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C. E. LOMAX

AUTOMATIC TELEPHONE SYSTEM

Filed March 20, 1926

2 Sheets-Sheet 1

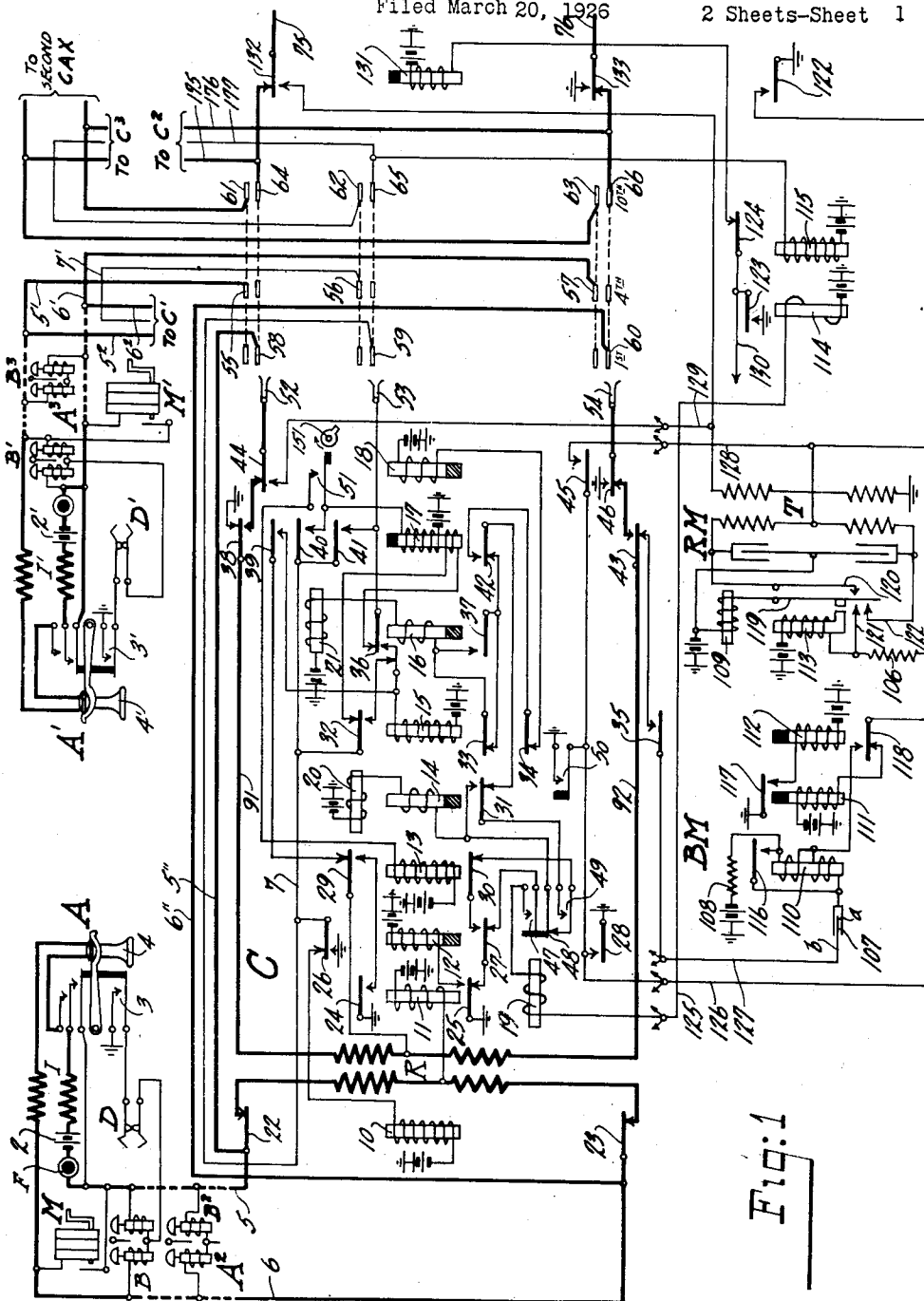


FIG. 1

Inventor
Clarence E. Lomax

R. S. Richardson Atty.

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C. E. LOMAX

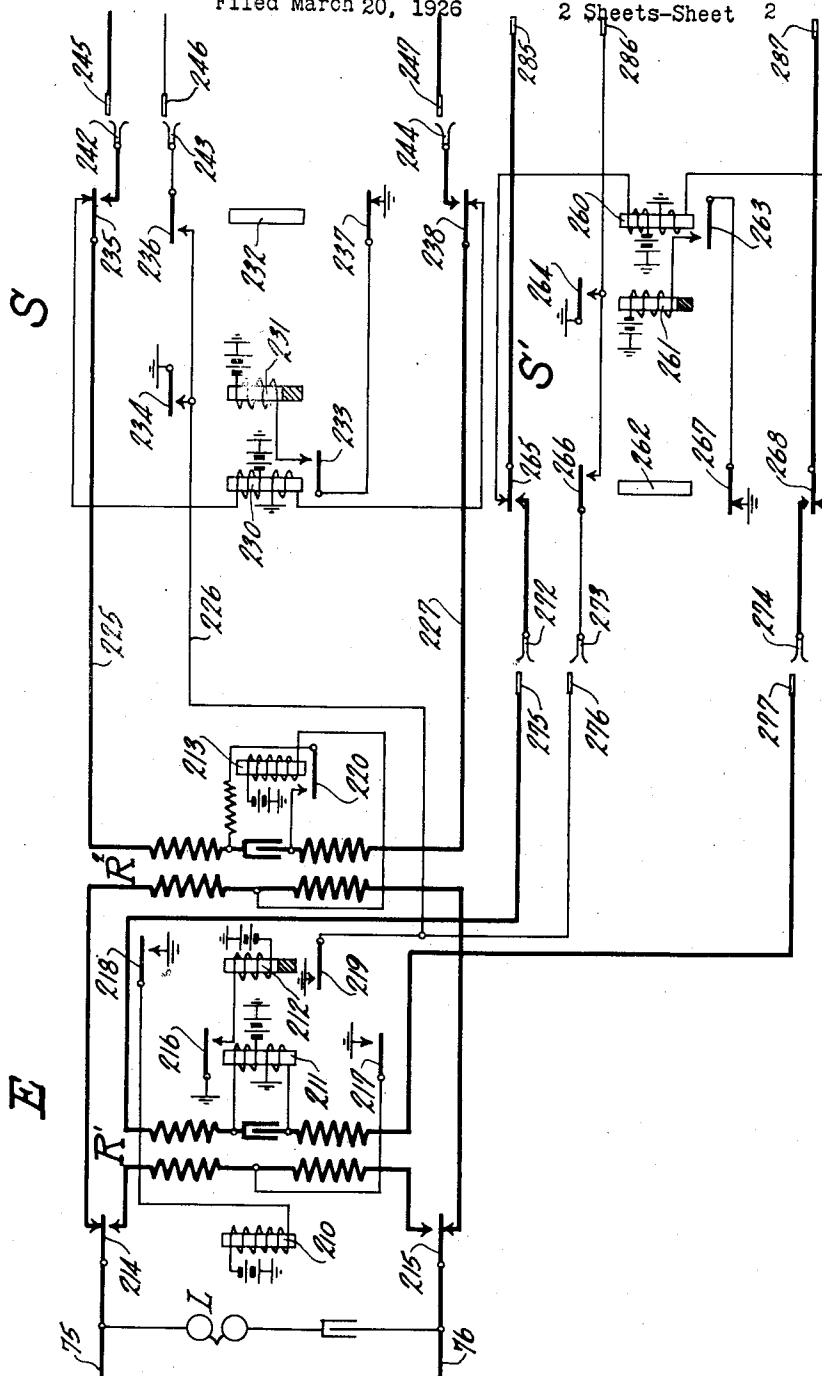
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2 Sheets-Sheet 2

