Jan. 7, 1930. J. WICKS 1,742,334

TELEPHONE SYSTEM

Filed March 17, 1927 3 Sheets-Sheet 1

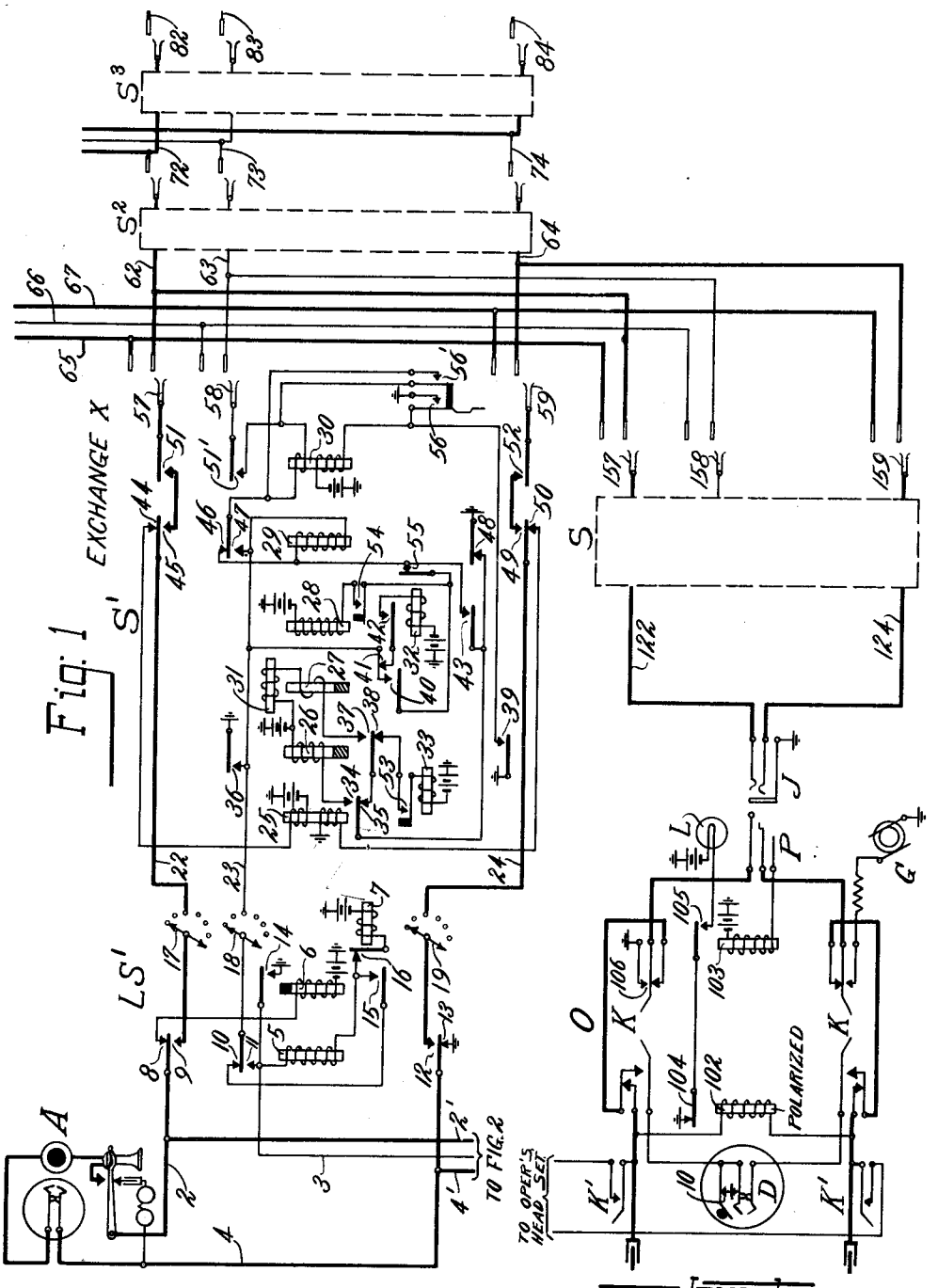


Fig. 1

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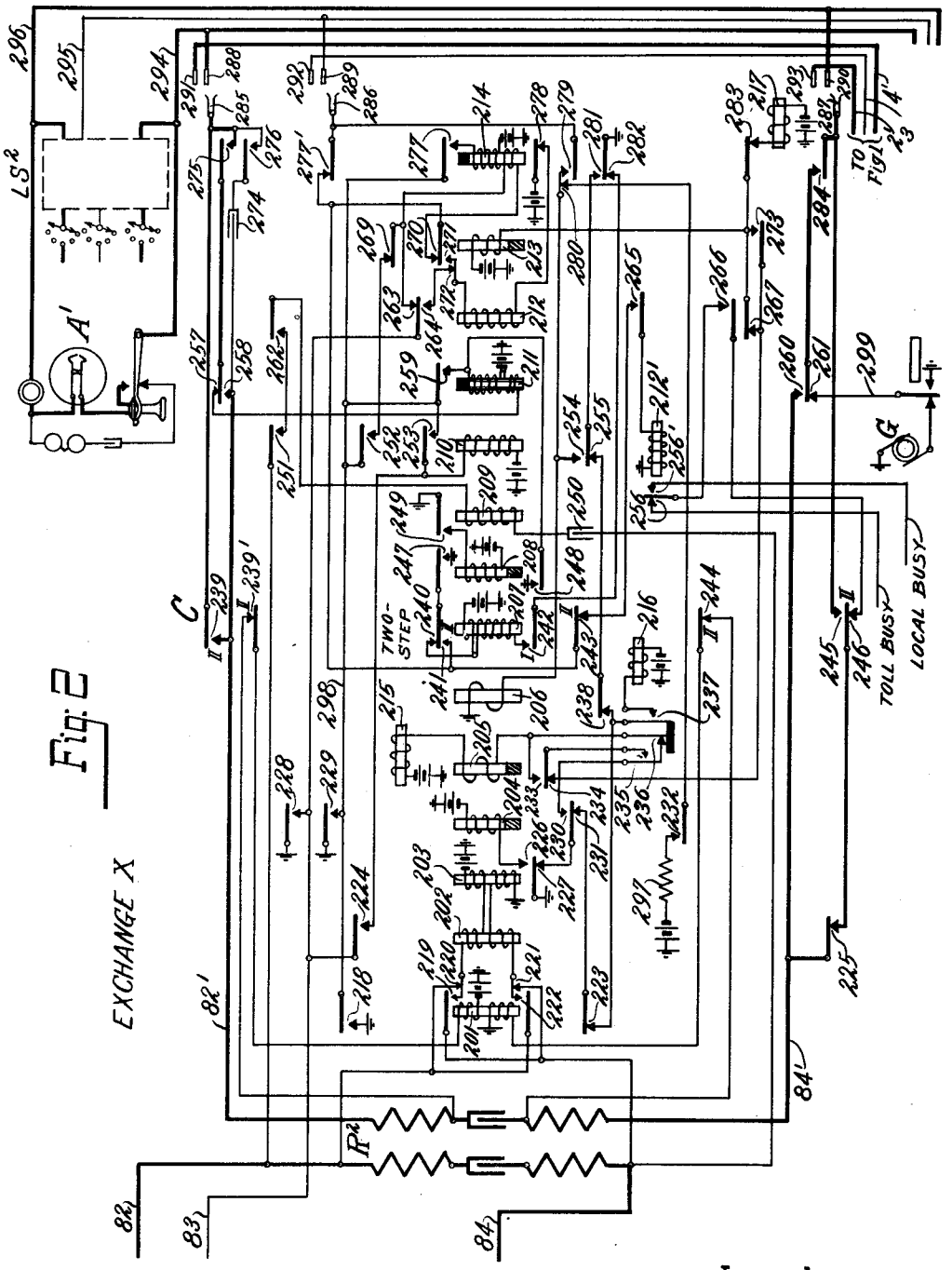


