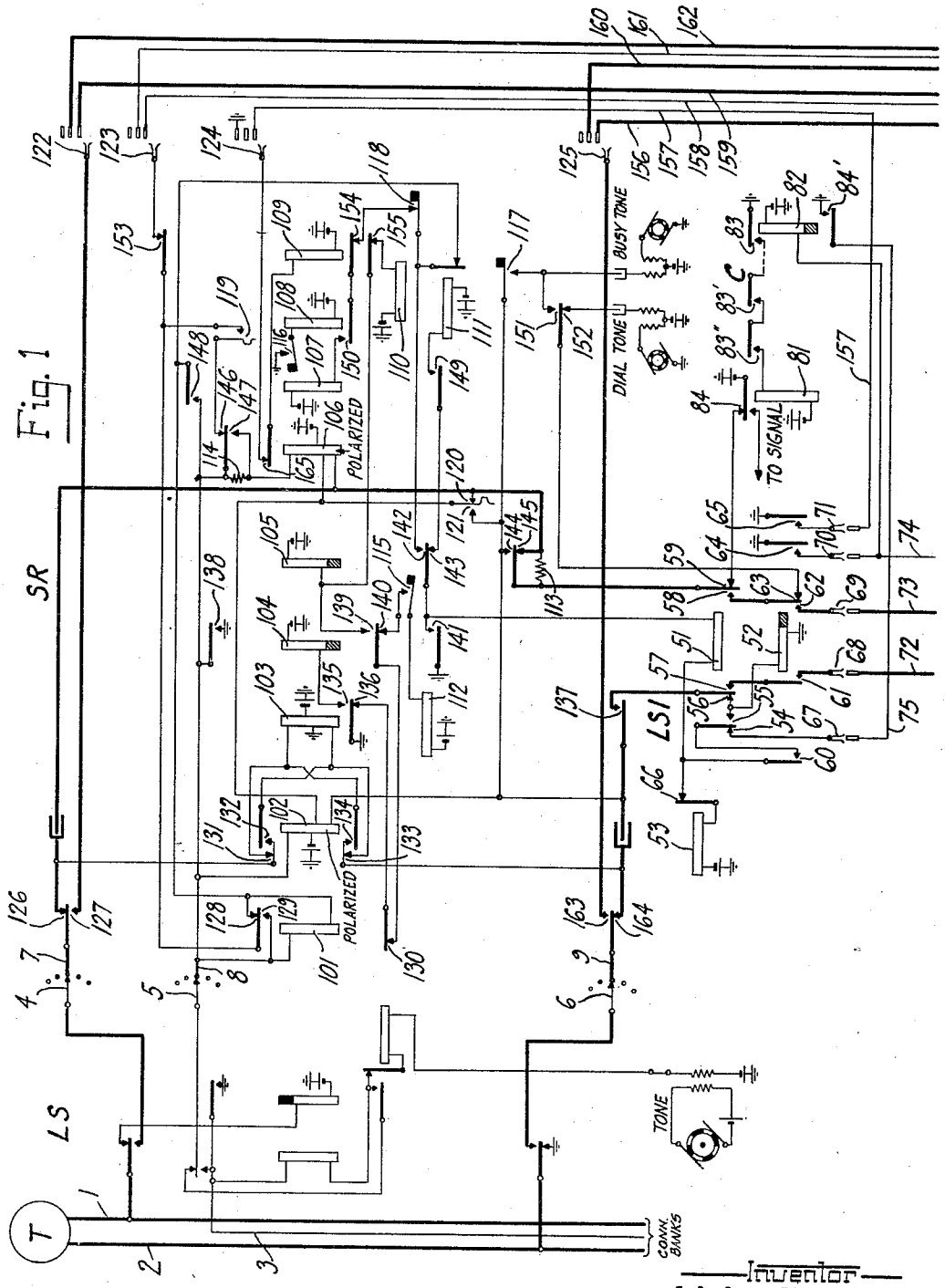
April 26, 1932. V. S. THARP 1,855,779

TELEPHONE SYSTEM

Filed July 21, 1930 5 Sheets-Sheet 1

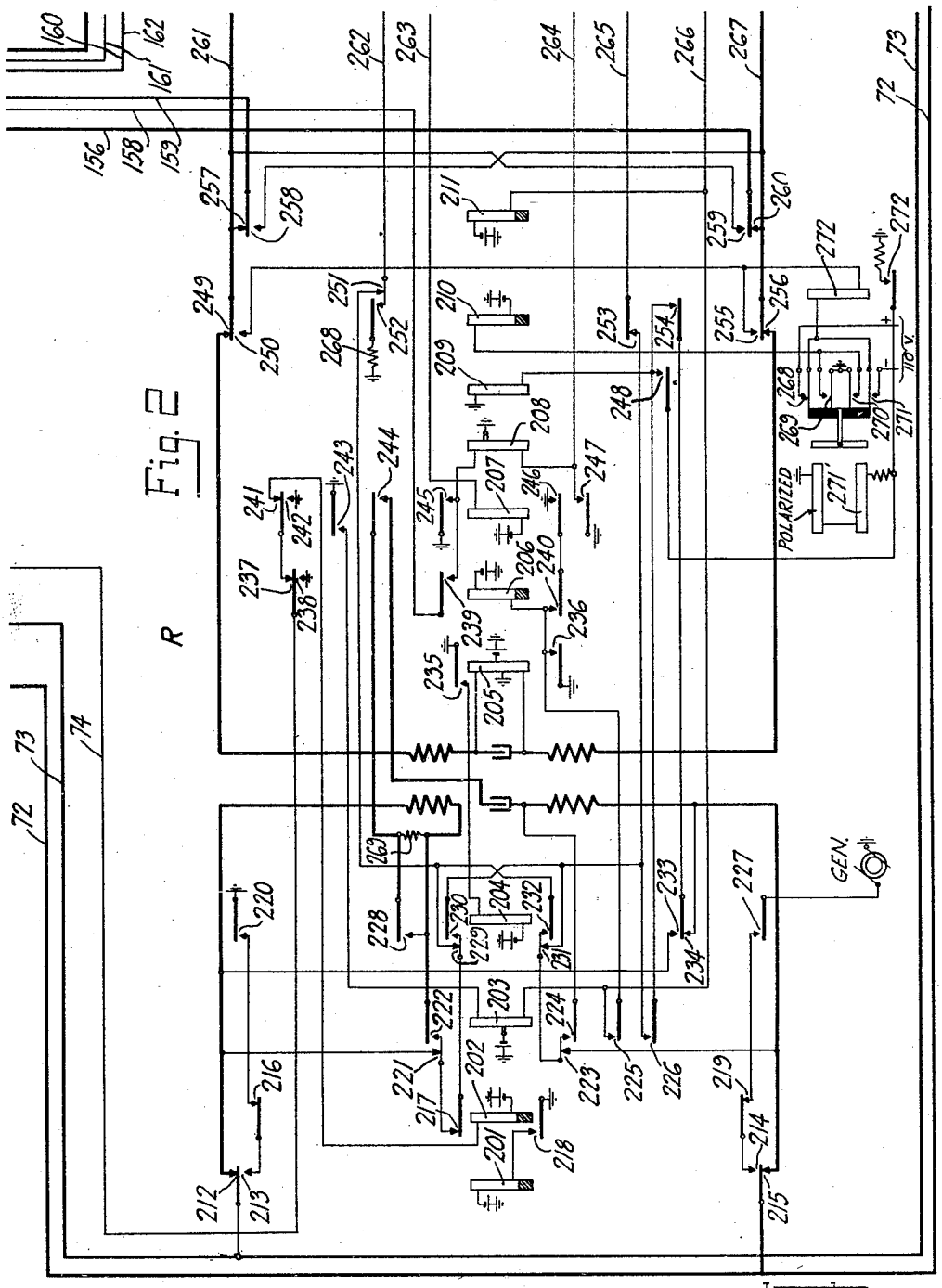


Inventor
Victor S. Tharp
R. S. Richardson
Atty.