Fig: 2



Inventor
Clarence E. Lomax

R. S. Richardson Atty.

UNITED STATES PATENT OFFICE.

CLARENCE E. LOMAX, OF OAK PARK, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC INC., OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

AUTOMATIC TELEPHONE SYSTEM.

Application filed March 20, 1926. Serial No. 96,150.

This invention relates to automatic telephone systems in general, but is more particularly concerned with small automatic telephone exchange systems comprising only a few lines; and the object of the invention, broadly stated, is the provision of new and improved automatic switching apparatus which is particularly suitable for use in such small automatic telephone systems.

A particular feature of the invention is a new and simplified connector switch adapted to be connected directly to a telephone line. This new connector switch functions as an ordinary connector when extending a connection to an individual subscriber's line, may be operated as a code ringing connector to signal a particular party on a party line, and may also be operated as a repeater for extending calls to some other telephone exchange, such as to the main automatic exchange of a neighboring city, or to another similar small automatic exchange.

Another feature of the invention is the provision of an automatic repeater for use at a main automatic exchange to terminate trunks from a small automatic exchange of the character herein described.

A further feature has to do with miscellaneous improvements in the ringing and supervisory equipment.

The foregoing and other features not specifically mentioned may be described more in detail by referring to the accompanying drawings comprising Figs. 1 and 2, which, when Fig. 2 is placed to the right of Fig. 1, show by means of the usual schematic circuit diagrams the apparatus to be used in a small automatic telephone exchange (commonly known as a community automatic exchange, and abbreviated, C. A. X.) to which this invention particularly pertains, and show the apparatus at a main automatic exchange (abbreviated, M. A. X.) having an association with the trunks extending from the C. A. X. to the M. A. X.

In Fig. 1 is shown the new and improved connector C which is individual to the party line comprising conductors 5 and 6, and has access in its banks to all the lines served by the C. A. X. and to the trunks extending to a M. A. X. and also to another community automatic exchange. Each line served by the C. A. X. and each trunk terminating at the C. A. X. terminates in a similar con-

ductor, the banks of all the connectors being multiplied together. The connector C is of the well known vertical and rotary type of switch having a plurality of horizontal rows of ten sets of contacts each. In this particular disclosure outgoing trunks to the M. A. X. and to the second C. A. X. are accessible in the tenth set of contacts in certain levels of the connector banks. In the drawings one trunk to the M. A. X., accessible in the tenth set of bank contacts in the first level, and one trunk to the second C. A. X., accessible in the tenth set of bank contacts in the second level, are shown.

The various party lines in the system may each serve as many substations as is considered desirable. In the drawing the party line comprising conductors 5 and 6 serves the substation A and the substation A². The substation A, which is like the other substations of the C. A. X., comprises the following apparatus: receiver 4, calling device D, transmitter F, induction coil I, bells B, and generator M. The substation is also provided with a local battery 2. Only the bells B² of substation A² are shown. The party line comprising conductors 5' and 6' is likewise shown as serving two substations, namely, A' and A³, substation A' being shown complete and only the bells of substation A³ being shown.

The signaling equipment is common to all the connectors in the exchange and comprises the busy machine BM, and ringing machine RM.

In Fig. 2 is shown the repeater E terminating the trunk comprising conductors 75 and 76 incoming to the M. A. X. from the C. A. X. This repeater is permanently connected by means of trunk conductors 225, 226, and 227 to the incoming selector S. The repeater E is also accessible in the bank contacts 275, 276, and 277, of the outgoing selectors, one of which is designated S'. The repeater E forms a particular part of this invention and will be described in detail below. The selectors S and S' are of the well known vertical and rotary type and are shown only in part.

In the above circuits, certain relays have a slow-to-pull-up characteristic. These are indicated by a cross-hatched section at the lower ends of their cores. Other relays have both a slow-to-pull-up and slow-to-release

characteristic. These relays are indicated by a solid black section at the upper ends of their cores.

Having described the system and the apparatus to be used, a detailed description of the operation thereof may now be given. For this purpose it will be assumed that the subscriber at substation A wishes to converse with the subscriber at substation A'. To establish the connection, the subscriber at substation A removes his receiver and dials, first the number of the line to substation A', and then dials the particular code to signal the subscriber at substation A'. As shown, the party line comprising conductors 5' and 6' is accessible in the fourth set of bank contacts in the second level. Therefore the line number of this party line is number 24. It may be assumed that the code to signal the substation A' is one long ring and one short ring. The subscriber at substation A will therefore dial the number 24 and then dial the digit 8 to produce the long ring and the digit 2 to produce a short ring, as will be described below.