Fig. 2

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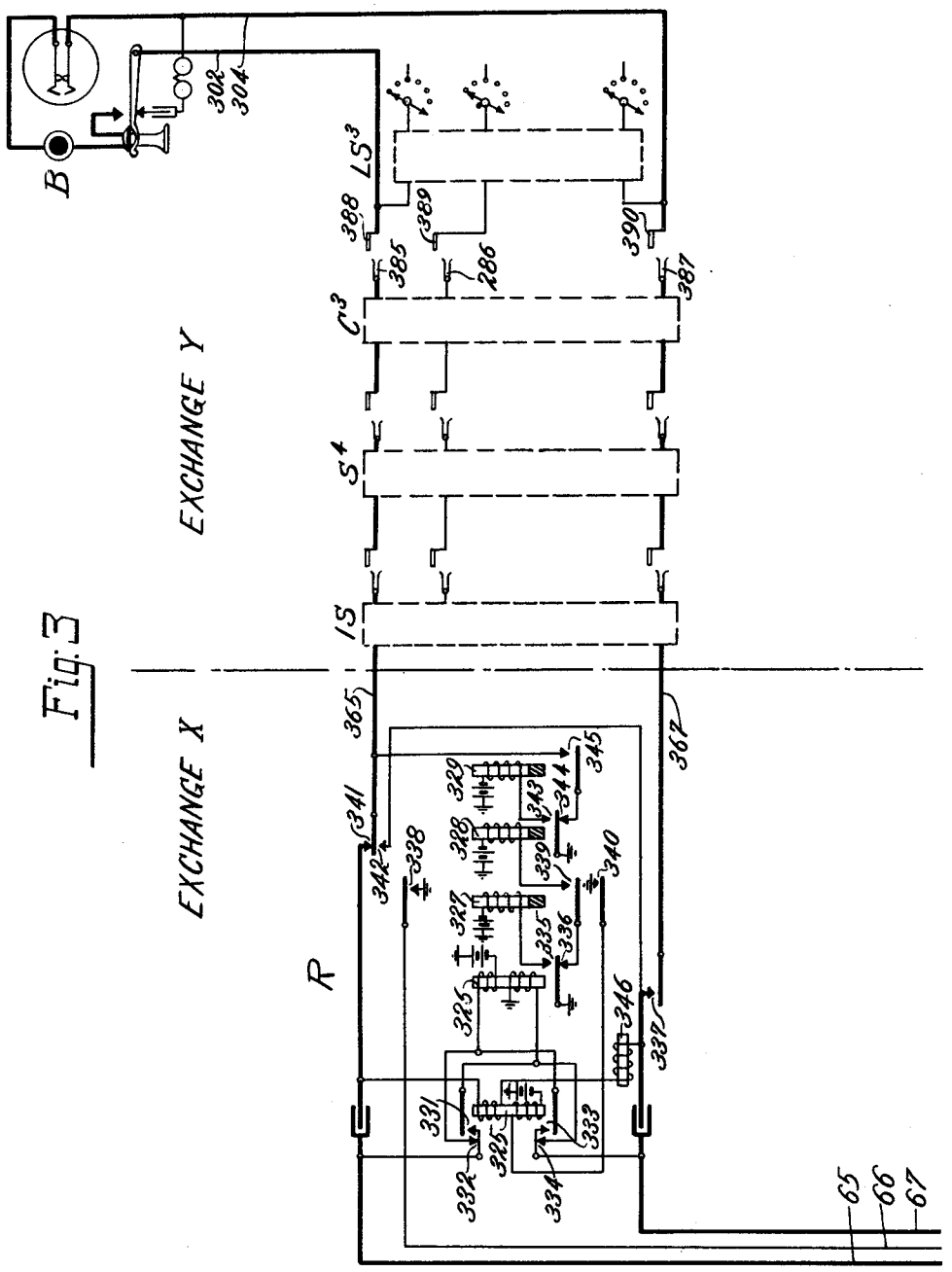


Fig. 3

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UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

Application filed March 17, 1927. Serial No. 175,973.

This invention relates to telephone systems in general, but is more particularly concerned with automatic telephone systems in which both local and toll connections are established by means of automatic switching mechanism controlled by the calling party in a local connection and controlled by the toll operator in a toll connection.

The object of the invention is the provision of new and improved switching mechanism for completing toll and local connections whereby the toll operator in extending a toll connection to a local subscriber, is informed whether the wanted line is busy or idle, and if busy, whether in a local connection or in a toll connection, and whereby, if the wanted local subscriber is busy in a local connection with another subscriber, she may cut in on the conversation and complete the toll connection, and then release the unwanted subscriber from the connection.

Large telephone systems are sometimes divided into different zones, and when giving the kind of service described above, generally known as "preferred service," it may be desirable to class the calls from one zone to another with toll calls. In such a case, calls from one zone to another are not to be interrupted by a toll operator. The new and improved automatic switches have been designed in accordance with this requirement which comprises a particular feature of this invention; that is, the toll operator may complete toll connections to a subscriber even though he may be busy in a connection with another subscriber in the same zone, but not if the wanted subscriber is busy in a toll connection or is busy in a connection with another subscriber in a different zone.

The various features of the invention will be described in detail in the following specification with the aid of the accompanying drawings comprising Figs. 1, 2, and 3, which show by means of the usual schematic circuit diagrams the principal apparatus of a telephone system embodying the principles of the invention.

The drawings to be most easily understood, should be placed with Fig. 2 to the right of Fig. 1, and Fig. 3 above Figs. 1 and 2, with the corresponding lines in alignment. Only two of the exchanges of the telephone system chosen to illustrate the invention have been indicated, namely exchange X and exchange Y, with the main toll board situated in exchange X. It is to be understood, of course, that the size of the system is immaterial.

Referring to Fig. 1 of the drawings, a subscriber's substation A is shown whose line terminates at exchange X in the individual lineswitch LS′ and is accessible to a group of connectors by way of conductors 2′, 3, and 4′. The lineswitch LS′ is of the well known rotary type having no normal position and moving in one direction only, being advanced upon the back stroke of the associated stepping magnet. The lineswitch LS′, together with other similar lineswitches, has access to trunk lines terminating in first selector switches, one of which is shown comprising conductors 22, 23, and 24 terminating in the first selector switch S′.

Mechanically, the selector S′ is of the well known Strowger vertical and rotary type. The circuit arrangement of the selector S′ is similar to that of the selector shown and described in detail in the inventor's Patent No. 1,520,268, with the modification of an additional relay, the function of which is peculiar to this invention and will be described in detail subsequently. The selector S′, together with other similar selectors, has access in certain levels to trunks extending to the other exchanges in the system, the trunk comprising conductors 65, 66, and 67 extending to exchange Y by way of repeater R, Fig. 3, being one of these. In a particular level in the banks of the first selectors, access is had to a group of local second selectors, the trunk line comprising conductors 62, 63, and 64 terminating in the second selector S^2 being one of these.

Mechanically and also in circuit arrangement, the selector S^2 may be identical to the selector shown and described in the above mentioned reference. It is therfore indicated only by a dotted rectangle. In the banks of the second selectors, access is had to the various groups of third selectors, a partic-

ular group of third selectors being accessible in each level.

The dotted rectangle labeled S^3 indicates one of the third selectors of a particular group. It may also be identical to the selector shown and described in the above mentioned reference. In the banks of each group of third selectors, access is had to a number of groups of connectors, a particular group being accessible in each level.

In Fig. 2 a connector is shown which is one of the group of connectors accessible in a particular level in the banks of the group of local third selectors containing selector S^3. Mechanically the connector C is like that of the well known Strowger vertical and rotary type. The circuits of the connector C, however, have been designed in accordance with the particular requirements of this invention, and will be described in detail hereinafter. In the banks of the connector C access is had to a group of subscribers' lines, the line of substation A', as well as the line of substation A, being one of this group. The individual lineswitch LS^2 of the substation A' may be identical to the lineswitch LS' shown in Fig. 1, and has therefore been indicated only by a rectangle.

It is assumed in this particular system that the main toll board is located in exchange X. In the lower left-hand corner of Fig. 1, the calling end of an operator's cord is shown. The key K' is the listening key for connecting the operator's headset (not shown) with the cord, and the key K is a combination dial and ringing key. The operator's calling device C is equipped with special off-normal springs which are closed when the dial is in a normal position and which are opened when the dial is moved off-normal.

A plurality of trunks terminating in jacks, such as the trunk comprising conductors 122 and 124 terminating in the jack J, are provided at the operator's position. Each of these trunks extend to a toll selector switch such as the toll selector S. The toll selector S may be identical to the selector shown and described in the above mentioned reference. The banks of these toll selectors are multiply connected with the banks of the first selectors, such as selector S', so that the toll selectors and the regular first selectors have common access to the regular second selectors and also to the trunk extending to the other exchanges in the system.

In Fig. 3, the repeater R of the trunk line comprising conductors 365 and 367 extending to the exchange Y and accessible in the banks of the first selector by way of conductors 65, 66, and 67, is shown. The circuit arrangement of the repeater R is generally like that known in the prior art, except that it is equipped to perform an additional function peculiar to this invention which will be described in detail later.