April 26, 1932. V. S. THARP 1,855,779

TELEPHONE SYSTEM

Filed July 21, 1930 5 Sheets-Sheet 2



Inventor
Victor S. Tharp

R. B. Richardson
Atty.

April 26, 1932. V. S. THARP 1,855,779

TELEPHONE SYSTEM

Filed July 21, 1930 5 Sheets-Sheet 3

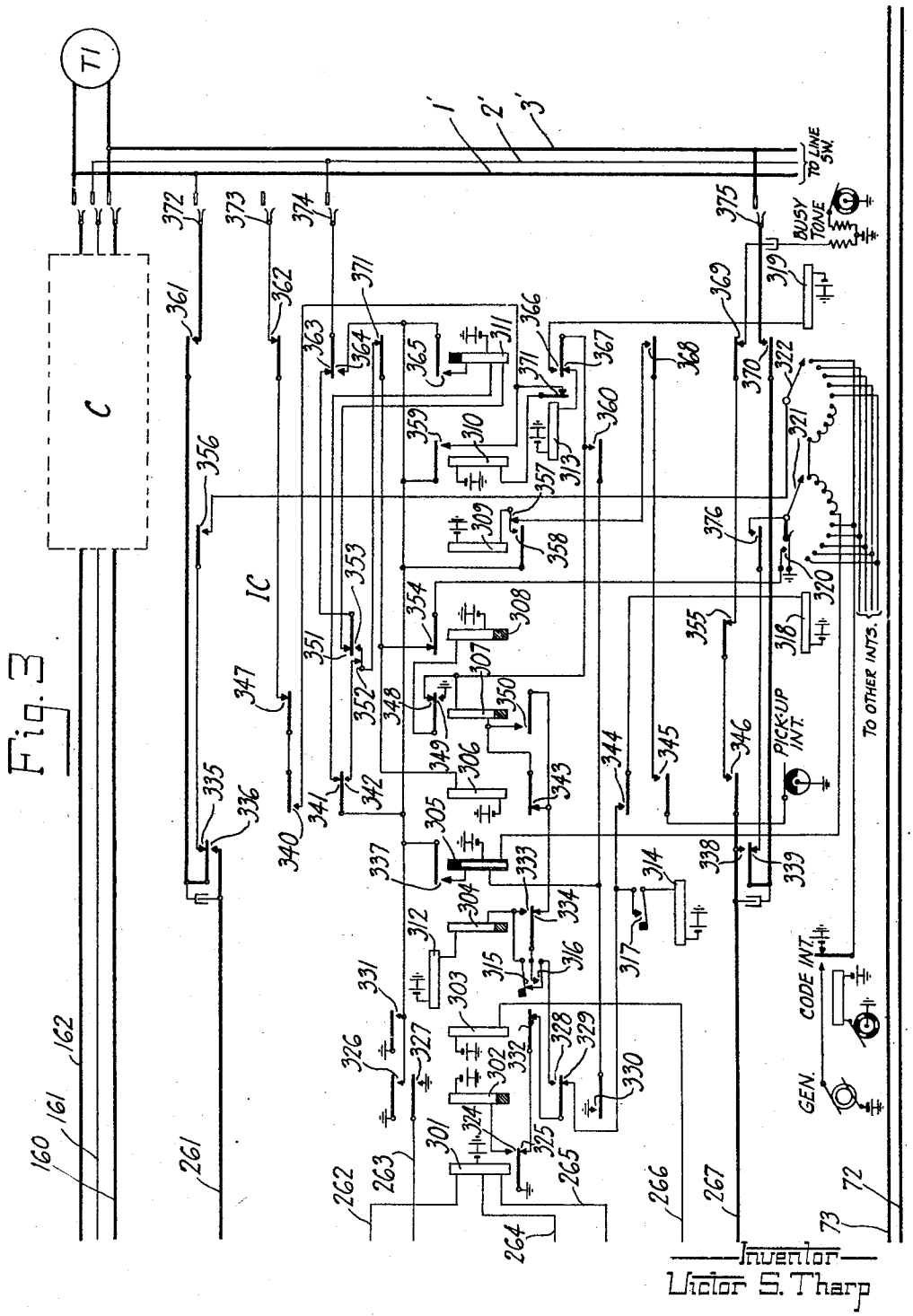


Fig. 3

Inventor
Victor S. Tharp

R. B. Richardson
Atty.

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TELEPHONE SYSTEM

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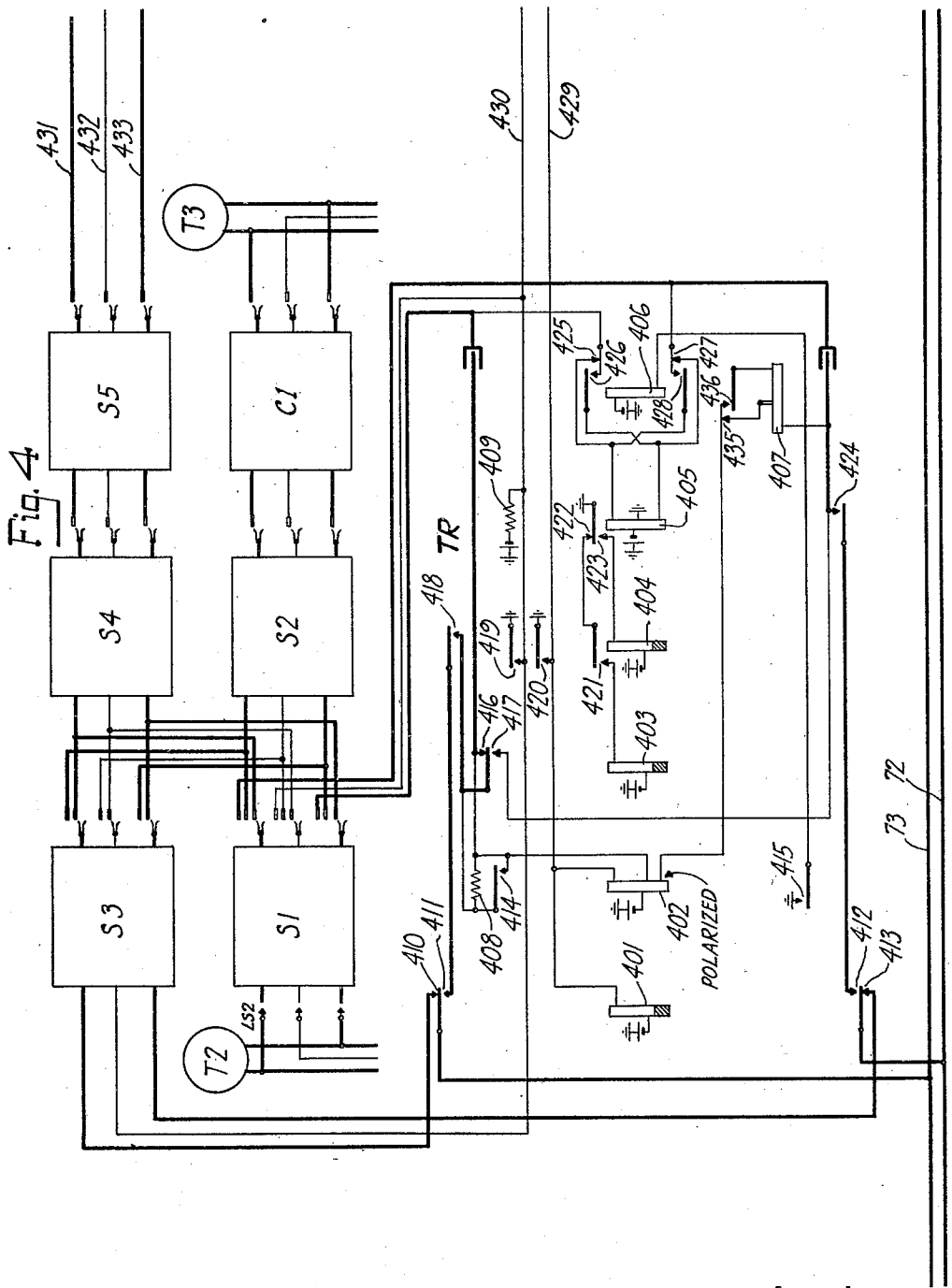

Fig. 4

Inventor
Victor S. Tharp

R S Richardson
Atty.

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TELEPHONE SYSTEM

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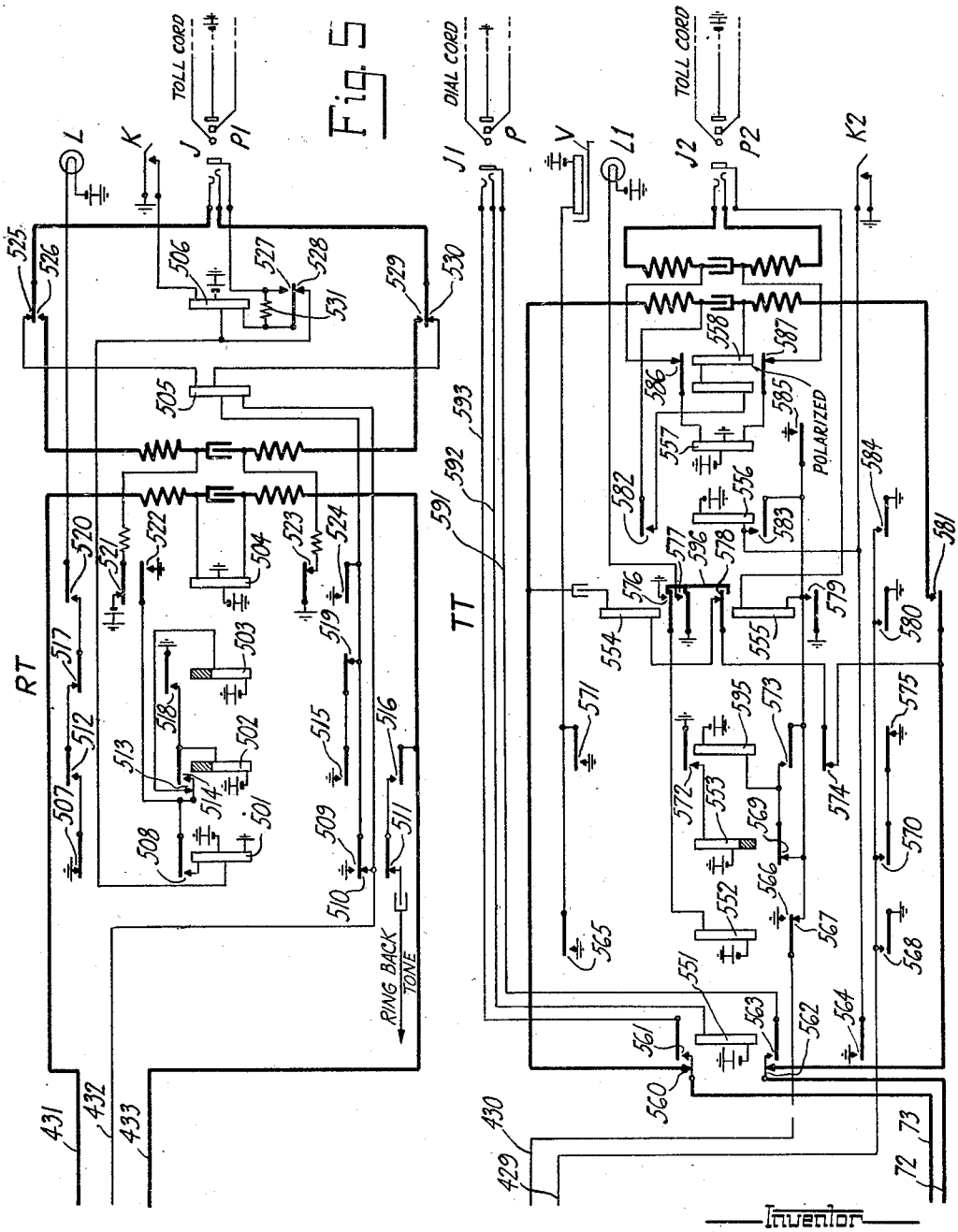

Fig. 5

Inventor
Victor S. Tharp

R. B. Richardson
Atty.

Patented Apr. 26, 1932 1,855,779

UNITED STATES PATENT OFFICE

VICTOR S. THARP, OF ELMHURST, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO ASSOCIATED ELECTRIC LABORATORIES, INC., OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE

TELEPHONE SYSTEM

Application filed July 21, 1930. Serial No. 469,530.

This invention relates to telephone systems in general, particularly to multi-office telephone systems which include satellite or sub-exchanges and in which connections are completed through the medium of automatic switches. The invention has for its object the provision of new and improved circuits and apparatus for interconnecting the various exchanges of such systems to provide reliable and efficient local, toll and auxiliary services.

