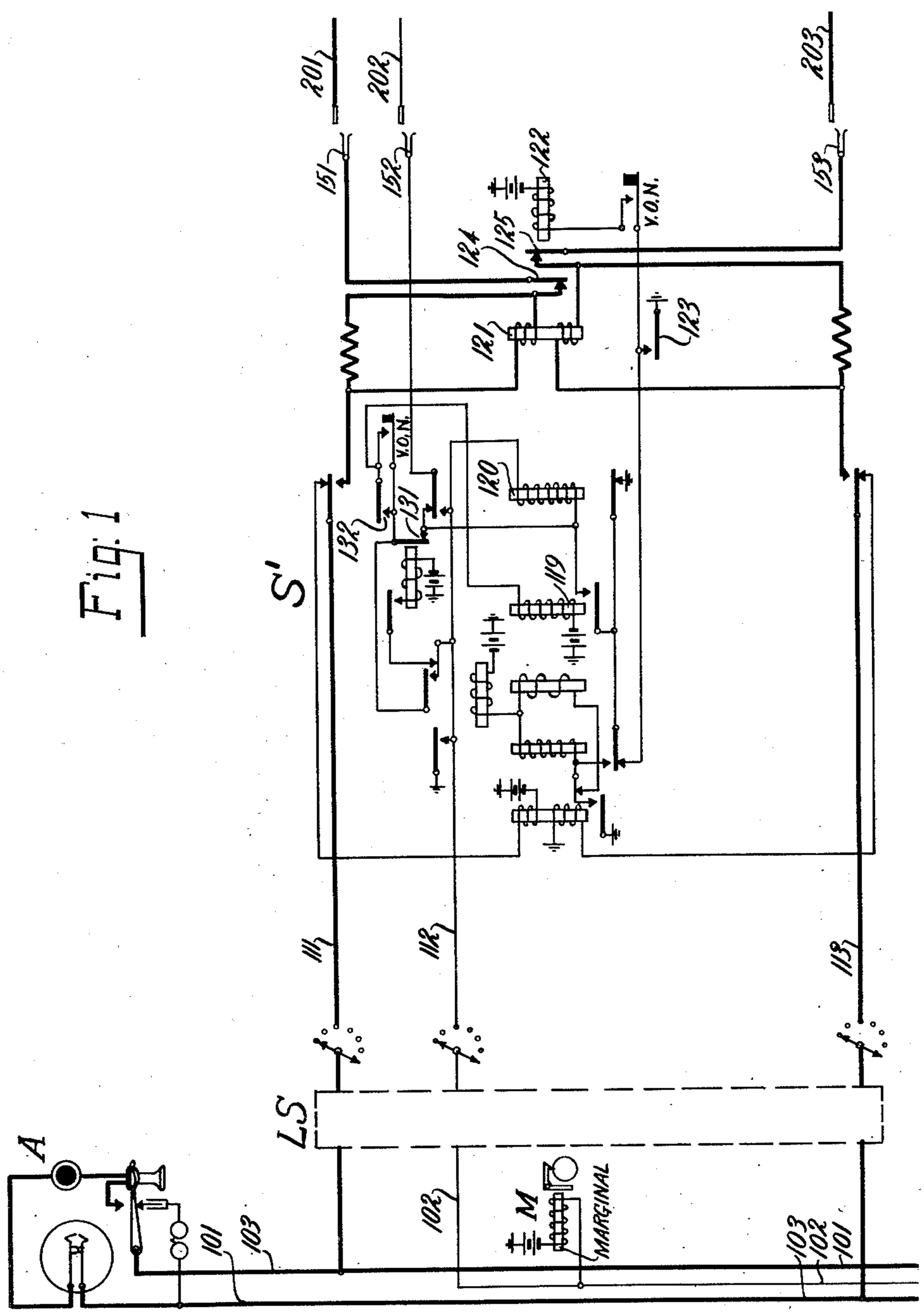
Oct. 7, 1930. V. S. THARP ET AL 1,777,420

AUTOMATIC TOLL SERVICE TRUNKING SYSTEM

Original Filed Oct. 19, 1927 5 Sheets-Sheet 1

Fig. 1



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AUTOMATIC TOLL SERVICE TRUNKING SYSTEM

Original Filed Oct. 19, 1927 5 Sheets-Sheet 2

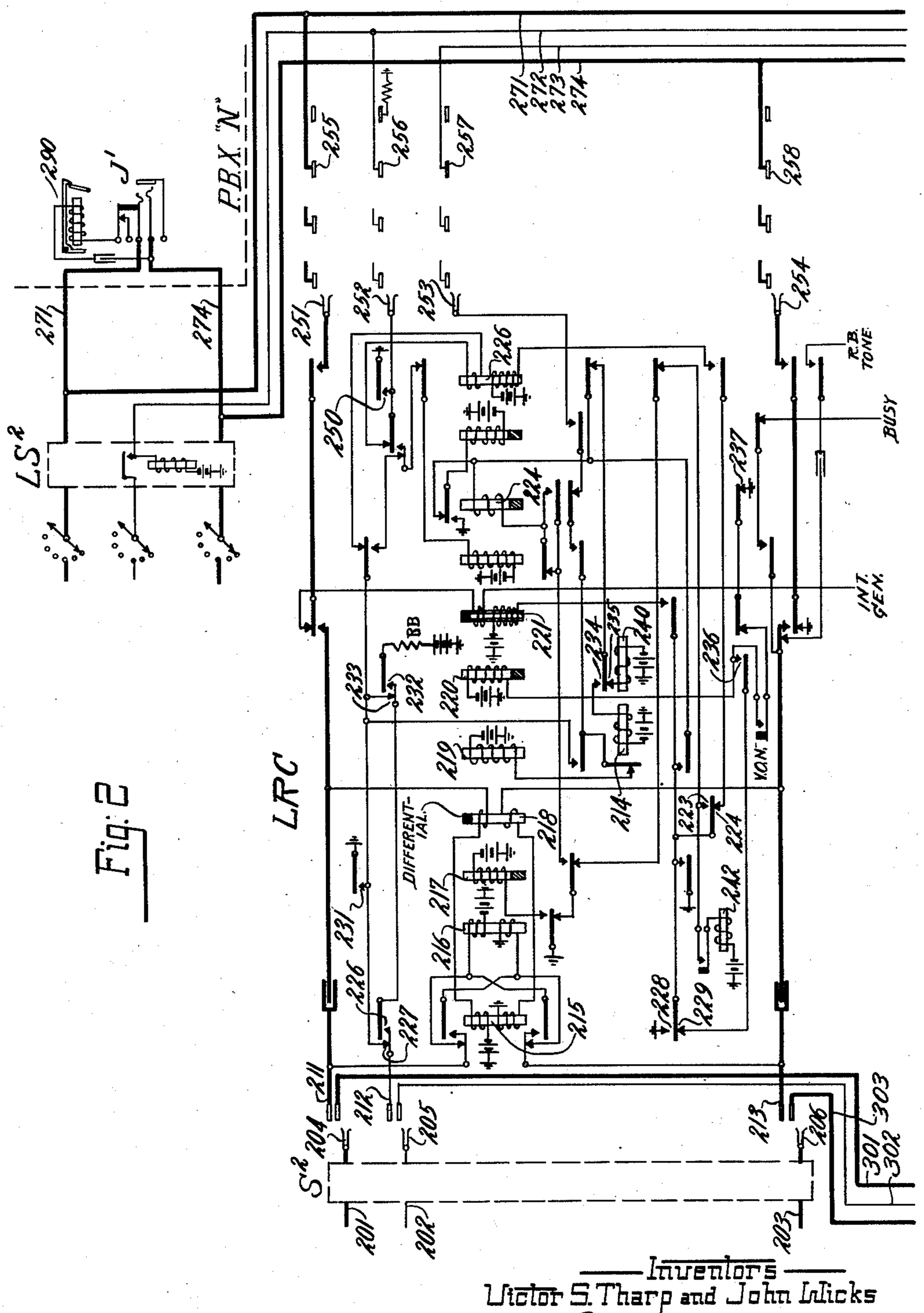

Fig. 2

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AUTOMATIC TOLL SERVICE TRUNKING SYSTEM

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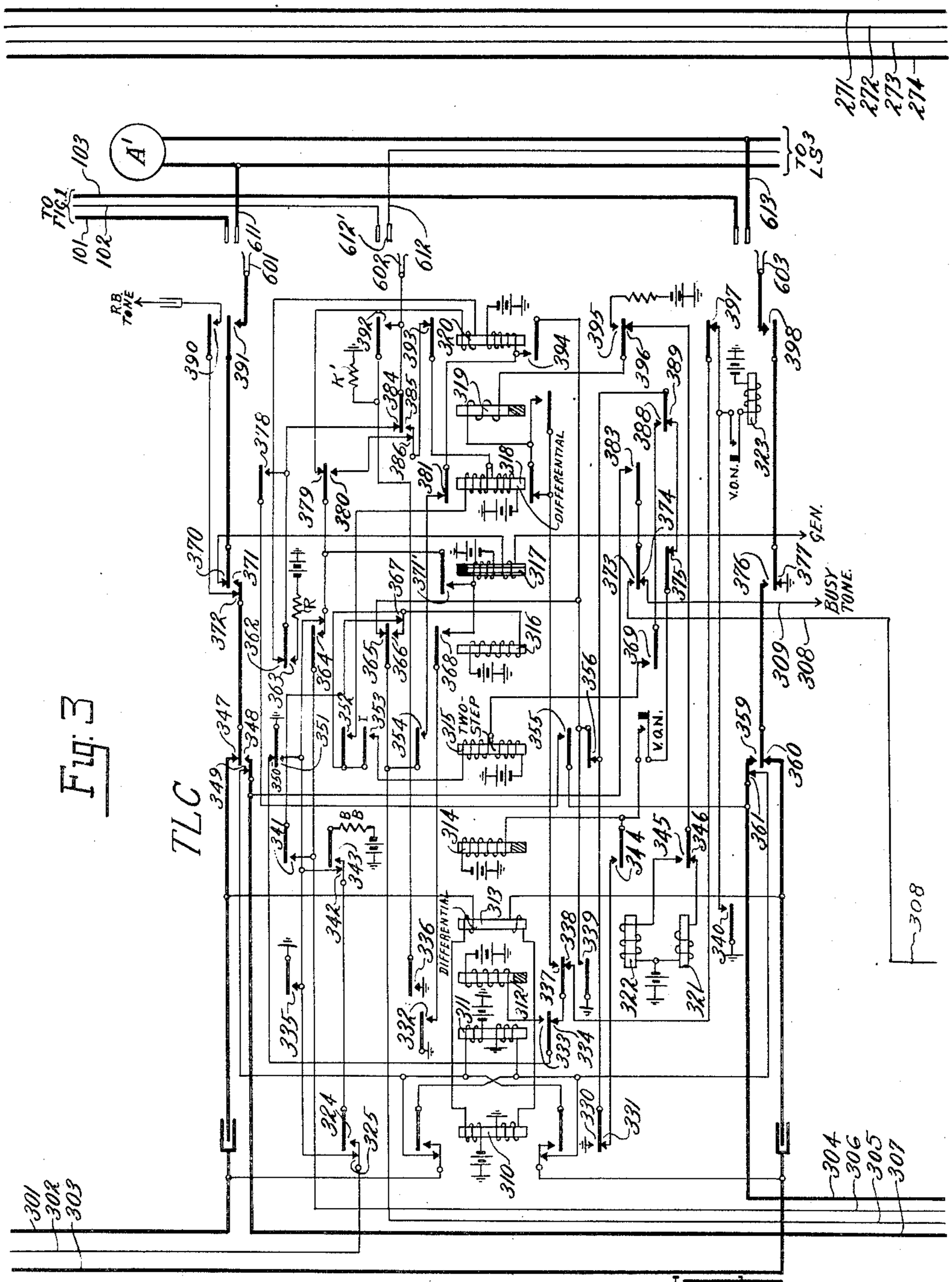
Fig. 3