At the exchange Y the trunk comprising conductors 365, and 367, terminates in an incoming second selector IS. In the banks of the selector IS in common with the local second selectors of that exchange access is had to a number of groups of third selectors, the third selector S^4 being one of a particular group. The incoming selector IS, as well as the third selector S^4, may also be like the selector shown and described in the above referred to reference. In the banks of each group of third selectors, access is had to a number of groups of connectors, the connector C^3 being one of a particular group. The connector C^3 is like the connector C shown in Fig. 2 in every detail. In the banks of the connector C^3 access is had to a group of subscribers' lines, the line of substation B being one of these. The lineswitch LS^3 of the line to substation B may be like the lineswitch LS' shown in Fig. 1.

It should also be mentioned that trunks extend to the exchange X from the other exchanges of the system, including exchange Y, and terminate at exchange X in incoming second selectors whose banks are multiply connected with the banks of the local second selectors, such as selector S^2. For the sake of simplicity, however, such trunks have not been shown.

With this general description of the object of the invention and the apparatus embodying the principles of the invention in mind, a further understanding and appreciation of the invention may be gained from a more detailed description of the invention to follow. According to this invention, when one subscriber completes a call to another subscriber in the same zone, that is, in the same exchange, both the line of the calling subscriber and the line of the called subscriber are marked "Locally busy." This consists in the connection of ground potential through the winding of a relay in the first selector to the test contact of the calling line, and in the connection of ground potential through the winding of a relay in the connector to the test contact of the called line. If, however, a line is connected with by the toll operator, the line is marked "Toll busy." In this case direct ground potential is connected to the test contact of that line. It is further assumed that zone to zone connections are to be classed as toll connections as far as the "preferred service" is concerned. Thus when one subscriber in one zone completes a call to another subscriber in a different zone, that is, in another exchange, the line of the calling subscriber and line of the called subscriber are also marked "Toll busy." For the purpose of describing how a subscriber's line is marked busy differently depending on the type of connection in which he is engaged, it will first be assumed that the subscriber at substation A wishes to establish a connection with the subscriber at substa-

tion A′, which is served by the same automatic exchange, and the detailed operations performed in the establishment of this connection will be described.

To establish this connection, the subscriber at substation A first removes his receiver, and then dials the directory number of the subscriber at substation A′. Removing the receiver at substation A places a bridge across the line conductors 2 and 4, thereby closing a circuit for the line relay 6 of the line-switch LS′. Line relay 6 operates and places ground potential on the private normal conductor 3 at contacts 14 and at the same time prepares an energizing circuit for switching relay 5. (Direct ground potential on the private normal conductor 3 is present thereon only until the subscriber dials the first digit, as will become apparent presently.) At contacts 15, the line relay closes a stepping circuit for magnet 7, providing the trunk upon which the switch wipers are positioned at this time is busy, in which case ground potential will be present on the contact engaged by test wiper 18. Assuming this trunk and also one or more adjacent trunks are busy, stepping magnet 7 operates in a buzzer-like manner to advance the switch wipers 17 to 19, inclusive, in search of an idle trunk. During this operation switching relay 5 is prevented from operating by reason of the ground potential on both ends of its winding.

When an idle trunk is reached, which will be assumed to be the trunk comprising conductors 22 to 24, inclusive, its idle condition being indicated by the absence of ground potential on the contact engaged by test wiper 18, stepping magnet 7 ceases to operate, and relay 5, being no longer short circuited, energizes in series with magnet 7. In operating, relay 5 prepares a holding circuit for itself at the contacts 11 and also for marking the calling line busy, disconnects the line conductors from the line relay 6 and ground at contacts 8 and 13, and extends the connection at contacts 9 and 12 by way of wipers 17 and 19, trunk conductors 22 and 24, contacts 44 and 50, through the upper and lower windings of line relay 25 to battery and ground, respectively. Line relay 25 operates and closes a circuit for release relay 26 at contacts 34. Release relay operates and grounds release conductor 23 at contacts 36, prepares a circuit for operating the vertical magnet 31 at contacts 37, and closes a circuit for the lower winding of the preferred service relay 30 at contacts 39. Relay 30 operates and closes points in the talking circuit at contacts 51 and contacts 52, and closes a normally open point in the holding circuit to be described later at contacts 51′.

The foregoing operations have all taken place responsive to the removal of the receiver at the calling substation. After removing his receiver, the calling subscriber at substation A dials the directory number of the called subscriber. Responsive to the dialing of the first digit, line relay 25 deenergizes and reenergizes a corresponding number of times, and at each deenergization closes a circuit for the vertical magnet 31 in series with series relay 27. Magnet 31 operates and steps the switch wipers 57 to 59 opposite the corresponding level of bank contacts. Relay 27 operates and closes contacts 42, and after the switch wipers have been raised from their normal position, off-normal springs 54 are closed, whereupon a circuit for stepping relay 28 is established. Relay 28 energizes and prepares a circuit for the rotary magnet 32 at contacts 42, and closes a locking circuit for itself at contacts 43, this circuit including contacts 55 and 48.

At the cessation of the impulses of the first digit, series relay 27 deenergizes and permits contacts 41 to close. This closes a circuit for the rotary magnet 32, causing this magnet to operate and rotate the switch wipers into engagement with the first set of bank contacts in the selected level. Near the end of its stroke, rotary magnet 32 opens the holding circuit of relay 28 at contacts 55. Relay 28 thereupon deenergizes and opens the circuit of the rotary magnet at contacts 42 and furthermore opens another point in its locking circuit at contacts 43.

If the trunk line terminating in the first set of bank contacts is busy, ground potential will be present on the test contact engaged by wiper 58, and another circuit will be established for stepping relay 28 from ground on this bank contact over a circuit including wiper 58, contacts 51′, through the upper winding of relay 30, contacts 46, contacts 55, springs 54, through the winding of relay 28 to battery. Again relay 28 energizes and closes the circuit of the rotary magnet 32 at contacts 42. Magnet 32 again operates and rotates the switch wipers into engagement with the next set of bank contacts. This operation of the rotary magnet 32 and the stepping relay 28 continues until the wipers have been positioned on a set of contacts terminating an idle trunk line, the idle condition thereof being indicated by the absence of ground potential on the contact engaged by wiper 58.

It may be assumed that the first idle trunk accessible in this level at this time is the one comprising conductors 62, 63, and 64. When the switch wipers are rotated into engagement with the set of bank contacts terminating this trunk, an energizing circuit for switching relay 29 becomes effective which extends from ground by way of contacts 36 through the winding of relay 29, contacts 55, springs 54, through the winding of relay 28 to battery. Relay 28 is insufficiently energized over this circuit to cause its operation. Relay 29 operates, however, and at contacts

47 connects release conductor 63 via the upper winding of relay 30 to release conductor 23, and extends the connection by way of contacts 45 and 49, contacts 51 and 52, wipers 57 and 59, conductors 62 and 64 through the windings of the line relay of the selector S^2. The line relay of the selector S^2 energizes in the usual manner and causes the release relay of this selector to energize and connect ground potential to the release conductor 63 and prepare the selector S^2 for operation.

Relay 29 in operating also opens the circuit of line relay 25 at contacts 44 and 50. Line relay 25 thereupon deenergizes and opens the circuit of release relay 26. The release relay thereupon deenergizes and removes direct ground potential from the release conductor 23 at contacts 36, and opens the circuit of the lower winding of relay 30 at contact 39. Relay 30, however, does not deenergize, since it is now energized over its upper winding in series with relays 29 and 28, and with relay 5 of the line-switch LS'. Thus the line at substation A is now marked "Locally busy"; that is, ground potential is supplied to the normal conductor 3 by way of ground connected to release conductor 63 through the upper winding of relay 30. It should be mentioned that the upper winding of relay 30 must be of comparatively low resistance, so that the lineswitch magnets operate in series therewith when testing for idle trunks.

Responsive to the dialing of the second digit of the called number, selector S^2 operates to step its wipers opposite the corresponding level of bank contacts, and then rotates its wipers into engagement with the first set of contacts terminating an idle trunk and extends the connection thereto.

It will be assumed that the trunk selected is the one comprising conductors 72, 73, and 74 terminating in the third selector S^3. Responsive to the dialing of the third digit of the called number, selector S^3 operates to step its wipers opposite the corresponding level of bank contacts, and then rotates them into engagement with the first set of contacts terminating an idle trunk and extends the connection thereto.

