line, a plurality of units relays so connected and arranged as sequentially to operate to select said calling line from said selected group of lines, a pair of relays operative in response to the selection of said calling line to connect said calling line to said trunk line, a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising a series of impulses transmitted from said impulsing device over said trunk line to select a group of said plurality of lines including a called line, and a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising another series of impulses transmitted from said impulsing device over said trunk line to select said called line from said last-mentioned selected group of lines; and means operative in the event the first-named plurality of relays of any link fails to select a group of lines including a calling line or the second-named plurality of relays of any link fails to select a calling line from a selected group of lines for assigning a second link to the calling line.

20. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange for interconnecting said lines to establish conversational circuits thereover, and allotter means comprising a plurality of relays so connected and arranged as successively to assign idle ones of said links to successive calling lines, each of said links comprising; a plurality of group select relays so connected and arranged as sequentially to operate in response to the initiation of a call on one of said lines to select a group of said plurality of lines including the calling line, a plurality of units relays so connected and arranged as sequentially to operate to select said calling line from said selected group of lines, a pair of relays operative in response to the selection of said calling line to connect said calling line to said trunk line, a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising a series of impulses transmitted from said impulsing device over said trunk line to select a group of said plurality of lines including a called line, and a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising another series of impulses transmitted from said impulsing device over said trunk line to select said called line from said last-mentioned selected group of lines; means operative in the event the first-named plurality of relays of any link fails to select a group of lines including a calling line or the second-named plurality of relays of any link fails to select a calling line from a selected group of lines for assigning a second link to the calling line, a signal device at said operator's station, and means operative in the event said second link also fails to select the calling line for energizing said signal device.

21. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange for interconnecting said lines to establish conversational circuit thereover, and allotter means comprising a plurality of relays so connected and arranged as successively to assign idle ones of said links to successive calling lines, each of said links comprising; a plurality of

group select relays so connected and arranged as sequentially to operate in response to the initiation of a call on one of said plurality of lines to select a group of said lines including the calling line, a plurality of units relays so connected and arranged as sequentially to operate to select said calling line from said selected group of lines, a pair of relays operative in response to the selection of said calling line to connect said calling line to said trunk line, a plurality of relays connected and arranged sequentially to operate in accordance with the impulses comprising a series of impulses transmitted from said impulsing device over said trunk line to select a group of said plurality of lines including a called line, and a plurality of relays connected and arranged sequentially to operate in accordance with the impulse comprising another series of impulses transmitted from said impulsing device over said trunk line to select said called line from said last-mentioned selected group of lines; a signal device at said operator's station, and means operative when all of said links become busy for energizing said signal device.

22. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange for interconnecting said lines to establish conversational circuits thereover, and allotter means comprising a plurality of relays so connected and arranged as successively to assign idle ones of said links to successive calling lines, each of said links comprising; a plurality of group select relays so connected and arranged as sequentially to operate in response to the initiation of a call on one of said plurality of lines to select a group of said lines including the calling line, a plurality of units relays so connected and arranged as sequentially to operate to select said calling line from said selected group of lines, a pair of relays operative in response to the selection of said calling line to connect said calling line to said trunk line, a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising a series of impulses transmitted from said impulsing device over said trunk line to select a group of said plurality of lines including a called line, a plurality of relays so connected and arranged as sequentially to operate in accordance with the impulses comprising another series of impulses transmitted from said impulsing device over said trunk line to select said called line from said last-mentioned selected group of lines; a signal device at said operator's station, means operative when all of said links become busy for energizing said signal device, and means including a plurality of relays operative in accordance with impulses transmitted from said impulsing device over said trunk line for connecting said trunk line to the connection established by way of any one of said links.