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AUTOMATIC TOLL SERVICE TRUNKING SYSTEM

Original Filed Oct. 19, 1927 5 Sheets-Sheet 4

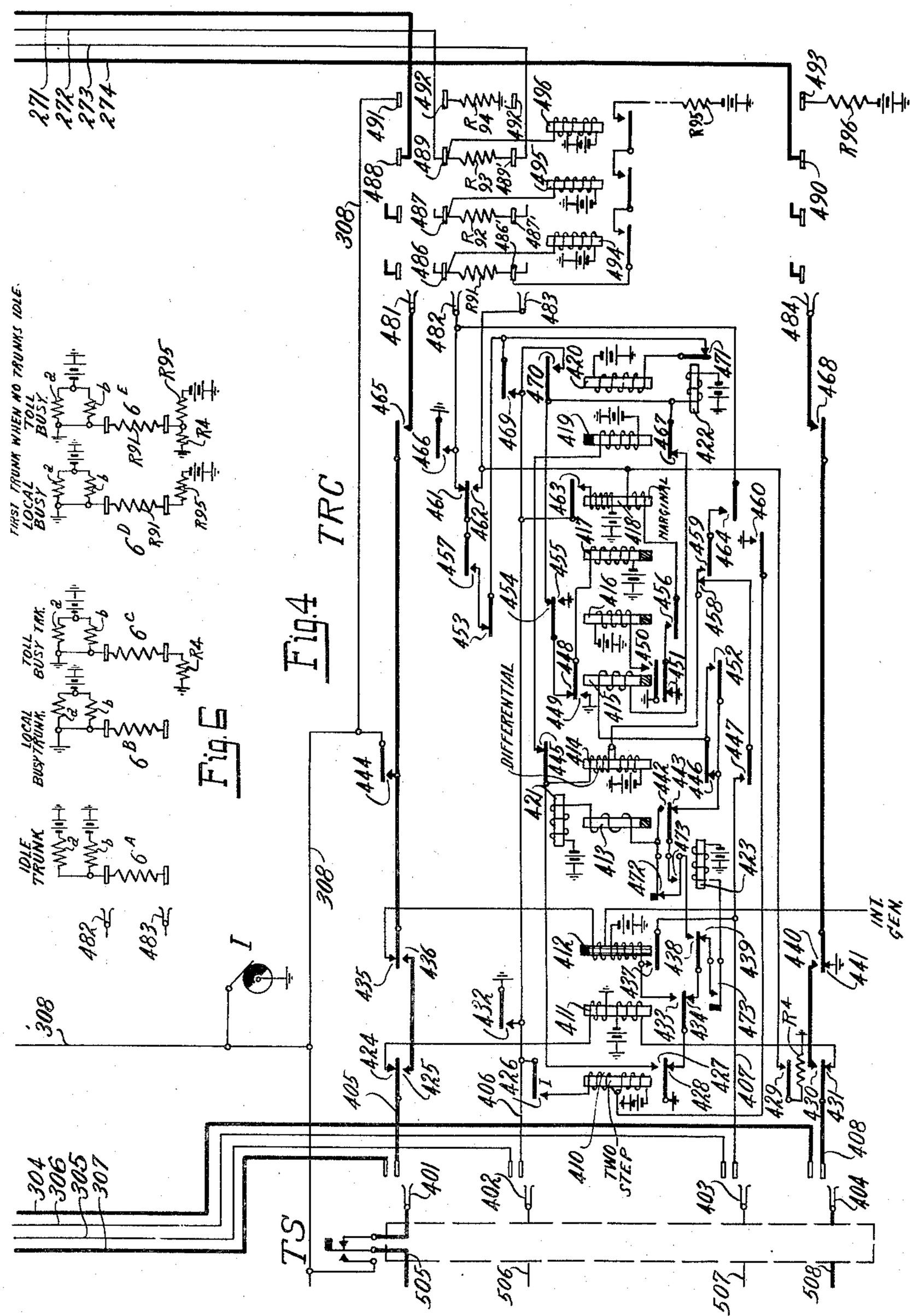

Fig. 4

Fig. 5

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AUTOMATIC TOLL SERVICE TRUNKING SYSTEM

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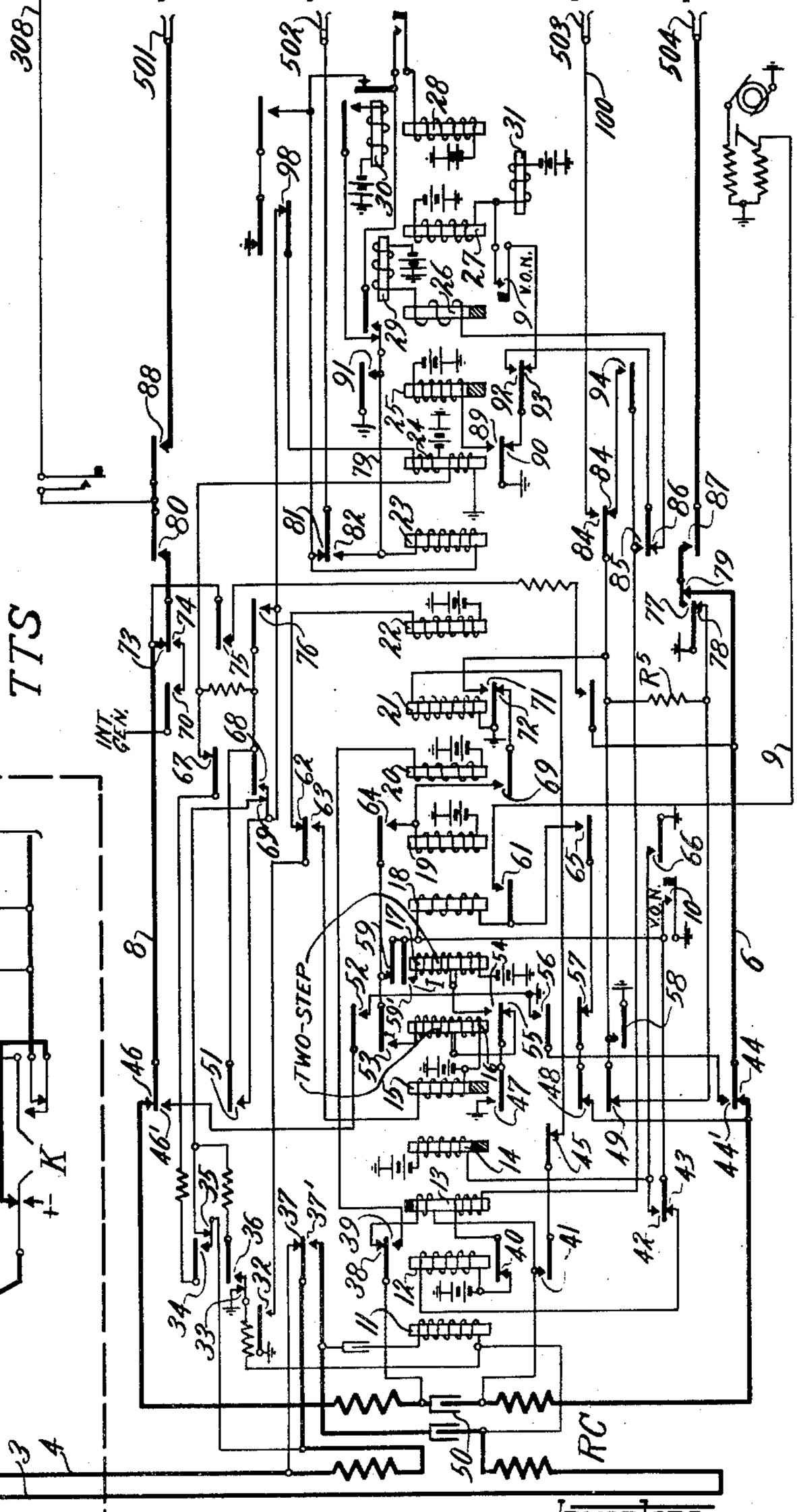
Fig. 5



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1,777,420

UNITED STATES PATENT OFFICE

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AUTOMATIC TOLL-SERVICE TRUNKING SYSTEM

Application filed October 19, 1927, Serial No. 227,130. Renewed April 4, 1930.

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 this invention is the provision of new and improved switching mechanisms for competing toll and local connections whereby the toll operator in extending a toll connection to a local subscriber is informed whether the wanted subscriber is busy or idle, and if busy, whether in a local connection or in a toll connection, and whereby, if the wanted 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.

A particular feature of this invention resides in the production of a new and improved rotary connector for extending connections to private branch exchanges, which will select an idle one of a group of trunks extending to a wanted branch exchange providing an idle one exists, and will select the first trunk engaged in the local connection, when all the trunks of the group are busy either in local connections or toll connections. The toll operator is signalled as to whether the connection has been extended to an idle trunk or a locally busy trunk, or whether no connection has been extended at all by reason of all the trunks being busy in toll connections. If a connection has been extended to a locally busy trunk, the operator is likewise able to cut in on the conversation and complete the toll connection and release the unwanted subscriber from the connection.

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 to 6, which shows by means of the usual circuit diagrams a schematic layout of a telephone system embodying the principles of the invention. The drawings to be most easily understood should be placed as follows: Fig. 2 to the right of Fig. 1, Fig. 3 underneath Fig. 2, Fig. 4 underneath Fig. 3, and Fig. 5 to the left of Fig. 4.

In Fig. 1, a subscriber's station A is shown whose line terminates at the exchange in the individual lineswitch LS and is accessible in the banks of a group of connectors. The lineswitch LS may be of any suitable type, such as the well-known rotary type having no normal position and moving in one direction only. The lineswitch LS, together with other similar lineswitches, has access to a group of first selector switches such as 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 application of John I. Bellamy and Rudolph F. Stehlik, Ser. No. 167,908, filed Feb. 14, 1927, 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 first selectors has access to a number of groups of local second selectors, a separate group being accessible in each level.