It is common practice in present day telephone systems of the above type to centralize the toll and auxiliary service switchboards in one exchange of the system and to connect this exchange with the other exchanges of the system with a separate group of trunk lines for each class of service. Trunking arrangements of this type are entirely satisfactory when the exchanges are close together and the inter-connecting trunk lines are relatively short. When long and expensive trunk lines are required, however, economic considerations require that these be reduced to a minimum. This may be accomplished by increasing the efficiency of the trunking system, for example, by carrying all traffic over one large trunk group instead of over a number of separate, smaller trunk groups.

There are numerous obstacles in the way of using a single group of trunk lines for all classes of calls, particularly when a satellite or sub-exchange is involved. This is due to a large extent to the inter-connection of the sub-exchange and the associated main exchange for the purpose of maintaining a uniform numbering arrangement in the system. Further difficulties arise when it is necessary to discriminate between different classes of calling lines as is usually the case when toll service is handled on the so-called C. L. R. basis. The desirability of using the more or less standard numbering codes for the various auxiliary services such as information, complaint, toll, etc., must also be considered in designing the trunking system.

The foregoing difficulties and others have been overcome in the present invention of which one of the main features is the arrangement whereby all traffic between a sub-exchange and a main exchange may be handled over a single efficient group of trunk lines while maintaining a uniform numbering arrangement throughout the system.

Another feature provides for identifying both the class of a calling line and the originating exchange on calls to the toll recording position.

Another feature is the arrangement whereby a repeater may be automatically inserted in a connection extending to the toll recording position to increase the transmission efficiency in case the call is to be further extended on a C. L. R. basis.

A further feature resides in the novel switching selector repeater for use in sub-exchanges of a multi-office system.

A still further feature is the arrangement for controlling the coin mechanism of pay-station lines on calls extended over long trunk lines.

An incidental feature is the arrangement of the code ringing party line connector for automatic hunting when such is required. This feature is particularly desirable in small exchanges in which few subscribers have more than one line listed under a single directory number.

The foregoing features together with others not specifically mentioned will be discussed in detail, reference being had to the accompanying drawings which disclose the invention in one of its narrower phases. These drawings, comprising Figs. 1 to 5, inclusive, show, by means of the usual circuit diagrams, sufficient apparatus in a system embodying the invention to permit the invention to be readily explained and understood. Fig. 1 shows apparatus at the satellite exchange including a switching selector repeater. Fig. 2 shows a repeater associated with a trunk connecting the satellite exchange with the main exchange. Fig. 3 shows a connector associated with the repeater of Fig. 2. Fig. 4 shows various switching units of the main exchange, of which only the repeater associated with the trunk extending to the satellite exchange is shown in detail. Fig. 5 shows the manual circuits for the toll operator's position.

Referring now to Fig. 1, there is shown an ordinary automatic substation T associated with a subscriber's line terminating in lineswitch LS. Lineswitch LS is of the well known rotary type arranged for class of service tone. This lineswitch together with other similar lineswitches associated with other subscribers' lines in the satellite exchange have access to the trunks terminating in switching selector repeaters, of which the trunk terminating in selector repeater SR is shown. In case there are paystation lines in the system there will be a repeater of the type disclosed in United States patent to Wicks, No. 1,649,430 of November 15, 1927 connected in the primary trunk over which such lines have access to the selector repeater SR. Selector repeater SR is of the well known Strowger type and associated therewith is a rotary lineswitch LS1, which in common with other similar lineswitches has access to outgoing trunks to the main exchange. The switching selector repeater likewise has access to these trunks by way of the first level of its banks, and over other bank levels has access to local connectors in the satellite exchange. One or more levels of these switches are set aside for switching purposes according to the usual practice.

Repeater R shown in Fig. 2 is associated with a trunk incoming from the main exchange and also with an incoming connector. This trunk and other similar trunks are accessible to the rotary lineswitches, such as LS1, and to the switching selector repeaters, such as SR. Repeater R and the associated connector IC of Fig. 3 are similar in general to the corresponding switches disclosed in the co-pending application of Tharpe et al., Serial No. 250,232, filed January 28, 1928, Patent No. 1,792,452, Feb. 10, 1931, modified, however, in accordance with the requirements of the present invention.

Incoming connector IC of Fig. 3 is associated individually with the incoming repeater of Fig. 2 and functions in both local and toll calls. The connector shown is of the ten-party code ringing type, although obviously a single party or rotary connector may be employed if required. The local connector C shown in skeleton form in this figure has access to various subscribers' lines of the satellite exchange in common with connector IC, and may be of the general type disclosed in the United States Patent to Ray et al., Serial No. 1,606,446 of November 9, 1926, modified for automatic hunting as shown in connector IC.

Fig. 4 is concerned primarily with the trunking arrangements of the main exchange. Outgoing repeater TR is associated with the previously mentioned trunk connecting the main exchange and the satellite exchange. A branch of this trunk extends to incoming selector S3 through which access is had to the switching apparatus of the main exchange. Substation T2 is an ordinary automatic substation whose associated line terminates in lineswitch LS2, through which access is had to the exchange first selectors, such as S1. Lineswitch LS2 may be similar to lineswitch LS previously referred to. The banks of the incoming selector S3 are multipled with those of the local first selector S1, so that these switches have common access to the main exchange switching apparatus. Selector S4 is a so-called special second selector which is accessible in the first level of the banks of the preceding rank of switches. These special second selectors have access to special third selectors through the first level of their banks, while the remaining levels are multipled back with corresponding levels of the preceding rank of switches. The special third selectors, such as S5, have access to special service trunks, such as information, complaint, toll recording, etc. Only the toll recording trunk is shown since the others are not particularly concerned with the invention. The special service trunking arrangement described above is more or less standard in present day telephone types, and is shown and described in Automatic Telephone Practice by H. E. Hershey, third edition published in 1920, pages 208 to 210, inclusive.

The incoming selectors and local first selectors also have access to the regular selectors of the main exchange of which selector S2 is shown. The selectors, such as S2, have access to connectors, such as C1, which in turn have access to the main exchange subscribers' lines. The selectors and connectors may be of the ordinary Strowger type similar in general to those shown on pages 60 and 38, respectively, of the above referred to Hershey publication.

Repeater TR of Fig. 4 is a well known type of impulse repeater associated with the trunks extending to the satellite exchange. This repeater functions to repeat the dialled impulses over the trunk on local calls.

In Fig. 5 is shown a recording trunk RT and a toll dialling trunk TT. The recording trunk is arranged for the so-called C. L. R. service, that is, requests for toll service coming in over this trunk may be forwarded direct without requiring a new connection to be set up over the toll switch train. The trunk is accessible in the banks of the special third selectors and is reached by dialling a special code number, for example the number 110, which is set aside for this service and listed as such in the directory. The trunk is equipped with a tone cut-off key and the usual jack and signal lamps.