It will be assumed that the trunk selected is the one comprising conductors 82 to 84, inclusive, terminating in the connector C, Fig. 2. When the connection is extended to the connector C, a circuit is closed for line relay 203 which includes the upper and lower windings of the differential relay 202. As indicated by its name, relay 202 is differentially wound and does not operate at this time. Line relay 203 energizes and closes a circuit for release relay 204 at contacts 226. Relay 204 energizes and places ground potential on the release conductor 83 at contacts 228, places ground potential on the holding conductor 298 in contacts 229, prepares the impulsing circuit at contacts 230 at the same time opening a point in the regular release circuit of magnet 216, and at contacts 232 closes a circuit for the preferred release relay 206. This latter circuit extends from battery through resistance 297, contacts 232, contacts 280, through the winding of relay 206 to ground. Relay 206 operates and opens a point in the preferred release circuit of magnet 216 at contacts 238.

The connector C is now in position to be operated responsive to the dialing of the fourth and fifth digits of the called number. Responsive to the dialing of the fourth digit, line relay 203 deenergizes and reenergizes a corresponding number of times, and at each deenergization closes the circuit of vertical magnet 215 in series with the series relay 205. Magnet 215 operates and steps the switch wipers opposite the level of bank contacts corresponding to the digit dialed. The slow-to-release series relay 205 operates in series with magnet 215 and maintains its armature attracted throughout the vertical movement. It should be noted that the circuit of the first impulse to vertical magnet 215 includes normally closed springs 236, while the circuit for the remaining impulses includes springs 235 and the contacts 233 of series relay 205, the off-normal springs being shifted upon the first vertical step of the switch wipers. At the termination of the vertical movement, series relay 205 deenergizes and transfers the impulsing circuit to the rotary magnet 217 at contacts 234.

In response to the dialing of the last digit of the called number, the line relay 203 is again deenergized and reenergized a corresponding number of times. At each retraction of the armature, a circuit is closed for the rotary magnet 217 which extends from ground by way of contacts 227, contact 230, off normal springs 235, contacts 234, contacts 267, contacts 283, through the winding of rotary magnet 217 to battery. A multiple circuit also extends through the winding of multiple relay 213 to battery. Relay 213 energizes and places a shunt around contacts 267 at contacts 273, and prepares the testing circuit for busy test relay 212 at contacts 271. The rotary magnet 217 operates and rotates the switch wipers 285, 286, and 287 into engagement with the bank contacts associated with the called line, these being contacts 288, 289, and 290. The multiple relay 213, being slow-acting maintains its armature attracted throughout the rotary movement.

The further operation of the connector C now depends upon whether the line to substation A' is busy or idle. It will first be assumed that the line is busy at this time, and since the attempted connection has been initiated by a local subscriber in the same zone, it is immaterial so far as the establish-

ment of the present connection is concerned whether the line is busy in another local connection or in a toll connection, there being ground potential present on the test contact 289 in one case, and ground through the winding of a relay in the other case, as will be described later. In either case, a circuit will be closed over the test contact 289, wiper 286, contacts 277′, contacts 271, through the winding of test relay 212, contacts 278 to battery. Test relay 212 operates and prepares a locking circuit for itself at contacts 264 which is closed when relay 213 falls back and permits contacts 272 to close, relay 213 falling back shortly after the cessation of impulses. Test relay 212 also closes a circuit for the discriminating test relay 212′ at contacts 265, closes a point in the busy tone circuit at contact 266, and opens a point in the impulsing circuit at contacts 267. If the called line is busy in a toll connection relay 212′ is not operated, but if the called line is busy in a local connection, relay 212′ operates in parallel with a relay of the connector used in the other connection corresponding to reay 206, as will be described later. If relay 212′ is operated the local busy tone conductor from the local busy tone machine (not shown) is connected by way of contacts 256′, contacts 266, contacts 246, and contacts 225 to the lower talking conductor 84′; if relay 212′ is not operated the toll busy tone conductor from the toll busy tone machine is connected by way of contacts 256, contacts 266, contacts 246, and contacts 225 to the lower talking conductor 84′. Thus the subscriber at substation A will hear either the "toll busy" tone or the "local busy" tone, which will indicate to him that the desired connection cannot be completed at this time. It is obviously unnecessary that the regular subscriber know the distinction between the two kinds of busy tones. Upon being informed of the inaccessibility of the called line, the subscriber at substation A will replace his receiver. This operation initiates the release of the operated switches as will be described later.

Returning to the point in the operation of the connection C where further operation thereof depended upon the busy or idle condition of the called line, it will now be assumed that the line to substation A′ is idle. In this case no circuit is closed for relay 212, and, after the retraction of the armature of relay 213, a circuit is completed for the switching relay 214 which may be traced from ground by way of contacts 228, contacts 263, through the lower winding of relay 214, contacts 270, contacts 277′, wiper 286, bank contact 289, conductor 295 to battery through the winding of the bridge cut-off relay (not shown) of the lineswitch LS^2. The bridge cut-off relay in the lineswitch LS^2 operates in the usual manner to disconnect the normal ground and battery connections from the called line. Switching relay 214 energizes and at contacts 277 closes a locking circuit for itself to the grounded conductor 298, and at contacts 279 the original circuit over which relay 206 was energized is opened, and this relay is connected to the test wiper 286, and is now energized from battery furnished through the winding of the cut-off relay of the lineswitch LS^2. It should be noted at this point that ground potential is now connected to the test contact 289 of the called line through the winding of relay 206. The called line is thereby marked "Locally busy". It is now inaccessible to other local subscribers, but may still be connected with by a toll operator, as will be described subsequently. Further results of the operation of relay 214 are as follows: At contacts 278 the battery connection to the lower terminal of the winding of the relay 212 is disconnected. The circuit over which relay 214 was originally operated is opened at contacts 277′. The rotary magnet 217 is disconnected from the impulsing circuit at contacts 283. At contacts 276 the usual ring-back tone circuit is closed through condenser 274. At contacts 275 and 284 points in the talking circuit and the signalling circuit for signalling the called subscriber are closed, the signalling circuit extending from conductor 299 to which the grounded generator G and direct ground are intermittently connected, contacts 261, contacts 284, wiper 287, bank contact 290, conductor 296 through ringer at substation A′, conductor 294, bank contact 288, wiper 285, contacts 275, through the lower winding of ring cut-off relay 211 to battery. The ringer at substation A′ is now operated until the subscriber thereat answers the call, or until the call is abandoned by the calling subscriber.

When the called subscriber at substation A′ removes his receiver to answer the call, the ringer thereat is disconnected and a direct current bridge is placed across the line conductors 296 and 294, thereby completing a direct current circuit for the lower winding of relay 211. Relay 211 energizes and closes a locking circuit for itself at contacts 259 to the grounded conductor 298, and by opening contacts 261 and contacts 257 opens the irnging circuit, and by closing contacts 258 and contacts 260 completes the talking connection. After relay 211 operates a circuit is also closed for the back-bridge relay 201, which circuit includes contacts 239′ and contacts 244, and the upper and lower right-hand windings of repeater R^2. Relay 201 operates and in the usual manner reverses the current over the calling line and also connects ground to holding conductor 298 at contacts 218 and opens a point in the regular release circuit at contacts 223 (so that the release of the connector is controlled by the last party to replace his receiver). The reversal of the cur-

rent over the calling line has no utility in this type of connection in the particular system as shown, but might be used to operate the calling subscriber's meter if one were supplied.

The calling and called subscribers may now hold conversation. At the termination of the conversation the subscribers will replace their receivers on their respective switch hooks. Replacing the receiver at substation A′ opens the bridge across the line conductors 296 and 294 thereby opening the circuit of the back-bridge relay 201. Relay 201 deenergizes and removes one ground connection from conductor 298 at contacts 218, closes a point in the regular release circuit at contacts 223, and by opening contacts 219 and 222, and permitting contacts 220 and 221 to close, reverses the current on the calling line back to normal.

Replacing the receiver at the calling substation opens the bridge across the calling line, thereby opening the circuit of line relay 203. Line relay 203 deenergizes and opens the circuit of release relay 204 at contacts 226. The relay 204 deenergizes and disconnects ground potential from the release conductor 83 at contacts 228, disconnects ground potential from the holding conductor 298 at contacts 229, and at contacts 231 closes the regular release circuit of release magnet 216 which extends from ground by way of contacts 227, contacts 231, contacts 223, off normal springs 237, through the winding of release magnet 216 to battery. Release magnet 216 operates and restores the switch wipers to normal. The removal of ground from the holding conductor 298 opens the holding circuit for relay 211 and relay 214 whereupon these relays restore their armatures to normal.