The local second selector S^2, indicated by a rectangle in Fig. 2, is accessible to the group of first selectors containing selector S′ by way of the trunk comprising conductors 201 to 203. Mechanically and also in circuit arrangement, the selector S^2 may be of any suitable type such as shown and described in detail in the Wicks Patent No. 1,520,268. In the banks of the second selectors, access is had to the number of groups of individual line connectors (each group containing both local connectors and combination toll and local connectors) and also to one or more groups of local rotary connectors, a separate group being accessible in each level.

The local rotary connector LRC is accessible to the group of local second selectors containing selector S^2 by way of the trunk comprising conductors 211 to 213. Mechanically, the local rotary connector LRC is of the well-known Strowger vertical and rotary type, and in circuit arrangement it is similar to

the rotary connector shown and described in detail in the Wicks Patent 1,644,968, granted Oct. 11, 1927, with certain modifications which will be described in detail subsequently. The local rotary connector LRC together with other connectors has access to a number of groups of trunks extending to private branch exchanges.

The trunk line comprising conductors 271 and 274 is one of a group of three trunks extending to the P. B. X. "N" and accessible to the connector LRC. This trunk line terminates at the main exchange in the lineswitch LS^2 which may be like the lineswitch LS and may have access in common with the lineswitch LS to first selectors.

In Fig. 3, a combination toll and local connector TLC is shown which is accessible to the group of local second selectors containing selector S^2 by way of the trunk comprising conductors 301 to 303, and is accessible to a group of toll second selectors (to be mentioned subsequently) by way of the trunk comprising conductors 304 to 307. Mechanically, the toll and local connector TLC is of the well-known Strowger vertical and rotary type. The circuit arrangement of the connector TLC forms a particular part of this invention and will be described in detail subsequently. The connector TLC, together with other connectors, has access to individual subscriber's lines, such as the line comprising conductors 101 and 103 extending to substation A, and the line comprising conductors 61 and 63 extending to substation A'. The line of substation A' also terminates in a lineswitch (not shown) which may be similar to the lineswitch LS and may have access to first selectors in common therewith.

In Fig. 5, the calling end of the toll operator's cord circuit O, terminating in the plug P and equipped with a listening key K' and a dialling and ringing key K, is shown. The dial D may be associated with cord circuit O by operating the key K to the right. The cord circuit O may be of any suitable type and is therefore not shown in full; only those elements which concern the invention are shown.

The toll operator has access to a group of toll transmission selectors by way of trunk lines accessible at jacks at her position. The toll transmission selector TTS is accessible at the toll operator's switchboard at jack J via the trunk line comprising conductors 3 and 4. Mechanically, the toll transmission selector TTS is of the well-known vertical and rotary type, and has access in its bank to a number of groups of toll second selectors, a separate group being accessible in each level. The circuit arrangement of the toll transmission selector TTS forms a particular part of this invention and will be described in detail subsequently.

The toll second selector TS, indicated in Fig. 5 by a dotted rectangle, is accessible to the toll transmission selectors by way of the trunk comprising conductors 505 to 508. Mechanically, and also in circuit arrangement, the selector TS may be of the well-known vertical and rotary type similar to the local second selector S^2, except that the ringing control conductor of the trunk terminating therein is connected to a fourth wiper upon the completion of the operation of the switch. In the banks of the toll second selectors access is had to a number of groups of combination toll and local connectors, and also to one or more groups of toll rotary connectors, a separate group being accessible in each level. The toll and local connector TLC shown in Fig. 3 is accessible to the group of toll second selectors containing selector TS by way of trunk conductors 304 to 307.

The toll rotary connector TRC is accessible to the group of toll second selectors containing selector TS by way of trunk conductors 405 to 408. Mechanically, the toll rotary connector TRC is of the well-known vertical and rotary type. The circuit arrangement of the connector TRC forms a particular part of this invention and will be described in detail presently. The banks of the toll rotary connectors are multiply connected with the banks of the corresponding local rotary connectors. Thus the toll rotary connectors have access in common with the local rotary connectors to the groups of trunk lines extending to the private branch exchanges.

Fig. 6 comprises five diagrams 6^A to 6^E which show the various test potentials existing on the test contacts of the trunks to a private branch exchange under different circumstances.

With this general description of the objects of the invention and the apparatus involved in mind, a detailed description of the operation will now be given. For this purpose, it will first be assumed that the subscriber at substation A desires connection with the subscriber at substation A'. To complete this connection, the subscriber at substation A removes his receiver and dials the directory number of the subscriber at substation A'. Responsive to the removal of the receiver at substation A, lineswitch LS operates in the usual manner and extends the connection to an idle first selector which will be assumed to be selector S'. Responsive to the dialling of the first digit of the called number, selector S' operates to raise its wipers opposite the level of bank contacts corresponding to the digit dialled, and then automatically selects an idle trunk accessible in that level. (A detailed description of the vertical and rotary operation of a selector similar to selector S' is given in the application of John I. Bellamy and Rudolph F. Stehlik, Ser. No. 167,908, referred to

above.) The windings of relay 21 of selector S′ are included in the talking circuit, but are wound differentially so that relay 21 is not operated when current flows through both its windings in series with the line relay of the succeeding switch.

Responsive to the second digit dialled by the calling subscriber, second selector S^2 operates in the regular manner and extends the connection to the first idle connector of the group accessible in the level of bank contacts corresponding to the digit dialled.

It is assumed that the connector selected is the toll and local connector TLC shown in Fig. 3, accessible by way of trunk conductors 301 to 303. When the connection is extended to the connector TLC, line relay 311 operates and prepares the connector for operation. Responsive to the dialling of the third digit, vertical magnet 321 operates and raises the switch wipers opposite the corresponding level of the bank contacts under the control of line relay 311, series relay 319 operating in series with magnet 321. At the end of the vertical movement, relay 319 deenergizes and by closing contacts 389, closes the circuit for the combination changeover and meter control relay 314, the circuit including vertical off normal springs closed upon the first step of the switch wipers. Relay 314, in operating, places rotary magnet 322 in the impulsing circuit instead of vertical magnet 321 by closing contacts 345 and separating contacts 346, and by separating contacts 342 and closing contacts 343 prepares the circuit over which the booster battery BB will later be applied to the release conductor 302.

Responsive to the dialling of the last digit by the calling subscriber, rotary magnet 322 operates and rotates the switch wipers into engagement with the set of contacts terminating the line to substation A′. If the line is busy, busy relay 318 operates in the usual manner (over its lower winding—its upper winding has no utility in this type of call) and gives the calling subscriber the busy signal. If the line is idle, switching relay 320 operates when relay 319 falls back and performs its usual circuit changes, including the closing of the signalling circuit at contacts 391 and 398, and the connection of ground potential to the private contact 612′, in this case, through contacts 336 of relay 312 thereby shunting resistance R′.

When the subscriber at substation A′ answers, ring cutoff 221 operates and trips the ring and completes the talking circuit, after which back-bridge relay 310 is energized in series with the windings of differential relay 313. Relay 313, being differentially wound, does not operate at this time. Back-bridge relay 310, however, operates and opens the holding circuit for relay 314 by separating contacts 331, and by closing contacts 324, causes the booster battery BB to be connected to the release conductor 302, thereby causing the operation of the subscriber's meter M. Shortly after its circuit is opened, relay 314 releases, after which direct ground potential is connected again to release conductor 302, via contacts 335, 342 and 324. In this type of connection, relays 315 and 316 are not operated, and the operations of the connector TLC are similar to the general connector operations well-known in the art, with the exception of the operations concerning relay 314 which have been described in detail. The release of the connection at the termination of the conversation takes place in the usual manner responsive to the replacement of the receivers of the two subscribers.

From the foregoing description, it should be noted that when one subscriber completes a call to another subscriber, the private normal contacts of both the calling line and the called line are grounded directly and according to this invention are thus marked "locally busy"; that talking current is furnished to the calling subscriber through the windings of the line relay of the connector used in the connection in series with the windings of a differential relay in the first selector, the latter relay by reason of its differential characteristic not being operated; and that talking current is furnished to the called subscriber through the windings of the back-bridge relay in the connector in series with the windings of a differential relay in the connector, the latter of which likewise by reason of its differential characteristic is not operated.

To further describe the invention, it will now be assumed that the toll operator has received a-toll call from a distant point for the subscriber at substation A′. To complete the call, the toll operator inserts the calling plug of a cord, plug P of the cord O for example, into the jack of an idle trunk such as jack J. Inserting plug P into jack J places a bridge across trunk conductors 3 and 4, thereby closing a circuit for the upper winding of line relay 24 which extends from ground at contacts 33 and includes trunk conductors 3 and 4 and contacts 36, 35, 69 and 98 in series. Line relay 24 operates and closes a point in the talking circuit at contacts 88 and closes the circuit of release relay 25 at contacts 89. Relay 25 operates and grounds the release conductor 99 at contacts 91, prepares the impulsing circuit at contacts 92, and closes a circuit for the lower winding of switch-over-control relay 13 at contacts 94, this latter circuit also including contacts 78, 49, 84 and 40. Relay 13 operates and opens a point in the circuit of switch-over relay 12 by separating contacts 43 and prepares a circuit for relay 14 at contacts 42.

After inserting plug P into jack J, the toll operator throws key K to the dialling posi-

tion and then dials the directory number of the subscriber at substation A′, after which she again restores key K to normal.

Responsive to the first digit dialled, vertical magnet 29 of the toll transmission selector TTS operates and raises the switch wipers opposite the corresponding level of bank contacts, after which rotary magnet 30 operates under the control of stepping relay 27 and rotates the wipers into engagement with the set of bank contacts terminating an idle trunk. After the trunk selecting operation, switching relay 23 operates and performs its usual circuit changes including the closing of points in the talking circuit at contacts 80 and 87, the connecting of the grounded release conductor 79 to test wiper 502 at contacts 82, and in addition, grounds the ring control 100 by closing contact 83, opens the initial holding circuit for the lower winding of relay 13 by separating contacts 84 and prepares another circuit for the lower winding of relay 13 by closing contacts 85. The operation of the toll transmission selector TTS in regard to its vertical and rotary movement is similar to the regular selector operation well-known in the art. A detailed description is therefore deemed unnecessary.

It is assumed that the trunk selected is the one comprising conductors 505 to 508, terminating in the toll second selector TS. When this trunk line is seized, a circuit for the line relay (not shown) of the toll second selector TS is closed, which includes the upper winding of relay 13, contacts 38, the two right hand windings of the repeating coil RC, contacts 46 and 44, conductors 8 and 6, and conductors 505 and 508 in series. Relay 13 is now held operated over this circuit, the initial circuit for its lower winding having been opened at contacts 84. Relay 13 is made slow-acting to prevent its dropping back during the short interval after the circuit of its lower winding is opened and before the circuit including its upper winding and the line relay of the toll second selector TS is established.