When the receiver 4 is removed from the switch-hook, the switch-hook springs are closed. A circuit is thereby completed for the line relay 11 of the connector C, which may be traced from ground at springs 3, dial D, through the coils of the bells B in parallel, over the two line conductors 5 and 6 in parallel, armatures 22 and 23 and their resting contacts, upper and lower left-hand windings of repeating coil R, through the winding of line relay 11 to battery. Line relay 11 operates and closes a circuit for release relay 12 at armature 25. Release relay 12 operates and places ground potential on the release conductor 7 at armature 26, and prepares an impulsing circuit at armature 27. Ground is also applied to the common start conductor 126 at armature 28. This initiates the operation of the busy-tone machine BM and also the ringing machine RM. The operation of these machines will be explained in later paragraphs. Release conductor 7 is connected to the private normal conductor extending to the bank contact 59. By the application of ground potential on this contact, the party line comprising conductors 5 and 6 is guarded from being connected to by some other connector at this time in the well known manner. In response to the dialing of the first digit, which in this case is 2, the circuit of the line relay 11 is opened a corresponding number of times. The first time the line relay 11 deenergizes, a ground impulse is sent to the vertical magnet 20 by way of armature 25 and the resting contact, armature 27 and the working contact, armature 30 and the resting contact, normally closed springs 48, through the winding of the series relay 14, through the

winding of the vertical magnet 20 to battery. Magnet 20 operates and raises the wipers 52, 53, and 54 one vertical step. This operation shifts the vertical off-normal springs opening springs 48 and closing springs 49, springs 47, and springs 50. Series relay 14 is also energized and operates its armature 31. The remaining impulse of the first digit traverses the same path except that the path now includes the closed springs 49 and armature 31 and excludes the springs 48, relay 14 by reason of its slow-acting characteristic being maintained operated. In response to this impulse, magnet 20 operates again and positions the switch wipers 52, 53, and 54 opposite the second level of bank contacts. At the termination of the first series of impulses, relay 14 deenergizes and prepares a circuit for the rotary magnet 21 at armature 31 and its resting contact.

In response to the dialing of the next digit, which in this case is 4, line relay 11 is deenergized and reenergized a corresponding number of times, thereby sending four ground impulses to the rotary magnet by way of armature 25 and the resting contact, armature 27 and the working contact, armature 30 and the resting contact, closed springs 49, armature 31 and the resting contact, armature 42 and the resting contact, resting contact and armature 33, through the winding of the series relay 16, through the winding of the rotary magnet 21 to battery. Rotary magnet 21 operates and rotates the wipers 52, 53, and 54 into engagement with the bank contacts 55, 56, and 57. Slow-acting series relay 16 operates over the above traced circuit and prepares a circuit for the test relay 15 at armature 36, and places a shunt around the armature 33 and its resting contact at armature 37. The shunting of armature 33 eliminates the possibility of the rotary circuit being opened by the energization of test relay 15 due to wiper 53 passing over busy test contacts. If any one of the subscribers on the party line comprising the conductors 5' and 6' are engaged in another connection at this time, ground potential will be present on the bank contact 56. A circuit will then be closed for the test relay 15, when wiper 53 engages bank contact 56, which may be traced from ground on bank contact 56, wiper 53, armature 36 and the working contact, through the winding of relay 15 to battery. Relay 15 operates and prepares a locking circuit for itself at armature 32, and connects the common busy-tone conductor 127 to the lower talking conductor 92 at armature 35. A short time after the termination of this second series of impulses, relay 16 deenergizes and releases its armatures, permitting the closure of the normally closed springs controlled by armature 36. A locking cir-

cuit is thereby completed for test relay 15, which may be traced from ground on conductor 7, armature 32 and the working contact, normally closed springs controlled by armature 36, through the winding of test relay 15 to battery. This relay will remain energized as long as the subscriber at substation A maintains the receiver off the hook. The subscriber at substation A hears the busy tone, however, which informs him that the line to the desired substation is busy at this time, whereupon he will replace his receiver and attempt to complete the desired connection at some later time.

Assuming that the line to substation A' is idle at this time, however, no ground potential will be present on the bank contact 56 and the test relay 15 will remain deenergized. When relay 16 deenergizes, at the termination of the rotary impulses, a circuit is completed which may be traced from ground on conductor 7, armature 32 and the resting contact, through the lower winding of the switching relay 17, resting contact and armature 36, wiper 53, bank contact 56, to conductor 7' terminating in the connector C' (not shown), by way of the armature similar to armature 26 and its resting contact, through the winding of the cut-off relay similar to the cut-off relay 10 to battery. The cut-off relay in connector C' operates to disconnect the conductors 5² and 6² from the repeating coil in the connector C'. Relay 17 operates, closes a locking circuit for itself at armature 40, and causes the following circuit changes: Conductors 91 and 92 are connected directly to the wiper 52 and 54 at armatures 38 and 43, respectively. A circuit is prepared for the test relay 15 at armature 39. Ground potential is placed directly on bank contact 56 by way of armature 41 and the working contact and wiper 53 to maintain the cut-off relay similar to relay 10 in the connector C' operated and to guard the party line comprising conductors 5' and 6' from being seized by some other connector at this time. The circuit for the ringing relay 18 is prepared at armature 42 and the working contact.