The removal of ground from the release conductor 83 also removes ground from the release conductors 73 and 63 serially connected to conductor 83 and removes ground through the upper winding of relay 30 from the release conductor 23 and from the private normal conductor 3. As a result the holding circuit of the switching relays in the selectors S^2 and S^3, the switching relay 29, and preferred service relay 30 in the selector S^1, and the circuit of relay 5 in the lineswitch LS′ is opened. The selectors S^1, and S^2, and S′ are then restored to normal in the usual manner, and the lineswitch LS′ is at normal with its wipers remaining on the contacts last used.

In the above explanation it has been shown how the connector C operates to establish a local connection to a subscriber and place ground potential through the winding of relay 206 on the test contact of the called line, thus marking the line to substation A′ "Locally busy". It will now be shown how the connector C may be used by the toll operator to establish a toll connection to a called subscriber, and by reason of the connection being a toll connection, how the connector C operates to mark the called line "Toll busy" by placing direct ground potential on the test contact of the called line. For this purpose it will be assumed that the toll operator has answered an incoming toll call which she has been informed is for the subscriber at substation A′.

To complete the call, the toll operator inserts the calling plug of the cord used to answer the incoming call, for example, the plug P of the cord O, into the jack of an idle trunk such as the jack J, and then throws the key K to the left to the dialing position and dials the number of the wanted subscriber. Inserting the plug P into the jack J closes a circuit for sleeve relay 103, and also places a bridge across the conductors 122 and 124, this bridge including the polarized relay 102. Relay 103 energizes and closes the circuit of lamp L at contacts 105. Placing the bridge across the conductors 122 and 124 closes a circuit for the line relay of the selector S which operates to prepare the selector S for operation in the usual manner. The current in the winding of the polarized relay 102 at this time is in such a direction as not to caues the operation of relay 102.

Throwing the key K to the dialing position substitutes the dial D for the polarized relay 102. Due to the off normal contacts 10, ground potential is connected at the mid-point of the bridge across the conductors 122 and 124 which short circuits one winding of the line relay of the selector S, but this has no particular effect at this time.

Responsive to the dialing of the first digit of the called number, the selector S operates to raise its wipers opposite the corresponding level of bank contacts and then rotates its wipers in search of an idle trunk in that level. When the dial D is moved off normal the short circuit of this winding is opened, again permitting the line relay of the selector S to operate over both its windings. It will again be assumed that the trunk comprising conductors 62 to 64, being accessible to both selector S′ and the selector S in the same level, is the one selected, and it will further be assumed that the connection is extended responsive to the dialing of the second and the third digits of the called number by way of the selectors S^2 and S^3 to the conductor C, Fig. 2.

When the connection is extended to the connector C, a circuit is again closed for line relay 203, but in this case since ground potential is present at the mid-point of the bridge across the talking conductors at contacts 10 of the dial D, both the lower winding of the differential relay 202 and the lower winding of the line relay 203 are short-circuited, and for this reason differential relay 202 is operatively energized. Line relay 203 operates as before and closes the circuit of release relay 204 at contacts 226. Release relay 204 ener-

gizes again and places ground potential on the release conductor 83 at contacts 228, places ground potential on the holding conductor 298 at contacts 229, prepares the impulsing circuit at contacts 230, and closes the circuit of preferred-release relay 206 at contacts 232. As a result of the operation of relay 202, a circuit is closed for the change-over relay 210 at contacts 224. Relay 210 operates and closes a locking circuit for itself at contacts 253 to the grounded conductor 298 and prepares other circuits to be described later.

Responsive to the dialing of the fourth digit of the called number, the vertical magnet 215 of the connector operates to position the wipers opposite the level of bank contacts corresponding to the digit dialed in a manner identical to that described in the previous connection. Likewise, responsive to the dialing of the last digit of the called number, the rotary magnet 217 is operated to rotate the switch wipers into engagement with the contacts 288, 289, and 290 associated with the line to substation A', relay 213 being operated in multiple with the rotary magnet 217.

At this point, further operation of the connector C again depends upon the busy or idle condition of the called line, and in this case also upon whether the line, if busy, is engaged in a local connection or in a toll connection. In order to show how the connector operates under the more normal condition and completes the connection to a called subscriber and then marks the called line toll busy, it will be first assumed that the line to substation A is idle at this time. In this case, as in the previous case when the called line was idle, no circuit is closed for relay 212, and upon relay 213 falling back shortly after the cessation of the last series of impulses, relay 214 operates over a circuit as traced in the previous connection. Relay 214, in operating, performs the same circuit changes as it did when used in establishing a local connection, and, in addition thereto, since relay 210 is now operated, places direct ground potential on the test contact 289 by way of contacts 281, contacts 254, contacts 279, and test wiper 286. This also causes relay 206 to be short circuited, whereupon this relay falls back. Relay 206 has no function in this type of connection. The other operations concerning the establishment of the connection and the release of the connection are the same as those described in the previous connection.

It should be noted now that the connector C, when taken into use by the toll operator for establishing a toll connection, places direct ground potential on the test contact of the called line instead of ground through the winding of relay 206 as in the case when used in a local connection. This substitution is performed by relay 210 the operation of which is controlled by the differential relay 202 which in turn is operated when ground potential is applied to one of the line conductors by contacts on the operator's dial in order to short circuit the lower winding of relay 202.

According to one of the main objects of this invention the operator in attempting to establish a toll connection is able to complete the connection even though the wanted subscriber is busy, providing he is busy in a local connection, but not if he is busy in a toll connection. To describe further operations of the connector when used by a toll operator in attempting to set up a toll connection it will now be assumed that the called line A' is busy in a local connection at the time that the connector C is rotated into engagement with the bank contacts 288, 289, and 290 of the line of substation A', and first let it be assumed that the local connection was extended to the substation A' rather than initiated from the substation A. Assuming, then, that a toll connection has been extended to the connector C, and that the connector C has been operated to the point where its further operation depends on whether the called line is busy or idle, test relay 212 is again operated over the test wiper 286 and performs the circuit changes previously described. Likewise, relay 212' operates, its circuit extending over wiper 286 in multiple with the relay of the connector used in the local connection corresponding to relay 206 of connector C. As a result of the operation of both relay 212' and relay 212, the local busy tone conductor connected to the local busy tone machine (not shown) is connected to the lower trunk conductor 84' of the connector C. The operator then hears the local busy tone which informs her that the wanted subscriber is engaged in a local connection.

Having been so informed, the operator throws the key K to the ringing position for a moment, which operation causes alternating current from the generator G' to be projected out on the line conductors.

This causes the operation of the alternating-current relay 209 in connector C, the circuit thereof including contacts 251 (relay 210 being operated) and contacts 262 (relay 212 being operated). Relay 209, in operating, closes a circuit for the control relay 208. Relay 208 operates and at its contacts 248 closes a circuit for the upper winding of the ring cut-off relay 211 and closes an initial energizing circuit for the two-step relay 207 at contacts 247. The ring cut-off relay 212 energizes and closes a locking circuit for itself at contacts 259 and completes points in the talking circuit at contacts 258 and contacts 260, at the same time opening the ordinary ringing circuit at contacts 257 and contacts 261. The two-step relay 207 operates to its first step and closes contacts 242, operating no further at this time because its lower winding is now short circuited.

After a moment, the key K is restored and the generator G′ is disconnected from the line conductors. Relay 209 deenergizes and releases its armatures and again opens the circuit of relay 208. Relay 208 deenergizes shortly, and in separating contacts 247 removes the short-circuit from the lower winding of relay 207. Relay 207 thereupon energizes to its second step and establishes an auxiliary talking circuit by closing contacts 239 and contacts 245, disconnects the back-bridge relay 201 from the line conductors at contacts 239′ and contacts 244, and disconnects relay 212′ from the test wiper at contacts 243. The operator is now able to listen to the ensuing conversation and will inform the wanted subscriber that there is an awaiting toll call for him and will also inform the unwanted subscribed that he will be disconnected from the connection.

The operator then throws the key K momentarily to the ringing position a second time. It should be noted at this point that the ground connected to the upper talking conductor at contacts 106 of the key K in addition to furnishing a return circuit for the alternating current from generator G′, completes a holding circuit for the upper winding of relay 203 to hold the connection and also causes the current in the windings of the differential relay 202 to be unbalanced which causes relay 202 to operate. Relay 202, in operating this time, opens the auxiliary talking circuit at contacts 225 thereby preventing the second application of alternating current from passing out on the called line and causing a disagreeable noise in the receiver at the called station which the called subscriber is holding to his ear. The second application of alternating current again causes the operation of the alternating current relay 209 in the connector C, which again closes the circuit of relay 208 at contacts 249. Again relay 208 operates and now, since contacts 240 are open and contacts 241 are closed, places ground potential by way of contacts 277′ and wiper 286 on the test contact 289 multiply connected with the corresponding test contact in the banks of the connector used in the local connection.