Line relay 24 again operates responsive to the dialling of the next digit, and at each deenergization opens the circuit of the line relay of the toll second selector TS at contacts 88. The toll second selector TS operates in the usual manner and raises its wipers opposite the level of bank contacts corresponding to the digit dialled and then selects an idle trunk in that level. A circuit is also closed for the lower winding of relay 13 each time line relay 24 deenergizes, this latter circuit including contacts 90, 92, and 85. Thus relay 13 is maintained energized over its lower winding during the intervals when the circuit of its upper winding is opened to operate the toll second selector TS so that relay 24 is maintained energized continuously.

It is assumed that the trunk selected by the toll second selector TS is the one comprising conductors 304 to 307, terminating in the toll and local connector TLC. When this trunk line is seized, the line relay of the toll second selector TS is disconnected from the talking conductors (by the operation of the switching relay of the selector TS) and a new circuit is established for the upper winding of the relay 13 through the windings of the line relay 311 of connector TLC. Thus relay 13 in the toll transmission selector TTS is now maintained energized over its upper winding in series with the line relay 311 of connector TLC. Line relay 311 also operates over this circuit and prepares connector TLC for operation as described previously.

Line relay 24 of the toll transmission selector TTS again operates responsive to the dialling of the third digit, opening the circuit of line relay 311 of connector TLC a corresponding number of times, causing the operation of vertical magnet 321 to step the wipers of the switch opposite the corresponding level of bank contacts. Series relay 319 again operates in series with vertical magnet 311, and at the end of the vertical movement deenergizes, again closing the circuit of relay 314 at contacts 389. Relay 314 operates, closing a locking circuit for itself at contact 344 and disconnecting the vertical magnet from the impulsing circuit by separating contacts 346 and connecting the rotary magnet thereto by closing contacts 345, and in addition thereto, closes a circuit for the reverting control relay 316 by closing contacts 341, ground being present on the ring control conductor 306 (connected via conductor 507 to conductor 100). Relay 316 operates and opens its initial energizing circuit by separating contacts 367 and closes a locking circuit for itself to the grounded toll release conductor 305 by closing contacts 366, prepares a circuit for energizing the two-step converting relay 315 to its first step by closing contacts 369, closes a circuit for the upper winding of ring cut-off relay 317 at contacts 368, and prepares the holding circuit for the ring cut-off relay 13 by closing contacts 364. Ring cut-off relay 317 energizes and closes its holding circuit to the ring control conductor 306 at contacts 371′, opens points in the ringing circuit by separating contacts 370 and 377, and performs other circuit changes which will be described presently.

Responsive to the last digit dialled by the toll operator, rotary magnet 322 operates and rotates switch wipers into engagement with the bank contacts terminating the line to substation A′. During the rotary motion, relay 319 operates in series with rotary magnet 322 and connects the test relay 318 to the test wiper 602 at contacts 385 and closes the energizing circuit of the lower winding of the two-step converting relay 317 at contacts

388, the latter circuit also including contacts 339, 356, and 369. Relay 315 operates to its first step to close contacts 355, thereby preparing the circuit over which it energizes to its second step when contacts 388 are again opened.

The called line may be busy in a toll or local connection, in which case test relay 318 energizes, but it will first be assumed that the called line is idle at this time. At the end of the rotary movement, relay 319 falls back and by separating contacts 388 causes relay 315 to operate to its second step to perform the following changes: By the separation of contacts 347 and 360, back-bridge relay 310 and differential relay 313, whose windings are connected in series with the windings of the back-bridge relay 310, are disconnected from the talking conductors. By the separation of contacts 349 and 361, line relay 312 is disconnected from the talking conductors. By the closure of contacts 348 and 359, points in the talking circuit are closed. A point in the circuit of release magnet 323 is opened by the separation of contacts 350. Release conductor 302 extending to the banks of the local selectors is grounded at contacts 351. A circuit is closed including the two windings of test relay 318 in series at contacts 352, but relay 318, being differentially wound, is not operated. A circuit over which the operation of the toll tone relay 18 in the toll transmission selector TTS is controlled is prepared at contacts 355; and a circuit for the lower winding of switching relay 320 is closed to release conductor 305 at contacts 354. Switching relay 320 operates and performs its usual circuit changes including the closure of points in the talking circuit at contacts 391 and 398 and the placing of ground potential on the private normal contact 612′ of the called subscriber's line by the closure of contacts 392. In this case, however, ground is connected to the private test contact of the called line through resistance R′ rather than being connected directly, since line relay 311 and then release relay 312 restore after relay 311 is disconnected from the talking conductors, as a result of which contacts 336 are opened. In this manner the line at substation A′ is marked "toll busy" as distinguished from being marked "locally busy" when direct ground is connected to the private normal contact, the purpose of which will be described subsequently.

When line relay 311 is disconnected from the talking conductors, the circuit over which the upper winding of relay 13 in the toll transmission selector TTS is held energized is interrupted. This relay thereupon deenergizes and completes the circuit for the switchover relay 12 by closing contacts 43, off-normal springs 10 having closed upon the first vertical step of the switch wipers. Relay 12 energizes and by separating contacts 33 and 35 and closing contacts 34 and 36 reverses the direction of current flow over trunk conductors 3 and 4, the upper and lower windings of the line relay 24 now being connected to trunk conductors 3 and 4, respectively. At contacts 40 a point in the circuit of the lower winding of relay 13 is opened. By the separation of contacts 38, another point in the circuit of the upper winding of relay 13 is opened and by the closure of contacts 39, battery feed relay 20 is connected to trunk conductor 8 via the upper right hand winding of repeating coil RC. By the closure of contacts 41, ground feed relay 21 is connected to trunk conductor 6 via the lower right hand winding of repeating coil RC. By the separation of contacts 37, the short circuit around the upper left hand winding of repeating coil RC is removed, and by the closure of contact 37′ the upper and lower left hand windings of the repeating coil RC are connected via the condenser. Due to the reversal of current flow over the trunk conductors 3 and 4, polarized relay 2 in the operator's cord circuit O energizes and causes the lighting of the lamp L.

The lighting of the lamp L at this time indicates to the toll operator that an idle line has been connected with and that she may signal the called subscriber as soon as she is ready. To signal the called subscriber, the toll operator throws the key K to the left to apply ringing current to the trunk conductors. Ringing relay 11, which is bridged across the trunk conductors 3 and 4, responds to ringing current and closes the circuit of relay 22 at contacts 32. Relay 22 operates and by separating contact 78, disconnects ground from the ring control conductor 100 connected via conductor 507 to the ring control conductor 306 to which ring cut-off relay 317 in the toll and local connector TLC is locked. As a result, ring cut-off relay 317 deenergizes and by permitting contacts 370 and 377 to close, starts the regular automatic interrupted ringing to signal the called subscriber. Relay 22 in operating also closes a local holding circuit for line relay 24 by closing contacts 76 to maintain relay 24 energized while ringing current is applied to trunk conductors 3 and 4.

When the called subscriber answers, ring cut-off relay 317 operates, being energized over its lower winding over the called line loop in the usual manner, and again closes its locking circuit to conductor 306 at contacts 371′, and closes points in the talking circuit at contacts 371 and 376. After the ring cut-off relay 317 is operated, both relays 20 and 21 of the toll transmission selector TTS energize over the called line loop. The operation of relay 21 is of no consequence at this time. Relay 20, in operating, disconnects the windings of line relay 24 from the trunk conduc-

tors 3 and 4 by separating contacts 67 and 69, closing a local holding circuit for line relay 24 by closing contacts 68. The disconnection of the windings of line relay 24 from the trunk conductors 3 and 4 interrupts the circuit of polarized relay 2 in the cord circuit O. Relay 2 thereupon deenergizes and extinguishes the lamp L. The extinguishment of lamp L notifies the toll operator that the called subscriber has answered. After receiving this signal, the toll operator takes necessary steps to complete the talking connection between the calling and the called subscriber, after which the two may hold conversation.

When the subscriber at substation A replaces his receiver at the termination of the conversation, the circuit of relays 20 and 21 is interrupted. Relay 20, in deenergizing, reconnects the windings of line relay 24 to trunk conductors 3 and 4, thus again establishing the circuit of polarized relay 2 in the operator's cord circuit O. Relay 2 in energizing lights lamp L. The lighting of the lamp L at this time indicates to the tool operator that the called subscriber has replaced his receiver whereupon she will remove plug P from jack J, to release the switches used in the connection.

Removing plug P from jack J opens the circuit of line relay 24, which thereupon deenergizes and opens the circuit of release relay 25. Relay 25 deenergizes and disconnects ground from release conductor 99 by separating contacts 91, thereby opening the circuit of switching relay 23, the switching relay of selector TS, and the holding circuits of relays 315, 316, and 320 of the connector TLC, whereupon these relays deenergize and restore to normal. Switching relay 23, in deenergizing, disconnects ground from ring control conductor 100 by separating contacts 83. The removal of ground from ring control conductor 100 opens the holding circuit of ring cut-off relay 317 of the connector TLC. Relays 315 and 320, in restoring, close a circuit for release magnet 323 by closing contacts 350 and contacts 397, respectively. Release magnet 323 thereupon operates and restores the switch wipers to normal. The release of the switching relay of the selector TS also initiates the release of the wipers of the selector TS. The closure of contacts 90 by the release of line relay 24 also closes the circuit of release magnet 31, vertical off-normal springs 9 having closed upon the first vertical step of the switch wipers. Magnet 31 operates and restores the switch wipers to normal. All the switches used in the above-described connection are now in their normal condition and are ready to be used in the establishment of other connections.

In accordance with one of the principles of the 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. To further describe the operations of the toll and local connector TLC when used by a toll operator to set up a toll connection, let us assume that the toll operator has again extended a toll connection to the connector TLC via the cord circuit O, toll transmission selector TTS, and toll second selector TS, and that the wanted line to substation A is busy at this time. As soon as the wipers of the connector TLC are rotated into engagement with the contacts terminating in the line to substation A′, test relay 318 is energized over its lower winding from ground potential (either direct, or through a resistance as R′, depending upon whether the line is locally busy or toll busy) on the test contact 612′. Relay 318 operates and prepares a locking circuit for itself at contacts 379, opens a point in the circuit over which switching relay 320 will later be energized by separating contacts 381, connects conductor 308 connected to interrupter I (Fig. 4) to the trunk conductor 307 at contacts 383, and prepares the circuit over which the operation of the tone control relay 18 in the toll transmission selector TTS is controlled at contacts 378.

Shortly after the termination of the rotary motion, relay 319 deenergizes and permits converting relay 315 to operate to its second step and perform the circuit changes, as previously described, closes the locking circuit for the lower winding of relay 318 to the ring control conductor 306 by permitting contacts 386 to close, and further prepares the circuit over which the operation of tone control relay 18 is controlled by permitting contacts 384 to close, that is, connects test wiper 602, via contacts 378 and 355, to trunk conductor 304. Both relays 317 and 318 are now locked to the ring control conductor 306. It should be noted that no current flows in the upper winding of relay 13 at this time, since ground is connected to both terminals thereof.