The subscriber at substation A now dials the digit 8 to produce a long ring and the digit 2 to produce a short ring to signal the subscriber at substation A'. In response to the dialing of the digit 8, the circuit of the line relay 11 is again interrupted a corresponding number of times, causing 8 ground impulses to be sent to the ringing relay 18 over the path similar to that traced above for the rotary magnet 21 to armature 42, but now including the working contact of armature 42, armature 34 and the resting contact, through the winding of the ring relay 18 to battery. Ringing relay 18 operates and at its armature 45 applies ground potential to

the mid-point of the left-hand windings of the transformer T. The vibrating armature 119 is now effective in closing a circuit through the upper left-hand winding of the transformer T and then through the lower left-hand winding of the transformer T. By the alternation of current flow through these two windings, an alternating potential is induced in the right hand windings of the transformer T. By the operation of armatures 44 and 45 this potential is connected to the conductors of the selected party line. Ringing relay 18 is slow acting and therefore maintains its armatures operated throughout the sending of the 8 impulses thereto. At the end of this digit, relay 18 falls back and releases its armatures. In response to the dialing of the digit 2, relay 18 again operates for a correspondingly shorter time. By reason of the application of this alternating potential applied to the conductors of the selected party line the bells of the substation on this line are caused to give one long ring and one short ring. The subscriber at substation A may repeat the ringing of the code until the subscriber at substation A' responds, or until he is convinced that no one is available at this substation to answer the call.

When the subscriber at substation A' removes his receiver to answer the call, a circuit is closed which may be traced from ground at springs 3', dial D', through the coils of bells B' in parallel, conductors 5' and 6' in parallel, bank contacts 55 and 57, wipers 52 and 54, armatures 44 and 46 and their resting contacts, working contacts and armatures 38 and 43, conductors 91 and 92, upper and lower windings of the repeating coil R, armature 29 and the resting contact, armature 39 and the working contact, through the winding of the test relay 15 to battery. Relay 15 operates and closes a locking circuit for itself at armature 32 and opens the circuit of ringing relay 18 at armature 34. The operation of the test relay 15 at this time prevents a further application of ringing potential to the conductors of the connected party line, should the dial at substation A again be operated. It is apparent from this that relay 15 performs a dual function; functioning as a busy test relay when the party line is first connected to, to test whether that line is busy or idle, and functioning as a ring cut-off relay responsive to the removal of the receiver at the called substation to interrupt the circuit of the ringing relay. This forms one of the features of this invention.

The subscribers may now engage in conversation. At the termination of the conversation, both subscribers will replace their receivers. When the subscriber at substation A replaces his receiver, the circuit of line relay 11 is opened by the separation of

springs 3. Line relay 11 deenergizes and opens the circuit of release relay 12. By the release of armature 26, ground potential is removed from the release conductor 7, thereby causing the deenergization of relays 15 and 17, which accordingly restore their armatures to normal. By the release of armature 27, a circuit is closed for the release magnet 19 which may be traced from ground by way of armature 25 and the resting contact, armature 27 and the resting contact, springs 47, which were closed upon the first vertical step of the switch wipers, through the winding of the release magnet 19, common release conductor 125, through the winding of the supervisory release relay 114 to battery. Release magnet 19 energizes and permits the switch wipers to return to normal in the well known manner. The return of the switch wipers to normal resets the off-normal springs, opening springs 47, 50, and 49, and closing springs 48. Supervisory release relay 114 energizes during the release of the switch, thereby momentarily placing ground on the trouble conductor 130 and armature 123. A circuit is momentarily closed for the signaling relay 131. This relay being both slow-to-actuate and slow-to-release, indicated by the solid black portion on the upper end of its core, does not respond to this momentary energization. The function of this relay will be explained in later paragraphs.

It is obvious, that if there were only the one substation A' on the line comprising conductors 5' and 6', the subscriber at substation A in signaling the subscriber at substation A' would need dial no special code. Ringing potential would be applied to the conductors of the line and the desired subscriber would be signalled however in the same manner as before by actuating the dial after the connection had been completed with the line.

The operation of the busy machine BM and ringing machine RM may now be explained more in detail. By the actuation of armature 28 (or the armature corresponding to armature 28 of the release relay of any connector) ground potential is placed on the common start conductor 126. Ground on conductor 126 causes the operation of the slow acting relay 111 over an obvious circuit. Relay 111 operates and closes a circuit for relay 112. Relay 112 operates and at armature 118 opens the circuit of relay 111, and closes a circuit for relay 110, which may be traced from ground on the start conductor 126, armature 118 and the working contact, through the upper winding of relay 110, resistance 108 to battery. Relay 110 is energized over the above traced circuit and operates armature 116. A circuit is now closed for the lower winding of relay 110 which may be traced from ground at arma-

ture 118 and the working contact, through the lower winding of relay 110, armature 116 and the working contact, resistance 108 to battery. Relay 110 is differentially wound. The closure of the circuit for the lower winding therefore causes the deenergization of relay 110. Armature 116 then releases, opening the circuit for the lower winding whereupon relay 110 again energizes over the upper winding. The above operation repeats itself in a buzzer like manner as long as armature 118 is in engagement with its working contact. Each time armature 116 operates, the potential on the "a" side of condenser 107 is varied. This produces a varying potential on the busy conductor 127, which produces the characteristic busy-tone "buzz". A short time after the circuit or relay 111 is opened at armature 118 and the resting contact, relay 111 deenergizes and opens the circuit of relay 112. Relay 112 is also slow acting and retains its armature 118 for a time after the circuit is opened, after which armature 118 is released and the above operations are again repeated, thereby causing the busy-tone potential to be placed on conductor 127 intermittently.

Ground on conductor 126 also closes a circuit for the vibrating relay 113, traced from ground on this conductor, resistance 106, through the winding of relay 113 to battery. Relay 113 attracts the armature 119 thereby connecting battery to the lower terminal of the lower left-hand winding of transformer T by way of impedance 109, armature 119 and working contact 122. By the attraction of armature 119, the winding of relay 113 is shunted from battery through the impedance 109, armature 119, and working contact 121. The shunting of relay 113 causes the deenergization of relay 113 and the release of armature 119. Armature 119 is weighted so that in releasing it swings back further than its normal position and makes contact with contact 120, and in so doing, connects battery to the upper terminal of the upper left-hand winding of transformer T by way of impedance 109, armature 119, and contact 120. As armature 119 leaves contact 121, the shunt is removed, thereby causing the reenergization of relay 113. This operation continues as long as there is ground potential on the common start conductor 126. The application of battery potential to the upper and lower left-hand windings of the transformer T is ineffective to induce ringing current potential in the right-hand windings of the transformer T, however, unless ground is placed on the common conductor 128 as has been described.