The toll trunk is equipped for dialling over a separate dial jack and is arranged for the usual supervision. A dialling cord suitable for operation of the trunk is shown in the previously referred to Tharpe et al. patent.

The trunk circuit is individual to the interoffice trunk extending to the satellite exchange, a branch of the trunk extending directly to the toll trunk for incoming calls. Both of the above trunk circuits are old and well known and have been shown to more clearly illustrate the operation of the invention. The trunk circuits are arranged to operate with the ordinary manual toll cord circuits commonly used for this type of service.

The operations involved in setting up various connections of this system will be described briefly in the following paragraphs. A call originating in the satellite exchange is extended to an idle switching selector repeater. The rotary lineswitch associated with the switching selector repeater operates to select an idle trunk to the main exchange terminating in an incoming selector thereof. The switching selector repeater and the incoming selector operate in synchronism in response to the first digit of the called number. In case this number indicates that the call is for a subscriber in the satellite exchange, the trunk to the main exchange is released and the selector repeater connects with a trunk terminating in an idle local connector. The local connector responds to the remaining digits of the called number and extends a connection to the called line in the usual way.

In the case of a call directed to a subscriber in the main exchange, the switching selector repeater is stepped to a level assigned for main exchange calls. The switching test wiper on finding the special switching condition, disables the selector from further operation and the call then proceeds over the trunk line and main exchange switches to the called subscriber.

A satellite exchange subscriber on calling the tool recording operator initiates a call as in the previous case but dials the usual code number, for example 110. The selector repeater and the incoming selector at the main exchange operate in synchronism, the latter switch selecting an idle special second selector. The switching selector repeater then automatically sets its wipers on the contacts associated with the trunk over which the call was extended by the rotary lineswitch, but does not connect with the trunk at this time. The lineswitch associated with the selector repeater marks the particular interoffice trunk selected in the bank of the switching selector repeater so that the wipers may be positioned as above described. The subscriber then dials the final digits of the code number, operating the special second selector and the special third selector to extend a connection to an idle recording trunk. This trunk is so arranged that the battery and ground connections to the trunk conductors are opposite to corresponding connections of the selectors and connectors. Thus when the special third selector seizes the recording trunk, battery is reversed over the interoffice trunk and certain switching operations are initiated in the selector repeater causing this switch to seize the trunk previously selected. The calling line is then extended to the trunk by way of the selector repeater and the trunk repeater R, and the previous connection by way of the lineswitch LS1 is released. Repeater R now sends out an impulse of ringing current which operates the ring-down relay of the toll trunk TT. The signal associated with the toll trunk is operated and the branch of the trunk over which the connection was originally extended to the recording trunk is disconnected, thereby releasing the switch train in the main office and also the previously connected recording trunk. The call will be answered by the tool operator and completed by means of a toll cord in the usual way. The routing of this incoming call to the toll position indicates to the operator that the call has originated in the satellite exchange and may, therefore, be handled in the manner required by local conditions.

Ordinary toll recording calls originating in the main exchange are trunked over the special switch train to the recording position and answered at that position. The lines may be arranged for discriminating service, in which case a tone will be connected to the release trunk conductor to notify the operator of the class of line originating the call. The operator may remove this tone by operating the tone removal key, and the call may be extended over a regular cord circuit in the usual way.

Subscribers in the main exchange may call subscribers in the satellite exchange by dialling the regular directory number. The call is extended over a level in the first selector and by way of an outgoing repeater, an interoffice trunk line, incoming repeater, such as R, and an incoming connector IC.

Toll connections to subscribers in the satellite exchange are set up over the toll trunk circuit TT, outgoing repeater TR, trunk line, incoming repeater R and connector IC. The toll operator connects with a trunk line by means of a regular toll cord inserted in jack J. The dialling cord is then inserted in jack J1 and the number of the called subscribers dialled. Connector IC responds to dial impulses and extends the connection to the wanted line. In case the called line is a pay-station line the toll operator may refund or collect coins by applying either refund or collect current to the talking conductors of the trunk in the usual way. This special current controls a polarized relay in the incoming repeater R which in turn applies corresponding current to the talking conductors of the called line. This arrangement is necessary when the interoffice trunks are rela-

tively long, in which case the resistance of the trunk renders the operation of the coin control apparatus somewhat unreliable when the source of the current is at the distant exchange.

Having briefly described the apparatus and the operations involved in setting up various connections in the system, a detailed description of the operation will now be given. It will be assumed first that the subscriber at substation T calls the subscriber at substation T1, both of which are located in the satellite exchange. When the receiver is lifted at substation T a loop circuit is closed over the calling line, and lineswitch LS operates in the well known manner to select an idle trunk, for example the trunk comprising conductors 7—9. The calling line loop is extended to a switching selector repeater, such as SR, over wipers 4 and 6 of the lineswitch, trunk conductors 7 and 9, normally closed contacts 126 and 164, normally closed contacts 131 and 133, through the upper and lower windings of relay 103, respectively, to battery and ground. Relay 103 operates, completes a circuit for relay 104 at contacts 135, and completes a circuit for lineswitch LS1 at contacts 137. Relay 104 operates and connects a holding ground to release trunk conductor 8 at contacts 138, prepares the impulsing circuit at contacts 139, opens a point in the release magnet circuit of contacts 140, and prepares the switching circuit of the lineswitch LS1 at contacts 141. Line relay 52 of lineswitch LS1 operates over a circuit extending from ground, winding of relay 52, contacts 56 and 137, lower winding of polarized relay 102, normally closed contacts 120 of the shaft springs, contacts 145, 59 and 84, to battery. Polarized relay 102 does not operate at this time since its upper winding is energized from ground at contacts 138 and opposes the lower winding which is energized in series with relay 52. The operation of relay 52 completes a number of circuits, only the test circuit through contacts 60 being effective, however, at this time. Assuming that the wipers of the lineswitch are standing on contacts associated with a busy trunk at this time, wiper 67 will encounter a ground from contacts corresponding to contacts 84′ of the associated chain relay. This ground extending by way of contacts 54 and 60, interrupter contacts 66, through the winding of the stepping magnet to battery, energizes the stepping magnet which interrupts its own circuit contacts 66. The magnet on deenergizing advances the wipers to the next set of contacts which are tested in the same manner, and if these contacts also are busy, the wipers are advanced a step further. This operation is repeated until an idle trunk is found which will be assumed to be the trunk comprising conductors 72—74. Relay 51, which was prevented from operating during the hunting since its winding was short-circuited by the ground on wiper 67, energizes when an idle trunk is encountered over a circuit extending from ground at contacts 141, winding of relay 51, interrupter contacts 66, winding of stepping magnet 53, to battery. The stepping magnet does not energize in series with relay 51 due to the high resistance of the relay. Relay 51 upon energizing completes a holding circuit for relay 52 in series with the stepping magnet at contacts 55, and extends the previously traced loop, over which relay 52 was operated, to conductors 72 and 73 by way of contacts 57 and 58 and contacts 61 and 62. Chain relay 82 associated with the trunk is energized from ground at contacts 64 and wiper 70, and the particular trunk in use is marked in the first level of the selector repeater banks, by ground at contacts 65, wiper 71 and conductor 157. Ground on conductor 74 also extends by way of contacts 237 and 241 to relay 202, which energizes and completes a circuit for relay 201. Relay 201 energizes and disconnects repeater R from the trunk. The previously referred to loop from the selector repeater is extended over conductors 72 and 73 of the trunk connecting the satellite exchange with the main exchange and through contacts 410 and 413 to the line relay of incoming selector S3. The line relay of the selector energizes in the usual way and prepares the selector to respond to the dialled impulses.