The disconnection of line relay 311 from the trunk conductors again causes the deenergization of relay 13 in the toll transmission selector TTS and as previously described causes the current flow over the trunk conductors 3 and 4 to be reversed, and causes relays 20 and 21 to be connected to conductors 8 and 6 respectively, the former operation resulting in the lighting of the lamp L. Since ground potential is intermittently applied to trunk conductor 308 at the toll and local connector TLC by the interrupter I connected thereto as previously described, a circuit is intermittently opened and closed for relay 20 in the toll transmission selector TTS. Relay 20 therefore operates accordingly, disconnecting the windings of line relay 24 from the trunk conductors 3 and 4 by separating contacts 67 and 69 each time it energizes, thus

intermittently opening and closing the circuit of the polarized relay 2 in the operator's cord circuit O. This causes the lamp L to flash, which signal indicates to the toll operator that a busy condition has been encountered.

Relay 20, in operating, also closes a circuit for relay 19 at contacts 69 via the normally closed contacts 72 of relay 21. Relay 19, in operating, closes a locking circuit for itself at contacts 64 from ground at the vertical off-normal springs 10 via contacts 59, and closes a holding circuit for relay 14 at contacts 66 to maintain this relay energized, its initial energizing circuit being opened by the separation of contacts 42 when relay 13 deenergizes. By the separation of contacts 62 and the closure of contacts 63, relay 15 instead of relay 22 is placed under the control of ringing relay 11. At contacts 65, relay 18 is connected via contacts 57 and 48 to the lower trunk conductor 6.

If now the called line is busy in a local connection, direct ground potential is present on the test contact 612′ engaged by test wiper 602, which is now connected via contact 384 and 378 to trunk conductor 304 connected to trunk conductor 6. Thus relay 18 is short circuited and remains unoperated. But if the line to substation A′ is busy in a toll connection, ground potential is connected to the test contact 612′ through a resistance such as resistance R′ in the connector used in the other toll connection. In such case, sufficient current is caused to flow through relay 18 from battery via resistance R connected to trunk conductor 304 via contacts 363 to cause it to operate. Relay 18, in operating, connects conductor 9, to which a characteristic tone current is applied, to the trunk conductor 6. This tone current, passing through the lower right hand winding of repeating coil RC and through the winding of relay 20, is induced in the left hand windings of repeating coil RC.

The toll operator upon perceiving the flashing of the lamp L, operates her listening key K1, providing it is not not already operated, to connect her headset across the trunk conductors for the purpose of determining whether the wanted line is busy in a toll connection or in a local connection. If she hears the special tone, she understands that the wanted line is busy in a toll connection whereupon she will remove the plug P from the jack J to release the connection she has set up, with the intention of attempting to establish a connection at some later time.

If, however, the toll operator hears no tone, it indicates to her that the wanted line is busy in the local connection. The toll operator thereupon momentarily operates the key K to the left, thereby applying ringing current to the trunk conductors 3 and 4 and causing the operation of the ringing relay 11 in the toll transmission selector TTS. Relay 11, in operating, closes the circuit of relay 15. Relay 15 operates and at contacts 47 closes the energizing circuit for the lower winding of relay 16, causing this relay to operate in its first step and prepare an energizing circuit at contacts 53 over which it will operate to its second step as soon as contacts 47 are again separated. Relay 15 also establishes a local holding circuit for line relay 24 at contacts 51 while ringing current is being applied to the trunk conductors 3 and 4, and opens the short circuit around resistance R5 by separating contacts 49, thereby removing the direct ground potential from the ring control conductor 100. This removes the short circuit from the upper winding of busy relay 318. The values of resistance R5, and the resistance of the upper winding of ring cut-off relay 317 and each of the windings of test relay 318 are approximately equal, by reason of which a balanced Wheatstone bridge is now formed with equal values of the current flowing in both the upper and lower windings of test relay 318. Since the windings of relay 318 are differentially wound, relay 318 now deenergizes. In deenergizing, relay 318 opens the circuit of its lower winding by separating contacts 380, disconnects conductor 308, connected to the ground interrupter I, from the talking conductor 307 by separating contacts 383, disconnects wiper 602 and also battery through resistance R from talking conductor 307 by separating contacts 378, and by closing contacts 381 closes a circuit via contacts 354 for switching relay 320. Relay 320 now operates and performs the circuit changes previously described, including the closure of the talking circuit by closing contacts 391 and 398.

After key K is restored, relay 11 and, a moment later relay 15, restore. Two-step relay 16 operates to its second step and closes a locking circuit for itself at contacts 53 via contacts 59 and vertical off-normal springs 10, prepares an energizing circuit for two-step relay 17 at contacts 54, grounds ring control conductor 100 at contacts 58, opens a point in the circuit of tone control relay 18 at contacts 57, and prepares the bridge by which ground will later be connected to the two trunk conductors at contacts 52 and 56.

The operator is now able to converse with the wanted subscriber and will inform him that there is an awaiting toll call for him, and will also inform the unwanted subscriber that he will be disconnected from the connection. The operator then operates the key K momentarily to the ringing position a second time. Ringing relay 11 again responds, and in turn, causes the operation of relay 15. By the closure of contacts 46′ and 44′ ground potential is now applied to both conductors 8 and 6. By the closure of contacts 47, an energizing circuit for the lower winding of

two-step relay 17 is closed, causing this relay to operate to its first step and prepare an energizing circuit at contacts 59′ over which it will operate to its second step as soon as contacts 47 are again separated.

Assuming that the wanted subscriber is busy in a local connection in which he is the called party, the placement of ground potential on both conductors 8 and 6 short circuits a winding of the back-bridge relay and a winding of the differential relay in the connector used in the local connection corresponding to the lower winding of relay 310 and the lower winding of differential relay 313 of connector TLC. The interruption of current in one winding of the differential relay in the connector used in the local connection causes that relay to operate and close at contacts which correspond to contacts 340 the circuit for the release magnet of that connector. The release magnet operates and restores the wipers of the connector to normal. Thus the unwanted subscriber is disconnected from the subscriber who is wanted in the toll connection.

Finding himself disconnected, the unwanted subscriber will then replace the receiver, if he did not when informed of the incoming toll connection for the other subscriber, thus causing the release of the other switches used in the local connection. Had the unwanted subscriber replaced his receiver as seen as the toll operator informed the two parties of the awaiting toll call, all but the connector used in the local connection would have been released at that time. In either case, however, the connector used in the local connection is released as above described.

When relay 15 falls back at the end of the second momentary operation of key K to the ringing position, two-step relay 17 operates to its second step, and by separating contacts 59, opens the holding circuit for two-step 16 and relay 19. Relay 19, in deenergizing, opens the circuit of relay 14 at contacts 66, opens another point in the circuit of tone control relay 18 at contacts 65, opens another point in its own locking circuit at contacts 64, and replaces relay 22 under the control of ringing relay 11. Relay 14, in deenergizing, again connects relay 21 to trunk conductor 6 by closing contacts 45.

If the wanted subscriber has maintained his receiver to his ear, as he is expected to do, relays 20 and 21 will now energize, with the result as previously described, lamp L remaining extinguished. If, however, the wanted subscriber has also replaced his receiver, relays 20 and 21 will not be energized and the lamp L will light. The toll operator may resignal the wanted subscriber by operating key K to the right a third time and thus cause relay 22 to operate and remove ground from ring control conductor 100. This starts the regular automatic ringing by causing the deenergization of the ring cut-off relay 317 in the toll and local connector TLC, which relay again operates upon the removal of the receiver at the called station, whereupon the talking connection is completed.

In the above case it was assumed that a combination toll and local connector was used in the local connection. It is understood, of course, that each group of individual line connectors comprises both local connectors and combination toll and local connectors, the local connectors being similar to the connector TLC, with relays 315 and 316 omitted. A local busy connector is released by the toll operator in the same manner as is a combination toll and local connector when used in a local connection.

In the above case it was assumed that the wanted subscriber was engaged in a local connection which he initiated. If the wanted subscriber is busy in a local connection in which he is the calling party, the toll operator may likewise intrude and release the unwanted subscriber from the connection. In such a case, the application of direct ground potential to the two trunk conductors, resulting from the operator's actuating her ringing and dialing key to the ringing position momentarily the second time to release the unwanted subscriber from the connection, operates on the first selector used in the local connection rather than on the connector.

To describe the manner in which a first selector in such a connection is operated upon, let us assume that the toll operator has extended a connection to a subscriber who at this time is engaged in a local connection which he initiated via the selector S′. As will be recalled from the local connection previously described, the differential relay 121 remained deenergized. The application of direct ground potential to the two toll talking conductors responsive to the second momentary operation of the ringing and dialing key to the ringing position in the present case short-circuits the winding of differential relay 121 which is connected in series with the grounded winding of the line relay of the connector used in the local connection, whereupon relay 121 operates and closes the circuit of release magnet 122 at contacts 123. Release magnet 122 operates and opens points in the talking circuit of the local connection by separating contacts 124 and 125, thereby causing the release of the succeeding second selector switch, and also restores the wipers of selector S′ to normal. Switching relay 120 of selector S′ is maintained operated over the circuit extending frrom the release conductor 112 connected to release conductor 102 to which ground potential is now applied in the toll and local connector used in the toll connection through a resistance such as resistance R′, through the winding of switching relay 120,

contacts 131, 132, through the winding of stepping relay 119 to battery. The connector used in the local connection is released when the called subscriber, finding himself disconnected, replaces his receiver.

As described in the introduction of the specification, a particular feature of this invention is the production of the toll rotary connector TRC, Fig. 4, which, when used by the toll operator to extend a toll connection to a private branch exchange, selects an idle trunk line of the group extending thereto, providing an idle one exists, or selects a locally busy line, providing all the trunks are locally busy or toll busy, after which the toll operator is able to force the release of the existing connection over the selected locally busy trunk line. In order to accomplish the latter operation, local rotary connectors such as the local rotary connector LRC shown in Fig. 2 are required. The manner in which these operations are accomplished will now be described, and for this purpose, it will be assumed that the toll operator wishes to extend a connection to the private branch exchange N, and has set up a connection via the cord circuit O, the toll transmission selector TTS, and the toll selector TS, to the toll rotary connector TRC.

When the connection is extended to connector TRC, line relay 411 operates and grounds conductor 406 at contacts 432, and closes a circuit for the lower winding of ring cut-off 412 at contacts 433. Relay 412 energizes and at contacts 437 closes a locking circuit for itself to the ring control conductor 407, to which ground is applied in the toll transmission selector TTS, closes points in the talking circuit at contacts 436 and 440, and prepares the impulsing circuit at contacts 438.

Responsive to the operator's dialing the next digit, vertical magnet 421 operates under the control of line relay 411 and raises the switch wipers 481 to 484 opposite the level of bank contacts in which the trunks to the P. B. X. "N" are accessible. The relay 413 operates in series with magnet 421, maintaining the vertical magnet circuit closed at contacts 442, vertical off-normal springs 472 opening and springs 472 closing on the first vertical step of the switch wipers. At the end of the vertical movement relay 413 falls back and prepares the circuit of the rotary magnet 442 by closing contacts 443.