In the above description the operation of the system for establishment of a connection between two local subscribers was described. A description of the operation of

the system for extending a connection from a local subscriber to a subscriber served by the main automatic exchange may now be given. For this purpose it will be assumed that the subscriber at substation A desires connection with a certain subscriber in the main automatic exchange. To establish this connection the subscriber at substation A will again remove his receiver, then dial two digits which will connect him with an outgoing trunk to the main automatic exchange, after which he will dial the regular directory number of the desired subscriber as it appears in the main automatic exchange directory. As shown in the drawings, one of the trunks extending to the main automatic exchange is accessible in the tenth set of bank contacts in the first level. Accordingly, the subscriber at substation A will dial the digit 1 and 0. In response thereto the connector C will operate to raise the wipers 52, 53, and 54 opposite the first level of bank contacts, and then rotate the wipers into engagement with the bank contacts 64, 65, and 66. If this trunk extending to the main automatic exchange accessible in these bank contacts is busy at this time, ground potential will be present on the bank contact 65 which will cause the operation of the test relay 15. The subscriber at substation A will thereupon be apprised of the busy condition of this line, these operations all taking place in the manner described above. If there is another trunk extending to the main automatic exchange, it may be accessible in the tenth set of bank contacts of another level, having a number corresponding to its position in the connector banks which will be known to the subscriber at substation A. Upon receiving the busy signal, subscriber at substation A will replace his receiver to release this connection and then again remove his receiver and dial the number of this other trunk extending to the main automatic exchange in an attempt to complete the connection via this other trunk.

It may be assumed, however, that the trunk accessible in bank contacts 64, 65 and 66, is idle at this time. When the wipers 52, 53, and 54 are rotated into engagement with the tenth set of bank contacts, the cam 151 attached to the shaft on which the switch wipers are mounted closes the springs 51, thereby preparing a circuit for the change-over relay 13. Upon the engagement of wiper 53 with the bank contact 65, a circuit is closed for the switching relay 17 from ground on conductor 7 over a path identical to that traced in the preceding paragraphs through the lower winding of relay 17, through the winding of the cut-off relay in the connector C² (not shown) connected to the selected outgoing trunk. This relay, similar to relay 10 of connector C, operates and disconnects the conductors 175 and 176 from the connector C². Relay 17 operates, closes a locking circuit for itself at armature 40, and performs the same circuit changes as described in the previous connection. Relay 115 connected to test contact 65 is also operated when ground potential is connected to this contact. The function of this relay, however, will be described subsequently. By the operation of armature 40, a circuit is also closed for the change-over relay 13 which may be traced from ground on conductor 7, armature 40 and the working contact, closed springs 51, through the winding of relay 13 to battery. Relay 13 operates and opens a point in the previously traced impulsing circuit at armature 30, and closes a new impulsing circuit at armature 29 and the working contact. A circuit is thereby closed which may be traced from armature 24 and the working contact, working contact and armature 29, upper and lower right-hand windings of repeating coil R in parallel, conductors 91 and 92, armatures 38 and 43 and their working contacts, resting contacts and armatures 44 and 46, wipers 52 and 54, bank contacts 64 and 66, resting contacts and armatures 132 and 133, outgoing trunk conductors 75 and 76 to the repeater E, armatures 214 and 215 and their resting contacts, through the upper and lower left-hand windings of the repeating coil R² in parallel, through the winding of the impulse repeating relay 213 to battery. Relay 213 operates and closes a direct current bridge across the conductors 225 and 227 connected to the incoming selector S. A circuit is thereby closed for line relay 230 of the selector S by way of conductors 225 and 227 bridged at armature 220, armatures 235 and 238 and their resting contacts through the upper and lower windings of the line relay 230 to battery and ground, respectively. Relay 230 operates and closes a circuit for release relay 231 at armature 233. Release relay 231 operates and places ground potential on conductor 226 at armature 234, grounding the bank contact 276 in the banks of the outgoing selectors thereby guarding repeater E from being seized for use in an outgoing call to the C. A. X. at this time. Other circuit changes take place in the selector S to prepare this selector to receive the next set of impulses to be dialled in the well known manner. The subscriber at substation A now dials the digits of the regular directory number of the desired substation. In response to dialing the next digit, line relay 11 is deenergized and reenergized a corresponding number of times. At each deenergization of the line relay 11, the circuit of the impulse receiving relay 213 of the repeater E is open at armature 24. Impulse receiving relay 213 deenergizes and opens the circuit of the

line relay 230 of selector S. In this manner line relay 230 is caused to deenergize a number of times corresponding to the digit dialled, and causes the operation of the selector S to extend the connection in the well known manner. In a similar manner the succeeding switches are operated in response to dialling the remaining digits by which the connection is completed. The called subscriber is signalled in any well known manner, and upon the removal of his receiver in answer to the call, conversation between him and the calling subscriber at substation A may take place.

At the termination of the call both subscribers will replace their receivers. When the receiver at the substation A is replaced, the circuit of line relay 11 is opened by the separation of springs 3. Line relay 11 deenergizes and opens the circuit of release relay 12 at armature 25, and also opens the circuit of the impulse receiving relay 213 at armature 24. Relay 12 deenergizes and closes a circuit for the release magnet 19 at armature 27 as described previously, and at armature 26 removes ground potential from the conductor 7 thereby opening the holding circuit for the switching relay 17 and the change-over relay 13, which relays then restore their armatures to normal. Release magnet 19 operates as described above and restores the switch wipers to normal.

By the deenergization of the impulse receiving relay 213, the bridge across the conductors 225 and 227 is opened at armature 220. The opening of this bridge causes the release of the selector S and of the succeeding switches in the well known manner.

In this system it is also possible for any subscriber served by the main automatic exchange to establish a connection with any subscriber in the C. A. X. system. For the purpose of describing the operations performed to establish such a connection, it will be assumed that a certain subscriber in the M. A. X. desires to establish a connection with the subscriber at substation A. The directory number of the C. A. X. subscriber in the M. A. X. directory is the same as in the C. A. X. directory with the exception of having one or more additional digits prefixed thereto, the number of digits prefixed depending on the size of the automatic exchange system. To establish the connection, the main automatic exchange subscriber will remove his receiver and dial the directory number of the C. A. X. subscriber at substation A.