The foregoing operations take place responsive to the initiation of the call. When the subscriber dials the first digit of the called number, relay 103 responds the usual way and with each retraction of its armature completes a circuit from ground, contacts 136, 130 and 139, through the winding of relay 105, to battery, and in parallel therewith, through contacts 155, winding of vertical magnet 110, to battery. The vertical magnet responds and raises the wipers step-by-step to the called level, which will be assumed to be the level in which the trunk comprising conductors 160–162 is accessible. Relay 103 also interrupts the loop extending to the main office at contacts 137 and selector S3 operates in synchronism with the selector repeater SR and raises its wipers to the corresponding level. Relay 105 energizes in response to the first impulse transmitted to the vertical magnet, and, due to its slow-to-release characteristics, remains operated throughout the series of impulses. The lower winding of relay 102 is short-circuited by the closure of contacts 144 to improve impulsing over the trunk. A circuit for stepping relay 107 is prepared at contacts 142 and the circuit of the rotary magnet is opened at contacts 143. Off-normal contacts 115 and 116 close when the wipers are stepped from normal position, the latter contacts completing a circuit for relay 108 which

energizes and completes a circuit for relay 107. Relay 107 operates and completes a locking circuit for itself which may be traced via contacts 150 and 154, eleventh position cam contacts 118, interrupter contacts of the rotary magnet, contacts 148, to ground on release trunk conductor 8. Relay 107 also prepares a circuit for the rotary magnet by closing contacts 149. Shortly after the last impulse of the series, relay 105 releases and closes a circuit for the rotary magnet at contacts 143. The magnet operates and steps the wipers of the switch in on the first set of contacts of the called level, at the same time opening the locking circuit of relay 107 at the interrupter contacts. Relay 107 restores and opens the circuit of the rotary magnet. In case the trunk encountered is busy, wiper 123 will find a ground which extends by way of contacts 153 and 128, interrupter contacts of the rotary magnet, cam contacts 118, contacts 154 and 150, winding of relay 107, to battery to reoperate relay 107 which repeats the cycle of operations previously described for stepping the switch to the next set of contacts. It will be noted that the circuit for relay 107 also extends through the winding of relay 101 to ground on the release trunk conductor. Relay 101, however, is prevented from operating at this time since it is shunted by the ground on the test wiper. When an idle trunk is encountered, for example the trunk comprising conductors 160—162, the shunt will be removed from relay 101 and that relay will operate in series with relay 107. Relay 107 is prevented from operating due to the high resistance of relay 101. Relay 101 in operating disconnects the calling loop from line relay 103 and extends it by way of contacts 127 and 163, wipers 122 and 125, conductors 160 and 162, to the line relay of connector C which operates. Relay 103 restores and opens the circuit of relay 104 which likewise restores after a slight delay to allow time for the connector to return the holding ground on the release trunk. Relay 103 on restoring also opens the circuit extending to the main exchange, thereby releasing selector S3 and relay 104 opens the holding circuit for relays 51 and 52 of lineswitch LS1, which restore. Lineswitch LS1 and the trunk are now in normal condition, and the trunk is available for other calls. The subscriber then dials the final digits of the called number, operating connector C in the well known manner to extend a connection to the called subscriber's line, which is signalled in the usual way.

When the subscribers finish talking, the subscriber at substation T on hanging up the receiver opens the loop circuit and the line relay of the connector deenergizes. Ground is removed from the release trunk which permits relay 101 of selector repeater SR to restore and complete the circuit of the release magnet at contacts 130. Release magnet 112 operates to restore the switch wipers to normal position in the usual manner and lineswitch LS, of course, restores in the usual manner likewise.

It may be noted at this point that the incoming selector at the main exchange is arranged to apply dial tone to the calling loop. This tone is audible to the calling subscriber who is connected to the loop through the talking condensers of the selector repeater SR. In the event that all trunks to the main exchange are busy, it is necessary that the subscriber receive a dial tone so that local calls may be completed if desired. A call originating under these conditions will operate selector repeater SR as in the previous instance. However, relay 81 will operate over a circuit including contacts 83, 83′ and 83″ of the chain relays, such as 82, associated with the outgoing trunks. The previously traced operating circuit for relay 52 will be incomplete due to the opening of contacts 84, hence, relay 52 will not operate as in the previous connection. Relay 51, however, will operate as hereinbefore explained and a circuit may be traced from the dial tone generator, contacts 152, 63, 58 and 145, upper talking condenser, to the upper talking conductor of the trunk, and thence to the called subscriber. The tone will inform the subscriber that an idle switch has been taken into use and the dialling may proceed. The call, if for a local subscriber, will proceed as previously described with the exception that no circuit will be completed for the incoming selector at the main exchange. If the call is for a subscriber in the main exchange, however, further switching operations are involved which will be described in later paragraphs.

A call from the subscriber T in the satellite exchange to subscriber T3 in the main exchange will now be considered. Initiation of the call operates selector repeater SR and lineswitch SL1 as in the previous case. The subscriber dials the first digit and the selector repeater and incoming selector S3 respond as in the previous connection. In this case, however, the wipers of the selector repeater are raised to a switching level, and, when the switch rotates on this level, wiper 124 encounters a grounded contact which completes a circuit for relay 109. Relay 109 in operating disconnects test wiper 123 at contacts 153, opens the circuit of relay 107 at contacts 154, and disconnects the rotary magnet at contacts 155. The wipers of the switch, therefore, remain on the first set of contacts of the called level, but switching relay 101 is prevented from operating due to its circuit being open at contacts 154. Relay 103 responds to subsequent digits of the called number and repeats the digits over the trunk

line to operate selector S3, a main exchange second selector, such as selector S2, and a connector, such as connector C1, to extend the connection to the called line. Connector C1 will signal the called subscriber in the usual way and on the subscriber answering will reverse battery over the trunk. Polarized relay 102 of selector repeater SR operates since its two windings will now assist each other, and reverses the connection of line relay 103 to the calling subscriber's line for metering or other purposes.

When the subscribers finish talking and restore their receivers, the opening of the calling loop permits relay 103 to deenergize, and this relay in turn opens the loop extending to the main exchange. Selector repeater SR releases in the usual way followed by the release of lineswitch LS1 and the switches in the main exchange.