Responsive to the dialing of the next digit by the toll operator, rotary magnet 422 operates and rotates the switch wipers into engagement with the set of contacts terminating the first trunk in the group of trunk lines extending to the P. B. X. "N". Relay 415 energizes in series with magnet 422, and closes a circuit for relay 417 at contacts 449, closes a circuit for relay 416 at contacts 450, and opens a point in the circuit of the lower winding of relay 418 at contacts 451. Relay 416 in operating, opens a point in the circuit of the stepping relay 420 by separating contacts 453, prepares a holding circuit for relay 417 at contacts 455, closes a point in the circuit of the lower winding of relay 418 at contacts 456. Relay 417 energizes and closes a point in the circuit of stepping relay 420 at contacts 457, prepares the circuit for the energizing winding of differential busy relay 414 at contacts 459, and at contacts 416 closes the initial energizing circuit of two-step relay 410, causing this relay to operate to its first step and prepare an energizing circuit at contacts 426 over which it will operate to its second step as soon as contacts 460 are again opened.

In the system shown in the drawings, it has been assumed that three trunks comprise the group extending to the P. B. X. "N", the last of which comprises conductors 271 to 274, accessible at bank contacts 488, 489, 489′, and 490, and terminating at the P. B. X. "N" in the jack J. The two test contacts for each trunk are connected together by resistances, contacts 489 and 489′ being connected by resistance R93. Each of the upper test contacts, such as contacts 486, 487, and 489, are connected to a chain relay which is operated when the trunk is busy. When all of the chain relays of one group of trunks are operated, a chain circuit is closed to connect battery through a resistance to the upper test contact of the first trunk of the group. No trunk is connected to the set of contacts immediately following the set terminating the last trunk of the group, but is equipped as follows: Contact 491 is connected to the ground interrupter I, contact 492 is connected to ground through resistance RA94, and bank contact 493 is connected to battery through resistance R96.

Fig. 6 shows the various test potentials which exist on the test contacts of the trunks under different conditions. Resistances "*a*" and "*b*" represent the switching relay of the lineswitch terminating the trunk and the chain relay of the trunk, respectively. When a trunk is idle, both test contacts are free from ground potential as shown at 6^A, Fig. 6. When a trunk line is busy in a local connection, direct ground potential is connected to the upper test contact as shown at 6^B, Fig. 6. When a trunk line is busy in a toll connection, direct ground potential is connected to the upper test contact and ground through a low resistance is also connected to the lower test contact as shown at 6^C, Fig. 6.

To continue with the description of the operation of the connector TRC, it will be assumed first, that one of the lines of the group, namely, the line comprising conductors 271 to 274, is idle at this time, the other two trunk lines being busy either in a toll connection or in a local connection. Since this trunk line is

idle, chain relay 496 is in a deenergized position, and battery through to resistance R95 is not connected to contact 486'. Shortly after the termination of the rotary motion, relay 415 falls back and opens the circuit of relay 416 at contacts 450, opens the initial circuit of relay 417 at contacts 449, closes a holding circuit for relay 417 at contacts 448, and closes a point in the circuit of the lower winding of relay 418 at contacts 451. In the case assumed, relay 418 is not sufficiently energized to cause its operation, and it therefore remains deactuated. Shortly after the circuit of relay 416 is opened, this relay deenergizes and a circuit is closed at contacts 453 for stepping relay 420 which extends from ground on test contact 486, wiper 482, contacts 461, 457, 453, 471, through the winding of stepping relay 420 to the battery. Relay 420 energizes and closes a holding circuit for itself to the release conductor 406 at contacts 469, and closes a circuit for rotary magnet 422 at contacts 470, at the same time closing a holding circuit for relay 417 which includes contacts 454 and 448. Magnet 422 operates and rotates the switch wipers into engagement with the bank contacts terminating the second trunk. Magnet 422, in operating, also opens the holding circuit of relay 420 at contacts 471. Relay 420 thereupon deenergizes and opens the circuit of relay 417 and magnet 422 at contacts 470. Since it is assumed that this trunk line is also busy, ground potential is also present on contact 487, and stepping relay 420 again energizes, again causing the operation of magnet 422 as previously described, the switch wipers being rotated into engagement with the bank contacts 488, 489, 489', and 490. Since no ground potential is present on bank contact 489, this trunk being idle, stepping relay 420 is not operated, and the switch wipers are arrested in this position.

After an interval, relay 417 falls back, opens a point in the circuit of relay 420 by separating contacts 457, and by separating contacts 460, permits two-step relay to operate to its second step. By the separation of contacts 424 and 431, line relay 411 is disconnected from the trunk conductors. By the closure of contacts 425 and 430, points in a talking circuit are closed. At contacts 429 ground through resistance R^4 is connected via wiper 483 to test contact 489' (and the contacts multiply connected therewith). By the closure of contacts 427, a circuit is established for the two windings of test relay 414 and for switching relay 419. Relay 414 is differentially wound, and therefore is not operated. Switching relay 419 operates and connects direct ground to test contact 489 at contacts 466 via wiper 482, and closes points in the talking circuit at contacts 465 and 468.

The disconnection of line relay 411 from the trunk conductors again initiates the changeover operation in the toll transmission selector TTS, whereupon the toll operator is signalled by the lighting of the lamp L, which indicates that connection has been established with an idle trunk. To intitiate the signaling of the attendant at the private branch exchange, the toll operator operates key K to the ringing position, which causes the ring cut-off relay 412 in the connector TRC to unlock by removing ground potential from the ring control conductor 100. Relay 412, in releasing, closes the signalling circuit at contacts 441 and 435, causing the operation of the drop 290 at the attendant's position at the private branch exchange N. The attendant answers the call by inserting the plug of a cord into the jack J'. This operation disconnects the drop 290 and closes a direct current circuit for the upper winding of ring cut-off relay 412, causing this relay to operate and again lock to ring control conductor 407, and also causing the extinguishment of lamp L. The attendant may now converse with the toll operator, after which the two take the necessary steps to place the distant calling subscriber and the called subscriber in connection.

At the termination of the conversation, the attendant removes the plug of her cord from the jack J', which causes the lighting of the lamp L as described above, whereupon the toll operator removes the plug P from the jack J, causing the release of the toll transmission selector TTS and the toll second selector TS in the manner previously described. The removal of ground from the release conductor 406 opens the circuit of relay 410, and the removal of ground from the ring control conductor 407 opens the circuit of ring cut-off relay 412, whereupon these relays deenergize. Relay 410, in deenergizing, opens the circuit including the two windings of relay 414 and relay 420, and by closing contacts 428 closes the circuit of release magnet 422, vertical off-normal spring 473 having been closed upon the first vertical step of the switch wipers. Release magnet 422 operates and restores the switch wipers to normal.

In order to describe the manner in which the toll rotary connector TRC selects the first locally busy trunk of a group, providing all the trunks are either locally engaged or toll engaged, it will now be assumed that the toll operator has extended a toll connection via cord circuit O, the toll transmission selector TTS, the toll second selector TS, to the toll rotary connector TRC at a time when both the first and second trunks extending to the P. B. X. "N" are engaged in toll connections and the trunk line comprising conductors 271 to 274 is engaged in a local connection, the local connection having been extended to the P. B. X. "N" via local rotary connector LRC. (A detailed description of the operation of connector LRC is deemed unnecessary

since its vertical and rotary operation responsive to two digits dialled is similar to that of connector TLC when used in a local connection, and its automatic trunk hunting operation is well-known, being controlled by stepping relay 219 which is operable in series with resistances such as R4 or R91, to be mentioned later.)

At this time, then, all three of the chain relays 494, 495, and 496 are operated and the chain circuit connecting battery through resistance R95 to test contact 486′ is closed. Also test contacts 486 and 487 are both grounded directly and test contacts 486′ and 487′ are grounded through resistances, such as resistance R4, as shown at 6^E and 6^C, Fig. 6. The conditions on test contacts 489 and 489′ are like that illustrated at 6^B, ground being connected to contact 489 by way of wiper 252 and springs 250 of connector LRC. Now, in this case, when relay 415 falls back and closes contacts 451 after the wipers of connector TRC have been rotated into engagement with the set of contacts terminating the first trunk to P. B. X. "N," sufficient current will flow through the lower winding of test relay 418 via resistance R96 to cause this relay to operate. In operating, relay 418 closes a locking circuit for itself at contacts 463, connects wiper 483 in the circuit of stepping relay 420 instead of wiper 482 by separating contact 461 and closing contacts 462, and prepares the circuit of busy relay 414 at contacts 464.

An interval after relay 415 falls back, relay 416 falls back and starts the rotary hunting operation. Switching relay 420 is operated from ground through resistances, such as resistance R4, connected to test contact 486′, and to test contact 487′. Consequently, the switch wipers are rotated into engagement with the third set of bank contacts. As assumed, the trunk terminating in the third set of bank contacts is busy in a local connection, no ground connection appears on contacts 489′, but direct ground is connected to bank contact 489. The value of resistance R93 is high enough, however, to prevent sufficient current flow through it and through the winding of stepping relay 420 to cause relay 420 to operate. Relay 420 therefore remains deenergized, and the wipers are arrested on this set of bank contacts. Busy relay 414 is also energized over its lower winding from ground on bank contact 489 via wiper 482 and contacts 464 and 459. In operating, relay 414 connects ground interrupter I to the upper talking conductor at contacts 444, opens a point in the circuit of switching relay 419 at contacts 445, and prepares a locking circuit to the ring control conductor 407 at contacts 447.

Upon the termination of the rotary operation, relay 417 falls back and opens a point of the circuit of switching relay 420 at contacts 457, and closes the locking circuit for the lower winding of busy relay 414 to the ring control conductor 407 by permitting contacts 458 to close. By the separation of contacts 460, two-step relay 410 is again permitted to operate to its second step and perform the circuit changes previously described, including the disconnection of line relay 411 from the trunk conductors. The toll operator now receives the busy signal by the flashing of lamp L, the interrupter I now being connected to the upper talking conductor, all as previously described.

The manner in which the toll operator establishes a talking connection to the engaged parties, and then forces a release of the local connection in this type of connection is the same as when extending a connection to a busy individual subscriber's line. The operator, by momentarily applying ringing current to the trunk conductors 3 and 4 causes the deenergization of the differential busy relay 414. Relay 414 deenergizes and closes the circuit of switching relay 419 which in operating closes points in the talking circuit at contacts 465 and 468. A second application of ringing current to the trunk conductors 3 and 4 causes ground potential to be applied to the two talking conductors 8 and 6 which unbalances the differential relay 218 in the local rotary connector LRC used in the local connection. Relay 218 by closing contacts 223, closes a circuit for release magnet 242, which in operating restores the wipers of connector LRC to normal. The toll operator is now connected to the private branch exchange over the third trunk line, and the subscriber who was connected with the private branch exchange over this trunk line has been disconnected.

Should the toll operator wish to signal the attendant at the private branch exchange, she may do so in the regular way by applying ringing current to the trunk conductors 3 and 4, which now causes the operation of relay 22 in the toll transmission selector TTS. Relay 22 by closing contacts 77 and 74, applies ringing current to the trunk conductors to operate the signal in the attendant's cord circuit.