It will be recalled that in a local connection the relay corresponding to relay 206 is energized over the test wiper. Thus when this ground potential is placed on the test contact 289 connected with the test contact in the bank of other connectors used, this relay in the other connector is deenergized. As a result the preferred release circuit is closed for the release magnet in the other connector which includes contacts in the other connector corresponding to contacts 281, contacts 255 (the relay in the other connector corresponding to relay 210 not being operated), contacts 238 (the relay in the other connector corresponding to relay 206 having just been deenergized) springs 237, through the winding of the release magnet of the other connector to battery. As a result the release magnet of the connector is operated, which restores the switch wipers to normal. Thus the unwanted subscriber is disconnected from the subscriber who is wanted in the present toll connection.

Finding himself disconnected, the unwanted subscriber will then replace his receiver, if he did not when informed of the incoming toll connection for the other subscriber. As a result, the other switches associated with the local connection are released. Had the unwanted subscriber replaced his receiver as soon as the toll operator informed the two parties of the waiting toll call, all but the connector used in the local connection would have been released at that time. In either case, the connector used in the local connection is released as just described.

After restoring the key K the second time, the alternating current relay 209 in the connector C again deenergizes, which in turn causes relay 208 to deenergize. Relay 208, in deenergizing, removes ground potential from the test contact 289 which enables the relay 214 to operate over a circuit extending from grounded conductor 298, contacts 252, contacts 269, through the lower winding of relay 214, contacts 270, contacts 277′, wiper 286, bank contact 289, conductor 295, through the winding of the bridge cut-off relay of the lineswitch LS^2 to battery. Relay 214 then operates performing the circuit changes as previously described, ground potential again being applied to wiper 286 by way of contacts 281, contacts 254, and contacts 279. The circuit of the two-step relay 207 is also opened by the separation of contacts 282, as a result of which this relay deenergizes and again connects back-bridge relay 201 to the talking conductors. Since both relays 214 and 211 are now operated, a circuit is now closed for the back-bridge relay 201 which includes the bridge at the called substation A′. This relay operates and as before applies ground to conductor 298, opens a point in the regular release circuit, and reverses the direction of current over the calling line. This causes relay 102 in the operator's cord circuit O to operate and open the circuit of the lamp L. Ordinarily, the extinguishment of the lamp L indicates to the toll operator that the called party has answered, but in this case of course the called subscriber was already at the phone before the connection was completed.

The calling party at the distant station may now hold conversation with the called party at substation A′. At the termination of the conversation, both the subscribers replace their receivers. Replacing the receiver at substation A′ opens the circuit of back-

bridge relay 201. This relay, in deenergizing, again reverses the direction of current over the line conductors back to normal, which causes the polarized relay 102 in the toll operator's cord to release its armature. By the closure of springs 104, the circuit of lamp L is again established. The lighting of the lamp L at this time indicates to the toll operator that the party at substation A' has replaced his receiver.

The toll operator will then remove the plug P from the jack J thereby opening the circuit of sleeve relay 103 and the bridge across the trunk conductors 122 and 124. Relay 103 deenergizes. Opening the bridge across the trunk conductors 122 and 124 initiates the release of the existing connection including selectors S, S^2, S^3, and connector C in the manner previously described, the locking circuit of relay 210 being opened when ground is removed from the holding conductor 298.

In the above case, had the subscriber at substation A' been engaged in a toll connection (or in a connection classed with a toll connection to be described later) when the connector C was operated into engagement with bank contacts associated with the line of substation A', relay 212 would have operated, this time from direct ground on the test contact 289, but relay 212' would not have operated. As a result the toll operator would have received the toll busy tone, instead of the local busy tone, which would have indicated to her that she could not establish the toll connection at this time. The operator may, of course, establish a talking connection with a subscriber whose line is marked Toll busy and hear the conversation by momentarily operating the key K once to the cut-in position, as previously described, but she cannot force the release of an existing connection marked Toll busy. It should be noted that even though the toll operator should inadvertently attempt to release an existing toll connection, or a connection classed as a toll connection, by the expediency of two separate operations of the key K to the cut-in position, the other connection would not be released for the obvious reason that the relay of the connector used in the existing connection corresponding to relay 210 of the connector C would be operated, and too, direct ground would already be present on the test contact.

In the above paragraphs describing how a toll operator is able to intrude upon a local connection, it was assumed that the wanted subscriber which was busy in a local connection was the called party of the local connection, that is, the wanted subscriber had been previously called by another local calling subscriber. A wanted subscriber may, however, be busy in a local connection in which he is the calling party, having initiated the local connection. A toll operator may likewise intrude on such a connection and establish a toll connection with the wanted subscriber and release the unwanted subscriber from the connection. The operations of the connector for performing this function are the same as described in the previous case, but the application of direct ground on the test contact of the wanted line when the operator operates the key of the cord to the cut-in position the second time in this case operates on the first selector used in the local connection to release the unwanted subscriber rather than on the connector used in the local connection.

To describe the manner in which the first selector in such a connection is operated upon, it will be assumed that the toll operator wishes to extend a toll connection to the line of substation A, which at this time it will be assumed is engaged in a local connection by way of the lineswitch LS', the first selector S', the second selector S^2, the third selector S^3, and the connector C. As will be recalled from the local connection previously described ground potential is now connected to the private normal conductor 3 through the upper winding of relay 30. The toll operator sets up the toll connection in the same manner as described before and is informed that the wanted subscriber at substation A is busy in a local connection by hearing the local busy tone when connection to this line is established. She thereupon as before operates the key of the cord used corresponding to key K to the cut-in position to establish a temporary talking circuit with the wanted subscriber and the other subscriber of the local connection. Then, after informing the wanted subscriber that a toll connection is being extended to his station and that the local connection will be interrupted, she momentarily operates the key a second time. This again causes the connector used in the toll connection to connect direct ground potential to the test contact to which the private normal conductor 3 is connected. This causes the upper winding of relay 30 of the first selector S' to be short circuited, whereupon this relay deenergizes. As a result of the deenergization of relay 30, the bridge across the trunk conductors 62 and 64 is opened at contacts 51 and contacts 52, and the holding circuit is severed at contacts 51'. Obviously the selector S^2 and S^3 are now released and restored to normal. The called subscriber of the local connection finding himself disconnected will then replace his receiver, if he did not when informed of the toll call for the other subscriber, causing the connector used in the local connection to release also. The lineswitch LS' and the selector S', however, remains in an operated position.

As stated in earlier paragraphs, it may be desirable to class calls from one zone to another zone the same as toll calls so that a connection from a local subscriber in one zone to

a local subscriber in another zone can not be intruded upon even by a toll operator. In order to accomplish this result, means have been provided in the first selector which come into effect when a call to another zone is made to cause the calling line to be marked Toll busy, and means have been provided in the outgoing repeater associated with each inter-office trunk, which operates on the connector used to complete the call to condition it the same as when it is used by a toll operator in setting up a toll connection.

To describe these operations in detail it will be assumed that the subscriber at substation A at the exchange X calls the substation B at exchange Y. To initiate the call, the subscriber at substation A removes his receiver and dials the directory number of the substation B. Responsive to the removal of the receiver at the substation A the line-switch LS′ is again caused to operate and select an idle trunk accessible in its banks and then extend the connection thereto. Assuming that the trunk comprising conductors 22, 23, and 24 is the one selected, line relay 25 of selector S′ again operates and at contacts 34 closes a circuit for the release relay 26. Relay 26 operates and grounds the release conductor 23 at contacts 26 and prepares the impulsing circuit at contacts 37, and at contacts 39 closes a circuit for the lower winding of relay 30.

Responsive to the dialing of the first digit, the selector S′ operates as previously described to raise its wipers opposite the level of bank contacts corresponding to the digit dialed. The selector S′ is provided with a set of shaft springs which are so positioned that they are closed whenever the switch wipers are raised to any one of the levels in which trunks to an exchange in another zone are accessible. Therefore, springs 56 and springs 56′ are now closed. A circuit is now established at springs 56 for the lower winding of relay 30 dependent of contacts 39 of the release relay 26, and the upper winding of relay 30 is short circuited at springs 56′.