In response to the first one or more digits, automatic switches are operated in the well known manner to select a trunk which will be assumed to be the trunk accessible in the bank contacts 285, 286, and 287 extending to the selector S'. In response to the next digit

dialled, the selector S' likewise operates in the well known manner to raise its wipers opposite the proper level of bank contacts in which access is had to the trunks to the C. A. X. in question, and then performs an automatic rotary operation to select an idle trunk in that level. It may be assumed that the trunk extending to the repeater E accessible at bank contacts 275, 276, and 277 is the trunk selected. Upon seizure of this trunk, a bridge is placed across the conductors terminating in bank contacts 275 and 277 in the well understood manner, thereby closing a circuit for the line relay 211 which extends over the talking loop by way of the bank contacts 285 and 287, wipers 272 and 274, bank contacts 275 and 277, upper and lower right-hand windings of repeating coil R', through the upper and lower windings of the line relay 211 to battery and ground, respectively. Relay 211 operates and closes a circuit for the release relay 212 at armature 216, and prepares an impulsing circuit at armature 217. Release relay 212 operates and places ground on the holding conductor connected to bank contacts 276 thereby maintaining the precedingly operated switches operated and guarding this trunk from being seized by another selector at this time. A circuit is also closed for the switching relay 210 at armature 218. Relay 210 operates and connects the trunk conductors 75 and 76 to the upper and lower left-hand windings of the induction coil R' at armatures 214 and 215 and their working contacts. This operation closes a circuit for the line relay in the connector C² similar to the line relay 11 in the connector C. The line relay and the release relay in the connector C² operate and affect circuit changes identical to those affected by the operations of relay 11 and 12 in the connector C as described above.

In response to the next two digits dialled by the calling subscriber which in this case are 1 and 1, the circuit of the line relay 211 is interrupted in the well known manner, thereby causing corresponding current interruptions over the trunk lines 75 and 76 in parallel and causing the connector C² to raise its wipers one step and rotate the wiper into engagement with the first set of bank contacts in this first level. If the party line to substation A comprising conductors 5 and 6 is busy at this time, the busy tone will be transmitted to the calling party in the manner described above. If the party line is idle at this time, as will be assumed, the calling subscriber at the automatic exchange dials the last two digits of the number of substation A which causes the ringing of the bells at the substation A, and the bells of all the other substations on this party line, in accordance with the code to which the subscriber at substation A responds.

When the subscriber at substation A removes his receiver in answer to the call, the two subscribers may engage in conversation. At the termination of the call, both subscribers will replace their receivers. Replacing the receiver at the called substation A performs no circuit changes other than shifting the switch-hook springs back to normal. Replacing the receiver at the calling substation opens the bridge across the talking conductors thereby deenergizing the line relay 211. Line relay 211 releases its armatures and opens the circuit of the line relay in connector C², similar to line relay 11 in connector C, at armature 217. The line relay in connector C² deenergizes, initiating the restoration of the connector C² back to normal in the manner described in connection with the operation of connector C. The circuit of release relay 212 is opened at armature 216, thereby causing the deenergization of relay 212. Ground is then removed from the release conductor connected to bank contact 276 at armature 219, initiating the release of the selector S' and the preceding switches in the well known manner. The circuit of the switching relay 210 is opened at armature 218 causing relay 210 to restore its armatures to normal.

Any subscriber in the C. A. X. such as the subscriber at substation A may also extend a connection to any subscriber in the second C. A. X. In the illustration, a trunk extending to the second C. A. X. is accessible in the tenth set of bank contacts in the second level. To establish a connection with a subscriber in the second C. A. X. the subscriber at substation A will remove his receiver and dial the number 20 which will cause the connector C to move the switch wipers 52, 53, and 54 into engagement with the bank contacts 61, 32, and 63, respectively, after which the subscriber of substation A will dial two more numbers to operate the connector at the second C. A. X. connected to this trunk, which may be similar to connector C, to extend the connection to the desired line in the second C. A. X. If this be a party line the subscriber at substation A will dial the remaining code ringing digits to signal the desired subscriber on that line.

One subscriber on a party line may signal any other subscriber on that same line merely by operating his generator such as the generator M individual to the substation A in accordance with the code assigned to the desired substation. When the called subscriber removes his receiver the two subscribers may engage in conversation directly. No other subscriber can connect with this party line at this time since the line relay of the connector individual to the line operates, closes a circuit for the release relay of that connector, which operates and places

ground potential on the test contact in the connector banks individual to that line.

A small C. A. X., as this is assumed to be, does not warrant the continuous attention of an attendant. It is necessary however that some provision be made to signal a trouble man should trouble occur in the C. A. X. In the present case, a method is devised whereby the attendant in the main automatic exchange is signalled by means of the bells L connected directly across the conductors of one of the regular trunks extending from the C. A. X. to the M. A. X. The manner in which this signal is given will now be described. As an example of a case of trouble, it may be assumed that the connector C, after conversation was completed, failed to restore in response to the replacement of the receiver at the calling substation A. With both line relay 11 and release relay 12 in a deenergized position, and the shaft carrying the switch wipers not in a normal position, the circuit of the release magnet 19 and the supervisory release relay 104 is maintained closed. As a result, ground potential is applied continuously to the trouble conductor 130. This causes the operation of the relay 131. Relay 131 operates and at armature 122 applies ground potential to the midpoint of the left-hand windings of transformer T, thereby making the transformer effective to generate ringing potential in the right-hand winding. This ringing potential is applied to the trunk conductors 75 and 76 at armatures 132 and 133 and the working contacts, respectively, thereby causing the ringing of the bells L. The attendant at the M. A. X., hearing the ringing of the bells L, will take such action as provided for to have a trouble man sent to the C. A. X. and correct the trouble.