In case all trunks to the main exchange are busy when a call is initiated as above, selector repeater SR operates as previously described, but lineswitch LS1 remains unoperated. Following the dialling of the first digit which designates the call as for main exchange subscriber, relay 109 operates and relay 107 deenergizes as previously described, and a busy tone returned to the calling subscriber by way of contacts 151, 63, 58 and 145, and the upper talking condenser of the selector repeater. This tone may be the same as the tone applied by the connector on encountering a busy line and will inform the calling subscriber that the connection cannot be completed at this time, after which the connection will be released in the usual way.

Since the present system employs a uniform numbering arrangement, subscribers in either exchange will dial the same code numbers to call the special service operators. The subscriber at substation T, for example, to call the toll recording operator will dial the digit 110. Lineswitch LS will operate in the usual way on the initiation of the call and seize an idle selector repeater which may be assumed to be selector repeater SR. This switch operates exactly as in previously described connections and a branch connection is set up by way of lineswitch LS1 and the interoffice trunk to incoming selector S3 at the main exchange. The subscriber then dials the first digit of the code, that is, the digit 1 and relay 103 responds. Vertical magnet 110 is energized once and raises the wipers of the selector repeater to the first level at which point the shaft springs are operated. The operation of the shaft springs closes a short-circuit around relay 101 and completes a circuit for relay 107 independent of the test wiper at contacts 119, and at contacts 120 and 121, respectively, the lower winding of polarized relay is connected in the loop extending to the main exchange and the lower winding of polarized relay 102 is short-circuited. The loop circuit to selector S3 is interrupted in the usual way and that switch operates to select an idle trunk accessible in its first level, for example the trunk terminating in special second selector S4. Referring now to the selector repeater, relay 108 operates responsive to the closure of off-normal contacts 116 and completes a circuit for the relay 107. Shortly after the impulse, relay 105 restores and completes the rotary magnet circuit. The rotary magnet energizes, steps the wipers in on the first set of contacts of the first level and opens the circuit of relay 107. Relay 107 deenergizes and in turn opens the circuit of the rotary magnet which also deenergizes. A circuit is now completed for relay 107 extending by way of contacts 150 and 154, cam contacts 118, interrupter contacts of the rotary magnet, contacts 128, shaft spring contacts 119, and contacts 146 and 138, to ground. Relay 107 re-operates and again closes the rotary magnet circuit which steps the wipers to the next set of contacts and again opens the circuit of relay 107. This action is repeated until the wipers reach the set of contacts marked by lineswitch LS1 which correspond to the trunk line over which the connection has been extended to the main office. In this position a circuit is closed from ground at contacts 65, wiper 71 of lineswitch LS1, conductor 157, test wiper 124 of the selector repeater, contacts 165, winding of relay 109, to battery. Relay 109 operates and opens the circuit of relay 107 at contacts 154 to prevent further stepping action. Relay 109 also disconnects the rotary magnet at contacts 155. No connection is extended over the wipers of the selector repeater at this time, since relay 101 is unable to operate due both to the short-circuit around its winding at shaft spring contacts 119 and since its series connection with relay 107 is open at contacts 154.

The subscriber now dials the second digit of the code, again the digit 1, and selector S4 is operated to the first level on which it selects an idle trunk leading to a special third selector, such as the selector S5. Selector S5 responds to the third and last digit of the code, which in this case will be assumed to be the digit 0, and selects an idle trunk terminating in the recording position, for example the trunk comprising conductors 431—433 terminating in trunk relay group RT. The calling loop is thus extended over conductors 431 and 433, left-hand windings of the repeating coil, through the upper and lower windings of relay 504 to ground and battery, respectively. It will be noted that in this circuit ground is connected to the upper talking conductor and battery to the lower talking conductor, whereas in the regular switches the connection is reversed. This results in a reversal of the direction of current flow in the loop from selector repeater SR.

Referring back to the selector repeater it

will be noted that with the switch wipers operated to the first level the lower winding of polarized relay 102 is short-circuited at contacts 121 and the short-circuit around the lower winding of polarized relay 106 is opened at contacts 120. In other words, the lower winding of relay 106 is substituted for the lower winding of relay 102 in the control circuit extending to the main office. Relay 106 does not operate initially, however, since its upper winding is differentially energized in series with resistance 114. When the recording trunk is seized current flow over the loop is reversed as described and relay 106 operates, since its two windings now assist each other. Relay 106 closes a locking circuit for itself at contacts 147, opens the short-circuit around relay 101 at contacts 146 and opens the circuit of relay 109 at contacts 165. Relay 109 restores and completes the series circuit for relays 107 and 101 at contacts 154 and again connects up the test wiper at contacts 153. There will be no potential on the contacts engaged by wiper 123, hence relay 101 will operate in series with relay 107 and switch the calling line loop straight through by way of wipers 122 and 125, conductors 156 and 159, contacts 257 and 260, contacts 249 and 256, right-hand windings of the repeating coil, through the upper and lower windings of relay 205, respectively, to battery and ground. Relay 205 energizes over the calling loop, completes a circuit for relay 204 at contacts 235 and a circuit for relay 206 at contacts 236. Relay 206 on operating disconnects relay 202 from conductor 74 and connects a busying ground to that conductor to mark the trunk busy after the lineswitch LS1 is released. Relay 206 also connects a holding ground to conductor 158 at contacts 239 to hold the selector repeater and preceding lineswitch operated following the restoration of the line and release relay of the selector repeater.

In the selector repeater, line relay 103 and release relay 104 restore to normal freeing lineswitch LS1 as in a local connection. The loop circuit extending to the main office is opened following the release of relay 103, consequently the switch train including selectors S3, S4 and S5 in the main exchange is released, thereby freeing the recording trunk.

Referring now to repeater R, relay 202 restores following the operation of relay 206 and opens the circuit of relay 201. Relay 201 is slow-to-release and maintains contacts 213 and 214 closed a short time after its circuit is opened. During this interval ringing current is transmitted over the trunk from generator GEN, contacts 227, 219 and 214, trunk conductor 72 to toll trunk TT, and via contacts 562, 574 and 578, winding of alternating current responsive relay 554, through the condenser and contacts 560, trunk conductor 73, back to repeater R and by way of contacts 213, 216 and 220, to ground. Relay 554 operates and is mechanically inter-locked with relay 555 and maintains its armatures in actuated position until restored by the interlocking arm 596 controlled by relay 555. The operation of relay 554 completes a circuit to relay 552 at contacts 576 and also a circuit for lamp L1 at contacts 577. Relay 552 operates and completes a circuit for the visual busy signal V at contacts 565, and at contacts 566 connects ground to conductor 430 to operate to mark the trunk line busy to the main office first selectors. Relay 401 operates and disconnects the trunk from the incoming selector at contacts 410 and 413, thereby insuring the release of these switches in case the previous open interval has been insufficient for this purpose. The lighting of signal lamp L1 indicates to the toll operator that a call has come in from the satellite exchange.