In the above case, it was assumed that the selected locally engaged trunk was busy in a connection extended to the P. B. X. "N". Had this trunk been busy in a local connection initiated from the P. B. X. "N", the first selector at the main exchange used in this local connection would have been operated on (as previously described) rather than the connector LRC.

Should all three trunks to the private branch exchange be busy at the time the toll operator attempts to extend a connection thereto, the wipers of the connector used, the toll rotary connector TRC for example, will be rotated past the set of bank contacts termi-

nating the last trunk and into engagement with contacts 491, 492, 492′, and 493, and will be arrested in this position, bank contact 492′ being unequipped. Busy relay 414 is operated from ground connected to contact 492 through resistance R94, connecting interrupter I to the upper talking conductor at contacts 444. Since battery potential through resistance R96 is connected to bank contact 493 now engaged by switch wiper 484, the tone control relay in the toll transmission selector also operates. Thus the operator not only receives the busy flash signal, but also receives a tone, indicating to her that all the trunks to the private branch exchange are busy in toll connections, whereupon she will release the connection and try again at some later time.

It is possible, after a toll rotary connector, such as connector TRC, is rotated into engagement with the contacts terminating the first trunk of the group to a private branch exchange N, for example, and by its preliminary tests has determined that there is an idle line in the group (indicated by the absence of battery connected through a resistance R95, on the test contact 486′) that the only idle line existing at that time may be seized by some other connector before the toll rotary connector TRC can seize it. This last trunk will then also test busy, and the toll rotary connector TRC will continue to rotate over the other busy contact sets and into engagement with contacts 491, 492, 492′ and 493. In such a case, of course, the busy relay 414 is not operated because relay 418 has remained deenergized, and switching relay 419 will operate immediately following the operation of relay 410. The toll operator now receives the same busy signals as when all the trunks are found toll engaged, since the interrupter I will now be connected to the upper trunk conductor via bank contact 491 and wiper 481. The operator, as before, will again withdraw the plug of her cord to release the toll switches operated, and redial the called number. In her second attempt, since now all the trunks are busy, she will obtain connection over the first locally busy trunk.

What is claimed is:

1. In a telephone system, a line which may be either idle or busy, switches including a selector and a connector for extending a connection to said line, means for sending an impulse of ringing current to said selector, and means in said selector responsive to an impulse of ringing current, providing said line is busy in another connection, for causing the release of said other connection.

2. In a telephone system, a line which may be idle or busy, switches including a selector and a connector for extending a connection to said line, means in said connector for signalling over said line, means for sending an impulse of ringing current to said selector, means in said selector responsive to an impulse of ringing current for starting the operation of said signalling means, providing the line is idle, and for causing the release of the connection in which said line is engaged, providing said line is busy.

3. In a telephone system, a line which may be busy or idle, switches including a selector and a connector for extending a connection to said line, means in said connector for signalling over said line, a switching relay in said connector for closing normally open contacts in the talking circuit, means for sending impulses of ringing current to said selector, means in said selector responsive to an impulse of ringing current for starting the operation of said signalling means, providing the line is idle when connection thereto is extended, and for causing the operation of said switching relay, providing said line is busy when connection thereto is extended, and responsive to a second impulse of ringing current for causing the release of the connection in which said line is engaged.

4. In a telephone system, a line which may be either idle or busy in another connection, means including a selector, a trunk, and a connector terminating the trunk for extending a connection to said line, means for sending ringing current to said selector, and means in said selector responsive to ringing current, providing said line is busy in another connection when connection thereto is extended, for applying a characteristic potential to the two talking conductors of said trunk line to cause the release of said other connection.

5. In a telephone system, a line which may be either idle or busy in another connection, means including a selector and a connector for extending a connection to said line, a relay in said connector operative when connection to the line is extended, providing said line is idle, for completing the talking connection from said selector to said line, means for sending impulses of ringing current to said selector, and means in said selector responsive to one impulse of ringing current for causing the operation of said relay, providing said line is busy in another connection when connection thereto is extended, and responsive to another impulse of ringing current for causing the release of said other connection.

6. In a telephone system, a line which may be either idle or busy in another connection, means including a selector, a trunk, and a connector terminating said trunk line for extending a connection to said line, a relay in said connector for completing the talking connection to said line automatically operative when connection to the line is completed, providing the line is idle, means in said selector for causing the operation of said relay when said line is busy in another connection and for causing the release of said other connection, the former operation being controlled over one con-

ductor of said trunk line and the latter over another conductor of said trunk line.

7. In a telephone system, a line, means including a selector, a trunk line comprising two talking conductors and a non-talking conductor, and a connector terminating said trunk line for extending a connection to said line, a relay in said connector for completing the talking connection from said selector to said line, and means in said selector for controlling the operation of said relay over said non-talking conductor, providing said line is busy in another connection when connection thereto is extended, and for controlling the release of said other connection over a talking conductor of said trunk line.

8. In a telephone system, a line, means including a selector, a trunk comprising two talking conductors and a non-talking conductor, and a connector for extending a connection to said line, a second connector for extending another connection to said line, a relay in said first connector operative to prevent the completion of the talking connection when connection to said line is extended while the line is busy in said other connection, and means in said selector for applying a characteristic potential to said non-talking conductor to release said relay to establish a talking connection to said line, even though the line is busy in said other connection, and for applying said potential to one of said talking conductors, and means in said first connector responsive to the application of said potential to one of said talking conductors for releasing said second connector.

9. In a telephone system, a line, a connector for extending a connection to said line, a selector for extending a connection to said connector, a ring control relay in said connector operated when a connection is extended to said connector, a busy relay in said connector for preventing the completion of the talking connection and for controlling a signal in case the line is busy when a connection thereto is extended, means for sending an impulse of ringing current to said selector, and means in said selector responsive to said impulse for causing the release of said busy relay, providing it is operated, and for causing the release of said ring control relay to signal over said line, providing the line is idle.

10. In a telephone system, a line, means including a selector, a trunk, and a connector terminating said trunk for extending a connection to said line, a first relay in said selector for disconnecting a normally applied potential from one conductor of said trunk, a second relay in said selector for causing said normally applied potential to be applied through a resistance, and means for making either relay effective depending upon whether the line is busy or idle when connection thereto is extended.

11. In a telephone system, a line, means including a selector and a connector for extending a connection to said line, a first and a second relay in said selector, a ring control relay and a busy relay in said connector, means in said selector for making either said first or said second relay effective depending on whether said line is busy or idle when connection thereto is extended, means controlled by said first relay for controlling said ring control relay, and means controlled by said second relay for controlling said busy relay.

12. In a telephone system, a line, means including a selector, a trunk, and a connector terminating said trunk line for extending a connection to said line, a ring control relay in said connector for controlling the signalling of the subscriber on the line, a busy relay in said connector for controlling the operation of a busy signal, and means in said selector for altering the character of the potential on one conductor of said trunk line differently depending on whether the line is idle or busy when connection thereto is extended to cause an operation of said ring control relay in one case and an operation of said busy relay in the other case.

13. In a telephone system, a line, means including a selector, a trunk, and a connector for extending a connection to said line, means in said selector for altering the character of one conductor of said trunk differently depending on whether the line is idle or busy when connection thereto is extended, a ring control relay in said connector effected by one alteration, and a busy relay in said connector for controlling a busy signal effected by the other alteration.

14. In a telephone system, a line, means including a selector, a trunk, and a connector for extending a connection to said line, means for sending ringing current to said selector, means in said selector responsive to ringing current for altering the character of one conductor of said trunk line differently depending on whether the line is busy or idle when connection thereto is extended, means in said connector responsive to one alteration for completing a talking connection providing the line is busy, and means in said connector responsive to the other alteration for signalling over said line, providing the line is idle.

15. In a telephone system, a line, a connector for extending a connection to said line, a busy relay in said connector having two windings differentially wound, means for operating said relay over one of its windings providing said line is busy when connection thereto is extended, and means for decreasing the current in the one winding and for pro-

ducing a current flow in the other winding to cause said busy relay to deenergize.

16. In a telephone system, a line, an operator's switchboard, a connector for extending a connection from said switchboard to said line, a busy relay in said connector having two windings differentially wound, means for operating said relay over one of its windings to prevent the completion of the talking connection providing said line is busy when connection thereto is extended, and operator controlled means for producing equal values of current in the two windings of said relay to cause it to deenergize and complete the talking connection.

17. In a telephone system, a line, means including a selector and a connector for extending a connection to said line, a busy relay in said connector having two windings differentially wound, means for operating said relay over one of its windings to prevent the completion of the talking connection providing said line is busy when connection thereto is extended, and means in the selector for producing equal values of current in the two windings of said relay to cause it to deenergize and complete the talking connection.

18. In a telephone system, a line, a nonnumerical hunting switch, a plurality of numerical switches, means for successively operating said switches to extend a connection from said line, means for applying a characteristic potential to a talking conductor of said line, and means in the first numerical switch responsive to said application for releasing said numerical switches while said hunting switch is maintained operated.

19. In a telephone system, a line, a plurality of switches, means for successively operating said switches to extend a connection from said line, means for applying a characteristic potential to a talking conductor of said line, means in one of said switches responsive to said application for causing the release of a succeeding switch while a preceding switch is maintained operated.

20. In a telephone system, a line, a plurality of switches, means for successively operating said switches to extend a connection from said line, a differentially wound relay in one of the switches, means for applying a characteristic potential to a talking conductor of said line to operate said relay, and means controlled by said relay for causing the release of a switch succeeding said one switch while a switch preceding said one switch is maintained operated.

21. In a telephone system, a trunk comprising talking conductors and a release conductor, a connector having two directed movements for extending a call from said trunk, a relay in said connector operated at the end of the first movement for conditioning said connector for its second movement, a second relay in said connector operated when the call is answered, and means jointly controlled by said relays for momentarily applying a characteristic potential to said release conductor.

22. In a telephone system, a trunk comprising talking conductors and a release conductor, a connector having two directed movements for extending a call from said trunk, a relay in said connector operated at the end of the first movement for conditioning said connector for its second movement, and means controlled by said relay for applying a characteristic potential to said release conductor when the call is answered.

23. In a telephone system, a toll trunk, a local trunk, a combination two motion toll and local connector operable over either of said trunks, a relay in said connector operable at the completion of one motion to condition said connector for its second motion, a two-step relay in said connector, means controlled by said first relay for operating said two-step relay to its first step providing said connector is operated over said toll trunk, and means operable at the completion of the second motion for operating said two-step relay to its second step, providing it has previously been operated to its first step, to condition said connector for toll operation.

24. In a telephone system, a toll trunk, a local trunk, a combination two motion toll and local connector operable over either of said trunks, a two-step relay in said connector, and means for operating said relay to its first step while the connector is executing its second motion and for operating said relay to its second step at the completion of the second motion, providing the connector is operated over said toll trunk, to condition said connector for toll operation.