As a further result of the operation of relay 131, ground potential is placed on both trunk conductors thereby closing a circuit which may be traced from ground by way of the secondary winding of transformer T and working contact and armature 132 to conductor 75, and by way of working contact and armature 133 to conductor 76, and thence by way of armature 214 and 215 and their resting contacts, upper and lower left-hand windings of repeating coil R², through the winding of relay 213 to battery. Relay 213 operates and causes the operation of relays 230 and 231 as previously described. At armature 234 ground is placed on conductor 226 connected to contact 276 thereby guarding the outgoing trunk from being seized at this time.

The trunk comprising conductors 75 and 76 is unguarded at the C. A. X. at this time, however. Therefore, should a subscriber, in extending a call to the M. A. X., operate the connector of his line to connect with

this outgoing trunk, relay 115 would be operated, as previously shown, and open the circuit of relay 131. The signalling potential would be disconnected from the outgoing trunk while the trunk was in use, but would be reapplied as soon as the trunk became idle. Obviously, if the trunk comprising conductors 75 and 76, is busy at the time trouble occurs, ground potential will be present on the bank contact 65 and relay 115 will be energized, thereby maintaining the circuit for relay 131 open at armature 124, until the trunk comprising conductors 75 and 76 becomes idle, after which relay 131 will be energized to cause the ringing of the bells L.

This completes the description of the operation and the features of the invention. What is considered new and desired to have protected by Letters Patent will be specifically stated in the appended claims.

What is claimed is:

1. In a telephone system, a connector connected to a calling line, ringing equipment comprising a transformer and an interrupter for intermittently connecting one terminal of a source of current to one terminal of the primary winding of said transformer, the other terminal of said source being normally disconnected from the other terminal of said primary winding, means in said connector responsive to the initiation of a call by the calling subscriber for actuating said interrupter, means in said connector responsive to digits dialled by the calling subscriber for extending the connection to a called party line, and means responsive to other digits dialled for connecting said other terminal of said source to said other terminal of said primary winding and for connecting the secondary winding of said transformer to the called line for long or short intervals depending on the digit dialled to signal a desired party on said line.

2. In a telephone system, a connector connected to a calling line, ringing equipment common to said connector and other similar connectors and normally ineffective to produce a ringing current supply, means in said connector responsive to digits dialled by the calling subscriber for causing said connector to connect with a called line, and means responsive to other digits dialled for rendering said ringing equipment effective and for connecting said supply to the called line to signal a called subscriber thereon.

3. In a telephone system, a connector switch for extending calls from a calling to a called line, ringing equipment comprising a transformer having a primary and a secondary winding and an interrupter for intermittently closing a point in the circuit of said primary winding, said circuit being normally open at another point, means for starting the operation of said interrupter

when said connector is operated, and means for closing said other normally open point in the circuit of said primary winding and for connecting said secondary winding to the called line when the subscriber on the called line is to be signalled.

4. In a telephone system, a connector switch connected to a calling line, means for operating said switch to connect to a called line, a test relay for testing said called line and for applying a busy tone to the calling line when the called line is found busy, a ringing relay for applying a ringing current supply to the called line, a circuit for said ringing relay including normally closed contacts on said test relay, and means for energizing said test relay responsive to the removal of the receiver of the called subscriber thereby opening the circuit of said ringing relay.

5. In a telephone system, a connector switch connected to a calling line, means for operating said switch to connect to a called line, a test relay for testing said called line and for applying a busy tone to the calling line when the called line is found busy, a ringing relay for applying a ringing current supply to the called line, a circuit for said ringing relay including normally closed contacts on said test relay, means for energizing said test relay responsive to the removal of the receiver of the called subscriber thereby opening the circuit of said ringing relay, and a locking circuit for said test relay to maintain said test relay operated when said called subscriber replaces the receiver.

6. In a telephone system, a connector for extending connections to called lines, a test relay in said connector for testing called lines, said relay be actuated when a line is found busy, and remaining deactuated when a line is found idle, means for applying a ringing current source to a called line to signal the called subscriber, and means for operating said relay to render said first means inoperative when the called subscriber answers the signal.

7. In a connector switch for extending connections from a calling line to a called line, a relay, means for operating said relay to apply a busy tone to the calling line when said called line is connected with and found busy, means for signalling the called subscriber after a connection is extended to a called line, and means for operating said relay to render said signalling means ineffective when the called subscriber answers the call.

8. In a telephone system, a first exchange, a second exchange, a trunk line extending from said first exchange to said second exchange, automatic switches at each exchange for extending connections between said exchanges, means for applying signalling current to said trunk line respon-

sive to the occurrence of trouble at said first exchange to signal the attendant at said second exchange, and means at said second exchange responsive to the application of said signalling current for causing said trunk line to become busy guarded against being taken for use in a call from said second exchange to said first exchange while said signalling current is being applied to said trunk line.

9. In a telephone system, a first exchange, a second exchange, a trunk line extending from said first exchange to said second exchange, automatic switches at each exchange for extending connections between said exchanges, means for applying signalling current to said trunk line responsive to the occurrence of trouble at said first exchange to signal the attendant at said second exchange, and means for disabling said first means to remove said signalling current operative when said trunk line is taken for use to complete a call from said first exchange to said second exchange.

10. In a telephone system, a first exchange, a second exchange, a trunk line extending from said first exchange to said second exchange, automatic switches at each exchange for extending connections between said exchanges, means for applying signalling current to said trunk line responsive to the occurrence of trouble at said first exchange to signal the attendant at said second exchange, and means responsive to said signalling current for busy guarding said trunk at the said second exchange end while maintaining said trunk line free to be seized at the said first exchange end.

11. In a telephone system, a first exchange, a second exchange, a trunk line extending from said first exchange to said second exchange, automatic switches at each exchange for extending connections between said exchanges, means for applying signalling current to said trunk line responsive to the occurrence of trouble at said first exchange to signal the attendant at said second exchange, means responsive to said signalling current for busy guarding said trunk at the said second exchange end while maintaining said trunk line free to be seized at the said first exchange end, and means for disabling said first means when said trunk line is seized.