After the selector S′ has raised its wipers opposite the level corresponding to the first digit dialed, it automatically rotates its wipers into engagement with the first set of contacts terminating an idle trunk in a selected level. It will be assumed that the trunk comprising conductors 65 to 67 extending by way of the repeater R, Fig. 3, to the exchange Y, and terminating thereat in the incoming second selector IS, is the one selected. When the connection is extended to the repeater R, a circuit is closed for the line relay 326. Relay 326 operates and closes a circuit for the release relay 327 at contacts 335. Relay 327 operates and places direct ground potential on the release trunk 66 at contacts 338, prepares a circuit for the impulse bridging relay 328 at contacts 339, and closes a polarizing circuit for relay 325 at contacts 340. Relay 327 remains energized during the entire connection, as will be seen from later descriptions, and since the upper winding of relay 30 is now short circuited, direct ground potential is present on the private normal conductor 3 and is maintained thereon during the entire connection. Thus the line to substation A is marked Toll busy, and being so marked is guarded against intrusion by any one including the toll operator as previously described. At contacts 337 line relay 326, in operating, also closes a bridge which includes the impedance 346 and the upper winding of polarized relay 325 across the outgoing trunk conductors 365 and 367. This causes the line relay and then the release relay in the incoming second selector IS, to operate and prepare the incoming selector IS for operation.

Responsive to the dialing of each of the remaining digits of the called number, line relay 326 deenergizes and reenergizes a corresponding number of times, opening the bridge at contacts 337 a like number of times. Furthermore each time that relay 326 deenergizes the circuit of relay 328 is closed at contacts 336. Relay 328 therefore energizes during each series of impulses and substitutes a short-circuiting bridge for the bridge including the impedance 346 and the upper winding of relay 325 by separating contacts 341 and closing contacts 342, thereby improving the impulse transmission. In operating, relay 328 also closes the circuit of the ground-impulse relay 329 at contacts 343. Thus relay 329 is also energized during each series of impulses. At the cessation of each series of impulses, the circuit of relay 328 is maintained open and consequently this relay deenergizes. In so doing, the normal bridge including impedance 346 and the upper winding of relay 325 is again placed across the outgoing line conductors by the closure of contacts 341 and the opening of contacts 342. As a further result, ground potential is momentarily applied to the upper outgoing conductor 365 by the closure of contact 344 during the time relay 329, which is slow-acting as indicated, maintains its armature attracted after its circuit is opened.

In this manner, the remaining series of impulses are transmitted over the trunk conductor 365 and 367 to the switches in the exchange Y, conductor 365 being momentarily grounded at the end of each series. Responsive thereto, the incoming second selector IS operates and extends the connection to an idle third selector in the proper group, for example, selector S^4; the third selector S^4 operates and extends the connection to an idle connector in the proper group, for example, connector C^3; and the connector C^3 is operated and extends the connection to the called line. As far as the operation of

the selectors IS and S^4 is concerned, the momentary grounding of conductor 365 after each series of impulses has no utility. In the connector C^3, however, this momentary application of ground to one conductor of the incoming trunk causes an unbalancing of the differential relay in the connector C similar to differential relay 202 of connector C, so that this differential relay operates. The differential relay, in operating, as will be recalled from the descriptions concerning connector C, causes the relay in connector C^3 corresponding to relay 210 in connector C to operate and lock, so that when the connection is finally completed, direct ground potential is connected to the test contact of the called line the same as in a toll connection. It should be noted that the differential relay in the connector C^3 may or may not operate when the connector is first seized, depending on the amount of rotation that the selector S^4 must perform to find the trunk to connector C^3. If the differential relay is not operated when the connector C^3 is seized, it will be operated by the momentary grounding of conductor 365 after the first series of impulses sent to connector C^3.

If the called line is busy, the calling subscriber will hear a busy tone, either the local busy tone or the toll busy tone depending on the kind of connection in which the called line is engaged, and no connection will be completed, but if the called line is idle, the connection will be completed and direct ground will be connected to the test contact of the called line so that this line will now test toll busy when any other connection thereto is attempted.

Thus on a zone to zone call, the specially provided shaft springs of the first selector are closed to provide an independent holding circuit for the relay 30 and to short-circuit the upper winding thereof so that direct ground may be placed on the private normal conductor to mark the calling line Toll busy, and the special means including relay 329 in the repeater R operate to momentarily place ground potential on one of the trunk conductors to cause the unbalancing of the differential relay in the connector used so that this connector will operate the same as when used in a toll connection and place a direct ground potential on the test contact of the called line to mark the called line Toll busy.

This completes the description of the operation of this invention and what is considered new and is desired to have protected by Letters Patent is pointed out in the appended claims.

What is claimed is:

1. In a telephone system, a combination toll and local connector, a trunk line terminating in said connector and accessible to local subscribers and to an operator, a differential relay in said connector connected across the conductors of said trunk line, said relay being inoperative when said connector is seized and operated by a local subscriber, means for causing the operation of said relay when said connector is seized and operated by said operator, and means controlled by said relay for causing said connector to operate as a toll connector.

2. In a telephone system, a combination toll and local connector accesible to a local subscriber and to an operator, and normally operative as a local connector, a calling device at the subscriber's station, a second calling device at the operator's position, means in said connector responsive to either calling device for controlling the operation of said connector, a differential relay in said connector responsive to the operation of said second calling device, and means controlled by said relay for causing the connector to operate as a toll connector in the latter case.

3. In a telephone system, a combination toll and local connector, a calling line, a called line, an operator's position, means for extending a connection either from said calling line or from said position to said connector, a calling device at the station on said calling line, a calling device at said operator's position, means responsive to either calling device for causing said connector to connect with said called line, local busying means operative when said connector is controlled from said first calling device for marking said called line locally engaged, a differential relay responsive to said second calling device and nonresponsive to said first calling device, and means controlled by said relay for disabling said local busying means and for marking said called line toll engaged.

4. In a telephone system, a combination toll and local connector accessible to a local subscriber and to an operator, a calling device at the subscriber's station, a second calling device at the operator's position, impulsing contacts in each calling device for transmitting impulses to said connector to operate the connector, a relay in said connector, said relay being inoperative when the connector is seized and operated by a local subscriber, additional contacts on said second calling device for controlling the operation of said relay, and means controlled by said relay for causing said connector to operate as a toll connector.

5. In a telephone system, a combination toll and local connector, a trunk line terminating in said connector and accessible to local subscribers and to an operator, a relay in said connector connected across the conductors of said trunk line, said relay being inoperative when said connector is seized and operated by a local subscriber, means for placing a temporary abnormal condition on said trunk line for causing the operation of said relay after said connector is seized, and

before said connector is operated, by said operator, and means controlled by said relay for causing said connector to operate as a toll connector when operated by said operator.

6. In a telephone system, a connector, a called line, means for operating said connector to connect with said line, a source of characteristic current, means for connecting and disconnecting said source to and from the talking conductors of said connector, and a relay energized under predetermined conditions responsive to the disconnection of said source from the talking conductors of said connector for establishing a talking connection with the subscriber on said line.

7. In a telephone system, a connector, a subscriber's line which may be either idle or busy in another connection, means for operating said connector to connect with said line, a source of characteristic current, means for connecting said source to, and disconnecting said source from, a conductor of said connector, means responsive to a disconnection of said source from said conductor after the same has been connected thereto for establishing a talking connection with the subscriber on said line providing said line is busy, and means responsive to a second connection of said source to said conductor for releasing the said other connection.

8. In a telephone system, a connector, a subscriber's line which may be either idle or busy in another connection, means for operating said connector to connect with said line, a source of characteristic current, means for connecting said source to, and disconnecting said source from, a conductor of said connector, means responsive to a disconnection of said source from said conductor after the same has been connected thereto for establishing a talking connection with the subscriber on said line providing said line is busy, means responsive to a second connection of said source to said conductor for releasing the said other connection, and means responsive to a second disconnection of said source from said connector for establishing an alternative talking connection and for opening said first talking connection.

9. In a telephone system, a connector, a subscriber's line which may be either idle or busy in another connection, means for operating said connector to connect with said line, a source of characteristic current, means for connecting said source to, and disconnecting said source from, a conductor of said connector, means responsive to a disconnection of said source from said conductor after the same has been connected thereto for establishing a talking connection with the subscriber on said line providing said line is busy, means responsive to a second connection of said source to said conductor for releasing the said other connection, and means for opening said talking connection while said source is connected to said conductor the second time.