25. In a telephone system, a line which may be in either of three conditions, a trunk, means including a connector for extending a connection from said trunk to said line, means for distinctively marking one talking conductor of said trunk providing said line is in the first or the second condition when connection thereto is extended, means for distinctively marking the other talking conductor of said trunk providing said line is in the first condition when connection thereto is extended, and means operative in accordance with said markings for indicating the condition of said line.

26. In a telephone system, a line which may be idle, locally engaged or toll engaged, means including a selector, a trunk, and a connector terminating said trunk for extending a connection to said line, means for intermittently applying a characteristic potential to one talking conductor of said trunk providing the line is toll or locally engaged, means for applying a characteristic potential to the other talking conductor providing the

line is toll engaged, and means in the selector operative in accordance with the potentials applied to said talking conductors for indicating the condition of said line.

27. In a telephone system, an operator's switchboard, a line which may be idle, locally engaged, or toll engaged, means including a selector, a trunk, and a connector for extending a connection from said switchboard to said line, means for distinctively marking one talking conductor of said trunk providing said line is locally or toll engaged, means for distinctively marking another talking conductor of said trunk providing said line is toll engaged, a signal at said switchboard, means in said selector operative when one talking conductor is marked for controlling said signal, and means in said selector operative when the other talking conductor is marked for giving the operator at said switchboard a distinctive tone.

28. In a telephone system, a line, a contact for said line, means for marking said contact differently to indicate the idle condition, the locally busy condition, or the toll busy condition of said line, means including a trunk for extending a connection to said line, a test relay operative, providing said line is locally busy or toll busy when connection thereto is extended, to connect said contact to a conductor of said trunk, and means controlled over said conductor to indicate whether said line is locally busy or toll busy.

29. In a telephone system, a line, a test contact for said line, means for marking said contact differently to indicate the condition of said line as to whether it is idle, locally busy or toll busy, means including a trunk for extending a connection to said line, a test relay for distinctively marking one conductor of said trunk and for connecting said contact to another conductor of said trunk providing said line is locally busy or toll busy when connection thereto is extended, and means controlled over said two conductors for indicating the condition of said line.

30. In a telephone system, a line, an operator's switchboard, a test contact for said line, means for marking said contact differently to indicate the idle condition, the locally busy condition, and the toll busy condition of said line, means including a selector, a trunk, and a connector for extending a connection from said switchboard to said line, an interrupter, a test relay in said connector for connecting said interrupter to one conductor of said trunk and for connecting said contact to another conductor of said trunk, a signal at said switchboard, means in said selector controlled over said one conductor for operating said signal, and means in said selector controlled over said other conductor for giving the operator at said switchboard a distinctive tone providing said line is toll busy.

31. In a telephone system, a group of lines, any one or more of which may be idle, locally busy, or toll busy, a rotary connector having two test wipers, and means including one of said test wipers for operating said connector to select an idle one of said lines, providing one is idle, and including the other test wiper for operating said connector to select a locally busy line providing all the lines are either locally busy or toll busy.

32. In a telephone system, a group of lines, any one or more of which may be idle, locally busy, or toll busy, a rotary connector having two test wipers, means controlled over either of said wipers for operating said connector, said means being effective to cause the connector to select an idle line, providing one is idle, when controlled by one test wiper and effective to cause the connector to select a locally busy line, providing all the lines are either locally busy or toll busy, and means operative previous to the selecting operation, providing all the lines are either locally busy or toll busy, for determining which wiper is to control the selecting operation.

33. In a telephone system, a group of lines, means for marking each of said lines in accordance as to whether it is idle, locally busy, or toll busy, means for further marking a certain one of said lines when all of the lines are either locally busy or toll busy, a rotary connector having two test wipers, means controlled over either of said wipers for operating said connector, said means being effective to cause the connector to select an idle line, providing one is idle, when controlled by one test wiper and effective to cause the connector to select a locally busy line, providing all the lines are either locally busy or toll busy, and means operative in accordance with the marking on said certain one of said lines for determining which wiper is to control the selecting operation.

34. In a telephone system, a local rotary connector, a toll rotary connector, lines consecutively accessible to said connectors, two test contacts for each line, means for distinctively marking the first test contact of each line when the line is locally busy, and for distinctively marking both test contacts of each line when the line is toll busy, means in said local rotary connector controlled by the markings on both test contacts of the lines preceding an idle line for causing the local rotary connector to select the idle line, providing one is idle, and means in said toll rotary connector controlled by the marking on the first test contact of the lines preceding an idle line for causing the toll rotary connector to select the idle line, providing one is idle, and controlled by the marking on the second test contact of the lines preceding a locally busy line for causing the toll rotary connector to select the locally busy line, providing all the lines are either toll busy or locally busy.

35. In a telephone system, a connector, lines consecutively accessible to said connector, two test contacts for each line, means for distinctively marking the first test contact for each line when the line is locally busy, and for distinctively marking both test contacts of a line when the line is toll busy, and means controlled by the markings on the first test contact of the lines preceding an idle line for causing the connector to select said idle line, providing one is idle, and controlled by the markings on the second test contact of the lines preceding a locally busy line for causing the connector to select said locally busy line, providing all the lines are either toll busy or locally busy.

36. In a telephone system, a connector, lines consecutively accessible to said connector, two test contacts for each line, means for marking the first test contact for each line when the line is locally busy, and for distinctively marking both test contacts of a line when the line is toll busy, means including a stepping relay normally controlled by the markings on the first test contacts of the lines preceding an idle line for causing the connector to select said idle line, providing one is idle, means operative providing all the lines are either busy or idle for causing said stepping relay to be controlled by the markings on the second test contacts of the lines preceding a locally busy line and cause said connector to select said locally busy line.

37. In a telephone system, a group of lines, a connector having two test wipers, testing means normally controlled over the first test wiper for causing the connector to select an idle line of said group, providing one is idle, means operative providing all the lines of the group are either toll or locally busy to cause said testing means to be controlled over the second test wiper and cause the connector to select a locally busy line of said group, and means controlled over the first test wiper providing all the lines are toll busy for operating a busy signal.

38. The method of rendering characteristically busy a line having two test conductors which consists in applying a busying potential directly to one test conductor only of said line when the line is involved in a connection of one class and for applying said busying potential directly to both test conductors when the line is involved in a connection of another class.

39. In a telephone system, a group of lines having a common call number, each line having two talking conductors and two local test conductors, two groups of connectors having access to said lines, each of said connectors having access to the said conductors of each line and being arranged to test and rotate over said lines successively to extend a connection to an idle one, means for causing the connectors of one group to rotate over a line or not depending upon the potential found on one test conductor of such line, and means for causing the connectors of the other group to rotate over a line or not depending upon the potential encountered upon the other test conductor of the same line.

40. In a telephone system, a line having two test conductors interconnected by a resistance element, means for extending a connection of either of two classes to said line, means effective when a connection of one class is extended to the line for placing a guarding potential on only one of said conductors so that it is transmitted to the other test conductor through the interconnecting element, and means effective when a connection of the other class is extended to said line for placing a guarding potential on each conductor independent of the other.

41. In a telephone system, a line having two test conductors interconnected by a resistance element, means for extending a connection of either of two classes to said line, means effective when a connection of one class is extended to the line for placing a guarding potential on only one of said conductors so that it is transmitted to the other test conductor through the interconnecting element, and means effective when a connection of the other class is extended to said line for placing a guarding potential on the other test conductor independent of said element.

42. In a telephone system, a group of lines having a common call number and arranged to be tested over successively by automatic switching apparatus, means for operating said automatic switching apparatus to test said lines in a given way when one line or more is idle, a test wiper through which said apparatus tests said lines, and means resulting from a busy condition of all the lines in the group and controlled through said test wiper for bringing about a circuit change within said automatic switching mechanism so that it applies a different test to said lines.

43. In a telephone system, a plurality of lines having a common call number assigned thereto, means whereby any one of said lines may become involved in a connection of either of two classes, means including automatic switching mechanism for extending a connection to any one of said lines, said mechanism being arranged to apply a given test to said lines successively in case one or more busy lines are encountered and until it encounters one which is not involved in a connection of either of said classes, and means responsive to the condition existing when all of said lines are involved in connections of one class or the other for bringing about a circuit change in said switching mechanism so that it will refuse connection to any line involved in a connection of one class and will permit a connection to a line involved in a connection of the other class.

44. In a telephone system, a line having a test conductor, means whereby said line may be included in a connection of either of two classes, means for connecting a guarding potential to said test conductor in case the line is involved in a connection of one class and for connecting the same guarding potential to said test conductor through a resistance element in case the connection in which the line is involved is of the second class, means including automatic switching apparatus for extending a connection to said line, said apparatus being arranged to complete the connection in case the line is idle and in case it is involved in a connection of the first class, and means for preventing the connection responsive to a test made over said test conductor and the encountering of the busy potential through the resistance element in case the connection in which the line is involved is of the second class.

45. In a telephone system, a line having a test conductor, means whereby said line may be included in a connection of either of two classes, means for connecting a guarding potential to said test conductor in case the line is involved in a connection of the first class and for connecting the same guarding potential to said test conductor through a resistance element in case the line is involved in a connection of the second class, automatic switching apparatus for extending a connection of the second class to said line, said apparatus being arranged to complete the connection in case the line is idle and in case it is involved in a connection of the first class, means for preventing the connection responsive to a test made over said test conductor and the encountering of the busy potential through the resistance element in case the connection in which the line is involved is of the second class, other automatic switching apparatus through which connections of the first class may be extended to said line, and means in said switching mechanism for preventing a connection of the first class to said line in case the line is involved in a connection of either class.

46. In a switching system, an automatic switch having two test wipers, a group of lines arranged to be tested over successively by one of the test wipers of said automatic switch, and means controlled through the said first test wiper responsive to a busy condition of all the lines in the group for causing the lines to be tested by means of the second test wiper instead of the first.

47. In a telephone system, a group of lines having a common call number and arranged to be tested over successively by automatic switching apparatus, means for extending a connection of either of two classes to any one of said lines and for marking any connected line characteristically busy in a manner dependent upon the class of the connection extended thereto, and means responsive to all lines of the group being busy for placing a third characteristic condition on the first line of the group.

48. In a telephone system, a group of lines having a common call number and arranged to be tested successively by automatic switching apparatus, means responsive to any line of the group being taken for use for marking the line engaged so that it tests busy to the automatic switching apparatus, and means responsive to all of the lines in the group becoming busy for altering the marked condition of the first line of the group.

49. In a telephone system, a group of lines having a common call number and arranged to be tested successively by automatic switching apparatus, means responsive to any line of the group being taken for use for marking the line engaged so that it tests busy to the automatic switching apparatus, and means responsive to all of the lines in the group becoming busy for altering the marked condition of one of the lines in the group.

In witness whereof, I hereunto subscribe my name this 17th day of October, A. D. 1927.

VICTOR S. THARP.

In witness whereof, I hereunto subscribe my name this 17th day of October, A. D. 1927.

JOHN WICKS.