12. In a telephone system, a calling line, a first exchange, a called line, a trunk extending to a second exchange terminating thereat in an automatic switch, a connector switch having access to said called line and said trunk, means for operating said conductor switch to connect with either said line or said trunk, said means being controlled at the calling substation over the conductors of said calling line in parallel, means controlled at said calling substation

for operating a signal at the called substation over the conductors of said called line in series when said called line is connected with, and means controlled at said calling substation for operating said automatic switch controlled over the conductors of said trunk line in parallel when said trunk line is connected with.

13. In a telephone system, a connector-repeater having direct access to subscribers' lines and trunk lines, means responsive to impulses for operating said connector-repeater to connect with any subscriber's line or trunk line, and means responsive to other impulses for repeating said other impulses over the conductors of the trunk line in parallel when a trunk line is connected with.

14. In a telephone system, an automatic switch having access to subscribers' lines and trunk lines, means responsive to impulses sent to said switch for operating said switch to connect with either a subscriber's line or a trunk line, means in said switch for signalling the called subscriber when a subscriber's line is connected with, and means for repeating other impulses over the conductors of the trunk line in parallel when a trunk line is connected with.

15. In a telephone system, an automatic switch having access to a subscriber's line and a trunk line, means responsive to impulses sent to said switch for operating said switch to connect with said subscriber's line or said trunk line depending on the number of impulses sent, means in said switch for signalling the subscriber over the conductors of said subscriber's line in series when said subscriber's line is connected with, and means in said switch for repeating other impulses sent to said switch over the conductors of said trunk line in parallel when said trunk line is connected with.

16. In a telephone system, a connector switch for connecting a calling subscriber's line with a called subscriber's line, means in said switch for ringing a called subscriber, talking conductors in said connector switch, and means in said connector switch controlled over said conductors in parallel and responsive to the removal of the receiver at the station on said called line for rendering said first means inoperative.

17. In a telephone system, a switch, a calling and a called line, means controlled over the conductors of the calling line in parallel for operating said switch to connect with said called line, subscriber controlled means in said switch for signalling the called subscriber over the two conductors of said called line in series, and means for disabling said signalling means controlled over the two conductors of said called line in parallel and responsive to the answering of the call by the called subscriber.

18. In a telephone system, a connector

switch for extending a call from a calling to a called line, a signalling machine normally ineffective to generate a difference of potential between its terminals when operated, means for causing the operation of said machine responsive to the call, and means operative when a connection with the called line is completed for rendering said machine effective to generate a difference of potential between its terminals and to connect said terminals to the called line.

19. In a telephone system, an automatic switch for connecting calling and called lines, a signalling machine normally ineffective to generate a difference of potential between its terminals when operated, means under the control of a calling subscriber for operating said switch to connect with a called line, and means under the control of the calling subscriber when said connection is completed for rendering said machine effective to generate a difference of potential between its terminals and connect said terminals to the called line to signal the called subscriber.

20. In a telephone system, a connector switch having access to lines of different character, a control circuit for said switch, means for closing said circuit responsive to the seizure of said switch, means responsive to series of interruptions in said control circuit for operating said switch to connect with a line of either character, means responsive to another series of interruptions for operating a signal on the line when a line of one character is connected with, and means for repeating said other series of interruptions when a line of another character is connected with.

21. In a telephone system, an automatic switch having access to lines of different character, a control circuit for said switch, means for closing said circuit responsive to the seizure of said switch, means for sending series of interruptions in said control circuit to said switch, means responsive to one series of interruptions for operating said switch to connect with a line of either character depending on the number of interruptions in the series, means responsive to another series of interruptions and operative when a line of one character is connected with for applying signalling current to the line, and means responsive to said other series of interruptions and operative when a line of another character is connected with for repeating said interruptions over the connected line.

22. In a telephone system, a trunk line terminating at one exchange, two repeating coils individual to said line, means for establishing an incoming call over the two sides of said trunk line in series via one of said repeating coils only, and means for establishing an outgoing call over the two

sides of said trunk line in series via the other of said repeating coils only.

23. In a telephone system, a line, ringing equipment normally ineffective to produce ringing potential, a connector and means for operating it to extend a connection to said line, and means in said connector operative after the connector has extended the connection to said line for rendering said ringing equipment effective to produce ringing potential, and for connecting said ringing equipment to said line.

24. In a telephone system, a first and a second exchange, an interconnecting trunk line, means for extending connections over said trunk line, means for applying signalling current to said trunk line responsive to the occurrence of trouble at said first exchange to operate a signal at said second exchange, and means for disabling said last means when said trunk line is taken for use to extend a connection from said first exchange to said second exchange.

25. In a telephone system, a first and a second exchange, an interconnecting trunk line, means for extending connections over said trunk line, means for applying signalling current to said trunk line responsive to the occurrence of trouble at said first exchange to operate a signal at said second exchange, and means responsive to said signalling current for marking said trunk line busy at the second exchange while maintaining said trunk line marked idle at the first exchange.

26. In a telephone system, a first and a second exchange, an interconnecting trunk line, means for extending connections over said trunk line, means for applying signalling current to said trunk line responsive to the occurrence of trouble at said first exchange to operate a signal at said second exchange, and means for preventing the trunk line's being taken for use to extend a call from said second exchange to said first exchange while signalling current is applied thereto.

27. In a telephone system, a line, a connector switch and means for operating it to connect with said line to extend a call, means in said switch for signalling over said line, talking conductors in said switch, and a relay in said switch energized over said conductors in parallel responsive to the answering of the call for disabling said signalling means.

28. In a telephone system, a two-way trunk line extending between two exchanges, a first repeating coil normally connected to, and a second repeating coil normally disconnected from said trunk line, and means for disconnecting the first repeating coil from, and for connecting the second repeating coil to, said trunk line whenever a call

is extended over said trunk line in a certain direction.

29. In a telephone system, a trunk line terminating at an exchange, two repeating coils for said trunk line, means for establishing an incoming call over said trunk line via one of said repeating coils only, means for establishing an outgoing call over said

trunk line via the other of said repeating coils only, and means for preventing the establishment of a call in one direction while a call in the other direction is in progress. 10

In witness whereof, I hereunto subscribe my name this 15th day of March, A. D., 1926.

CLARENCE E. LOMAX.