23. In a telephone, system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange, allotter means for successively assigning idle ones of said links to successive calling lines, and control apparatus associated with said trunk line and common to said links for causing said links to operate and interconnect said lines to establish conversational circuits thereover, said apparatus comprising a pair of impulse-responsive relays so connected and arranged that one thereof operates at the beginning of each odd impulse transmitted from said impulsing device over said trunk line and restores at the beginning of each even impulse, each of said links comprising; a plurality of group select relays so connected and arranged as sequentially to operate in response to the initiation of a call on one of said lines to select a group of said plurality of lines including the calling line, a plurality of units relays so connected and arranged as sequentially to operate to select said calling line from said selected group of lines, a pair of relays operative in response to the selection of said calling line to seize said apparatus and connect said calling line to said trunk line, a plurality of relays so connected and arranged as sequentially to operate in response to the operation and restoration of said one impulse responsive relay during the transmission of one series of impulses from said impulsing device to select a group of said plurality of lines including a called line, and a plurality of relays so connected and arranged as sequentially to operate in response to the operation and restoration of said one-impulse responsive relay during the transmission of another series of impulses from said impulsing device to select said called line from said last-mentioned selected group of lines; a switch at said operator's station operable from one position to a second position to connect said operator's telephone to said trunk line and to condition said common equipment for the transmission of impulses to said impulse-responsive relays, means operative following the connection of said called line to said calling line and in response to the operation of said switch from said second position to said one position for releasing said common apparatus without breaking the connection between said calling and called lines, and means including a plurality of relays operative in accordance with impulses transmitted from said impulsing device for connecting said trunk line to the connection established by way of any one of said links.

24. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said operator's station, a plurality of finder-connector links included in said second exchange, allotter means for successively assigning idle ones of said links to successive calling lines, and control apparatus associated with said trunk line and common to said links for causing said links to operate and interconnect said lines to establish conversational circuits thereover, said apparatus comprising a pair of impulse-responsive relays so connected and arranged that one thereof operates at the beginning of each odd impulse transmitted from said impulsing device over said trunk line and restores at the beginning of each even impulse, each of said links comprising; a plurality of group select relays so connected and arranged as sequentially to operate in response to the initia-

tion of a call on one of said plurality of lines to select a group of said lines including the calling line, a plurality of units relays so connected and arranged as sequentially to operate to select said calling line from said selected group of lines, a pair of relays operative in response to the selection of said calling line to seize said apparatus and connect said calling line to said trunk line, a plurality of relays so connected and arranged as sequentially to operate in response to the operation and restoration of said one impulse responsive relay during the transmission of one series of impulses from said impulsing device to select a group of said plurality of lines including a called line, and a plurality of relays so connected and arranged as sequentially to operate in response to the operation and restoration of said one-impulse responsive relay during the transmission of another series of impulses from said impulsing device to select said called line from said last-mentioned selected group of lines; a switch at said operator's station operable from one position to a second position to connect said operator's telephone to said trunk line and to condition said common equipment for the transmission of impulses to said impulse-responsive relays, means operative following the connection of said called line to said calling line and in response to the operation of said switch from said second position to said one position for releasing said common apparatus without breaking the connection between said calling and called lines, a signal device at said operator's station, means operative when all of said links become busy for energizing said signal device, and means including a plurality of relays operative in accordance with impulses transmitted from said impulsing device for connecting said trunk line to the connection established by way of any one of said links.

25. In a telephone system, a control exchange, a second exchange remote from said control exchange, a plurality of lines extending to said second exchange, said lines being divided into groups, a trunk line interconnecting said exchanges, an operator's station at said control exchange, an operator's telephone and an impulsing device at said station, a finder switch in said second exchange, said finder switch comprising a plurality of group select relays individually corresponding to said groups of lines and so connected and arranged as sequentially to operate in response to the initiation of a call on one of said plurality of lines to select the group of lines including the calling line, and a plurality of units relays sequentially operative to select the calling line from the selected group of lines, means responsive to the selection of the calling line for establishing a connection between said calling line and said trunk line, a switch at said operator's station, means responsive to the operation of said switch for applying a ringing current to said calling line, thereby to complete a reverting call, and means including a connector switch for selecting a called line from said plurality of lines and for establishing a connection between said calling and called lines, said connector switch including means operative in accordance with impulses transmitted from said impulsing device over said trunk line for selecting said called line from said plurality of lines.

EDWARD S. PETERSON.

CERTIFICATE OF CORRECTION.

Patent No. 2,158,945. May 16, 1939.

EDWARD S. PETERSON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 21, first column, line 20, claim 2, for the word "at" read as; page 23, first column, line 4, claim 10, after "relays" insert so; line 33, claim 11, for the word "successive" read successively; page 25, second column, line 71, claim 21, for "circuit" read circuits; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 11th day of July, A. D. 1939.

Henry Van Arsdale

Acting Commissioner of Patents.

(Seal)