10. In a telephone system, a connector, a subscriber's line which may be either idle or busy in another connection, means for operating said connector to connect with said line, a source of characteristic current, means for connecting said source to, and disconnecting said source from, a conductor of said connector, means responsive to a disconnection of said source from said conductor after the same has been connected thereto for establishing a talking connection with the subscriber on said line providing said line is busy, means responsive to a second connection of said source to said conductor for releasing the said other connection, and means responsive to the second connection of said source to said conductor for opening said talking connection until said source is disconnected again.

11. A telephone system as claimed in claim 7 in which the means responsive to a disconnection of the said source is a two-step relay, being operated in its first step responsive to the connection of said source to said conductor and operated in its second step responsive to the first disconnection of said source.

12. In a telephone system, a calling line, a first switch, a second switch, a called line, means for successively operating said switches to extend a connection from said calling line to said called line, means for extending a second connection to said calling line while the first connection is intact, and means for then causing said second switch to be released to open said first connection without causing the release of said first switch.

13. In a telephone system, a calling line, a first switch, a second switch, a called line, means for successively operating said switches to extend a connection from said calling line to said called line, a second calling line, means for extending a second connection from said second calling line to said first calling line while the first connection is intact, and means controlled over the second calling line at will for then causing the release of said second switch to open said first connection without causing the release of said first switch.

14. In a telephone system, a calling line, a first switch, a second switch, a called line, means for successively directively operating said switches to extend a connection from said calling line to said called line, a relay in said first switch and means for operating it, means including a circuit extending from said second switch for maintaining said relay operated, a second calling line, means for extending a second connection from said second calling line to said first calling line while the first connection is intact, means for short-circuiting said relay when said second connection is established, and means con-

trolled by said relay for opening said first connection and causing the release of said second switch.

15. In a telephone system, a calling line, a switch, a first and a second trunk line accessible to said switch, means for operating said switch to extend a connection from said calling line over either trunk line, a relay in said switch for controlling the connection over either trunk line, controlling means including a conductor of the first trunk line for controlling the operation of said relay when the first trunk line is connected with, and means independent of any conductors of the second trunk line for controlling said relay when the second trunk line is connected with.

16. In a telephone system, a calling line, a switch, a first and a second trunk line accessible to said switch, means for operating said switch to extend a connection from said calling line over either trunk line, a relay in said switch for controlling the connection over either trunk line, controlling means including a conductor of the first trunk line for controlling the operation of said relay when the first trunk line is connected with, means independent of any conductors of the second trunk line for controlling said relay when the second trunk line is connected with, means for extending a second connection to said calling line, and means for disabling said controlling means to cause the opening of an existing connection from said calling line over said first trunk line providing such exists when said second connection is established.

17. In a telephone system, a calling line, a switch, a first and a second trunk line accessible to said switch, means for operating said switch to extend a connection from said calling line over either trunk line, a relay in said switch for controlling the connection over either trunk line, controlling means including a conductor of the first trunk line for controlling the operation of said relay when the first trunk line is connected with, means independent of any conductors of the second trunk line for controlling said relay when the second trunk line is connected with, means for extending a second connection to said calling line, means for disabling said controlling means to cause the opening of an existing connection from said calling line over said first trunk line providing such exists when said second connection is established, and means for preventing the opening of an existing connection from said calling line over said second trunk line providing such exists when said second connection is established.

18. In a telephone system, a calling line, a combination toll and local connector normally operative as a local connector, a trunk, means for extending a connection from said calling line via said trunk to said connector, a dial at the station on the calling line for sending current impulses over said line, a repeater associated with said trunk for repeating said impulses to said connector over said trunk, a relay in said connector having windings in the circuit over which the impulses are received and being normally ineffective to said impulses, means in said repeater for momentarily producing a characteristic condition on said trunk line to cause the operation of said relay, and means controlled by said relay to cause said relay to operate as a toll connector.

19. In a telephone system, a trunk line comprising two inductively coupled sections, means for sending series of current impulses over the two conductors of the first section in series, an impulse repeater for repeating the series of current impulses over the two conductors of the second section in series, and means in said repeater for momentarily placing a characteristic condition on the second section following the repeating of each series of current impulses.

20. In a telephone system, a trunk line comprising two inductively coupled sections, means for sending series of current impulses over the two conductors of the first section in series, an impulse repeater for repeating the series of current impulses over the two conductors of the second section in series, and means for momentarily applying a characteristic potential to one conductor of the second section following the repeating of each series of current impulses.

21. In a telephone system, a calling line, a preselector, a first selector, means for extending a talking connection from said line via said preselector and said first selector, a relay in said first selector, contacts in said talking connection controlled by said relay, a private normal conductor for said calling line, and means whereby said relay is controlled over said private normal conductor.

22. In a telephone system, a calling line, means including a selector switch for extending different kinds of connections from said calling line, and means in the selector switch for marking said calling line busy differently depending on the kind of connection extended.

23. In a telephone system, a calling line, an automatic switch, means for operating said switch to different positions to extend connections from said calling line to different points, and means in the switch for marking the calling line busy differently depending on the position to which the switch is operated.

24. In a telephone system, a calling line, a called line, a cut-off relay for said called line, a connector, means for operating said connector to extend a connection from said calling line to said called line, a release relay in said connector operated over a local circuit before the connection to the line is established and in series with said cut-off relay when said

connection is established, a second calling line, means for establishing a second connection from said second calling line to said called line, means controlled over said second calling line for short-circuiting said release relay, and means controlled by said release relay for causing the release of said connector to open said first connection.

25. In a telephone system, a calling line, a called line, a connector, means for operating said connector to establish a connection from said calling line to said called line, an operator's switchboard, means for extending a second connection from said switchboard to said called line while the first connection is intact, a release magnet in said connector for releasing the same, a first release relay in said connector for operating said magnet controlled over the calling line, and energized before said connector is operated, and a second release relay in said connector for operating said magnet controllable from said operator's switchboard when a second connection is established while said first connection is intact.

26. In a telephone system divided into zones, means for establishing connections between subscribers in the same zone and between subscribers in different zones, an operator's position, means for extending a connection from said position to a subscriber whether he be idle, busy in a connection with another subscriber in the same zone, or busy in a connection with another subscriber in a different zone, means controlled by the operator at said position after a connection from said position to a busy subscriber is established for opening the existing subscriber to subscriber connection providing both subscribers are in the same zone, and means for preventing the opening of an existing connection between two subscribers in different zones.

27. In a telephone system, a connector accessible to local subscribers and to an operator for extending a connection to a line, means automatically responsive to the establishment of a connection to the line for distinctively marking the line when the connector is used by a local subscriber, a relay for causing the marking to be different when the connector is used by the operator, a calling device for the operator for controlling the operation of said connector, and contacts on said calling device for controlling said relay.

28. In a telephone system, a combination toll and local connector normally operating as a local connector, a trunk line terminating in said connector, means for sending digit impulses over said trunk to operate said connector, a relay connected to said trunk nonresponsive to said digit impulses, means for placing a temporary abnormal condition on said trunk to operate said relay when said connector is to be used as a toll connector, and means controlled by said relay for causing the connector to operate as a toll connector.

29. In a telephone system, a line, a connector and means for operating it to connect with said line, means for connecting and disconnecting a characteristic source of current to and from the talking conductors of said connector, a relay bridged across the talking conductors of the connector operated responsive to the connection of said source, and means controlled by said relay in releasing responsive to the disconnection of said source from said conductors for establishing a talking connection with the subscriber on said line.

30. In a telephone system, a line which may be either busy or idle, a connector and means for operating it to connect with said line, a source of current, means responsive to a momentary connection of said source to a conductor of said connector, providing the line is busy in another connection, for establishing an initial talking connection to said line, means responsive to a second momentary connection of said source to said conductor for releasing said other connection and for establishing a second talking connection to said line, and means in said connector operative when said source is connected to said conductor the second time for opening said initial talking connection.

31. In a telephone system, a connector, a called line which may be either idle or busy in another connection, means for operating the connector to connect with said line, a source of characteristic current, means for connecting and disconnecting said source to and from the talking conductors of said connector, and a relay energized responsive to the disconnection of said source from the talking conductors of the connector after the same has once been connected thereto, for establishing a talking connection with the called line when said line is busy in another connection.

32. In a telephone system, a selector, a plurality of trunks accessible to said selector, a relay in the selector for controlling the operation thereof, means including a conductor of a trunk line for controlling the operation of said relay when certain of said trunk lines are connected with, and means independent of any conductors of a trunk line for controlling the operation of said relay when other of said trunk lines are connected with.

In witness whereof, I hereunto subscribe my name this 9th day of March, A. D., 1927.

JOHN WICKS.