Referring now to repeater R, relay 201 on deenergizing disconnects the ringing current source from the loop to the main exchange at contacts 213 and 214 and at contacts 212 and 215 extends the loop to line relay 301 of connector IC (Fig. 3). This circuit may be traced from trunk conductor 73, contact 212, 221, 217, 230 and 253, conductor 265, lower winding of relay 301, conductor 264, lower winding of impedance 208, to ground, and from trunk conductor 72 by way of contacts 215, 223, 232 and 251, conductor 262, upper winding of relay 301, to battery. Relay 301 does not energize at this time due to the condenser in series with relay 554 at the toll position.

It may be assumed, for example, that the calling line is restricted in regard to toll service, in which case a characteristic tone will be connected to the release trunk conductor through the cut-off relay of the lineswitch. This tone by way of wiper 5 of the lineswitch, release trunk conductor 8, contacts 129 and 153, wiper 123 of the selector repeater, conductor 158, contacts 239, and upper winding of impedance 208, to ground, induces a similar tone in the lower winding of the impedance through which ground is supplied to the lower winding of relay 301 of connector IC. It will be recalled that relay 301 is bridged across the loop extending to the toll trunk, hence this tone will be transmitted over the trunk line to the operator.

The operator on noting the lighted condition of lamp L1 will answer the call by inserting the plug of a regular toll cord in jack J2 and operate the associated answering key. The insertion of the plug into the jack completes an operating circuit for relay 557 over the talking conductors of the cord, ring and tip springs of jack J2, right-hand winding

of the repeating coil, contacts 586 and 587, upper and lower windings of relay 557, respectively, to battery and ground. Relay 557 operates and at contacts 585 completes a circuit from ground, winding of relay 555, to battery via the sleeve of the jack and plug. A parallel circuit is also completed from the ground at contacts 585, contacts 569, winding of relay 595, to battery. Relay 595 upon operating connects an additional holding ground to the busy marking circuit at contacts 571, completes a circuit for slow-acting relay 553 at contacts 572, completes a locking circuit for itself at contacts 573 to maintain itself operated after relay 553 is energized, and at contacts 574 disconnects relay 554 from in bridge of the trunk. Relay 555 on operating restores the contacts of relay 554 to normal by means of the mechanical interconnecting link 596, completes an additional circuit for itself and relay 595 at contacts 579, at contacts 580 connects ground to conductor 429 to maintain relay 401 of repeater TR operated, and at contacts 581 extends the incoming loop through the left-hand winding of the repeating coil to relay 558. It will be noted that the loop circuit is still open at contacts 582. The tone current from the calling line will pass through the condenser separating the two windings of the repeating coil and will induce similar current in the right-hand winding of the repeating coil. This current will be audible to the operator who is thereby informed of the class of the calling line and if necessary may deny toll service thereto. In case toll service is permitted the line, the operator will clear the tone by operating key K2, thereby closing the circuit for relay 556 which operates and completes the loop circuit at contacts 582. Relay 556 locks itself to ground at contacts 579 by closing contacts 583 and at contacts 584 connects an additional ground to conductor 429. Referring now to the sub-exchange switches, relay 301 operates over the loop to the toll board following the closure of the direct current circuit at contacts 582 and completes a circuit for relay 302 at contacts 324. Relay 302 operates and closes various circuits, the only effective one in the present instance being that from ground at contacts 327, conductor 263, winding of relay 207, to battery. Relay 207 on operating completes a circuit for relay 203 at contacts 243, connects the two left-hand windings of the repeating coil at contacts 244, short-circuits impedance 208 by closing contacts 245 and 247, and at contacts 246 completes a holding circuit for relay 206, thereby maintaining the relay operated independent of line relay 205.

The toll operator may now converse with the calling subscriber and determine his requirements. If the call is to be further extended the operator will insert the calling plug of the toll cord used for answering the call, into the jack of a toll line (not shown) and extend the call in the usual way. It will be recalled that relay 207 in operating completed a circuit for relay 203. Relay 203 operates and prepares the talking circuit by cutting the left-hand windings of the repeating coil into the loop circuit. This circuit now extends by way of contacts 212, upper left-hand winding of the repeating coil, contacts 222, 217, 230 and 253, conductor 265, lower winding of relay 301, conductor 264, to ground at contacts 247, and also by way of contacts 215, lower left-hand winding of the repeating coil, contacts 224, 232 and 251, conductor 262, upper winding of relay 301, to battery. Relay 203 also closes a locking circuit for its lower winding in parallel with relay 211 via contacts 225 and 236. Relay 211 operates and reverses the incoming trunk conductors with respect to relay 205 by opening contacts 257 and 260 and closing contacts 258 and 259.

The loop circuit at the toll position is the same as previously described and includes polarized relay 558, which is not operated at this time due to the direction of current flow in the loop. The toll operator extends the call, if such is required, by means of the answering toll cord and a toll line (not shown).

When the subscribers have finished talking and restore their receivers the operator receives supervision from the called line in the usual way. The calling subscriber on restoring opens the loop circuit for relay 205 and this relay restores and opens the circuit for relay 204. Relay 204 restores and reverses the connection of relay 301 to the trunk by opening contacts 230 and 232 and closing contacts 229 and 231. The reversal of current flow in the trunk deenergizes relay 558 which was previously operated in series with the line relay of the connector. Relay 558 connects relay 557 to the cord circuit loop, thereby operating the supervisory lamp of the cord in the well known manner. The operator may then release the apparatus by removing the plug from the jack whereon the circuit for relay 555 is opened and that relay restores. Relay 555 removes the busying ground from conductor 430 at contacts 579, thereby removing the busy condition from the trunk and opening the circuits of relays 556 and 595, which restore. Relay 595 opens the busy visual circuit at contacts 571, opens the circuit of relay 553 at contacts 572, reconnects relay 554 across the trunk conductors at contacts 574, and completes a circuit at contacts 575 for maintaining ground on conductor 429 until slow-to-release relay 553 has restored to normal. Relay 556 opens the loop circuit from the satellite office and relay 301 of connector IC restores and opens the circuit of relay 302. Relay 302 disconnects holding ground from conductor 263, whereon

relay 207 of repeater R restores and opens the holding circuit of relay 206. Relay 206 restores, removes the busy marking ground from conductor 74 at contacts 238, and disconnects the holding ground from release trunk conductor 158 by opening contacts 239. Selector repeater SR and lineswitch restore in the usual manner following the removal of ground from conductor 158.

In the event that a call such as has just been described originates at a paystation line, the discriminating tone will inform the toll operator to this effect. In connections of this type it will be necessary for the operator to refund the coin in case it has not been possible to complete the desired connection or to collect the coin in case the connection has been completed. In either case the operator will insert the plug P of the dialling jack into jack J1 of the trunk and operate the refund key or collect key as required. Relay 551 operates over a circuit completed via the sleeve of the dialling cord and extends the trunk conductors to the cord via contacts 561 and 563 and conductors 591 and 593.

If the refund key is operated, high voltage current of one polarity is applied to the trunk. This current operates high resistance relay 209 of repeater R which is connected to trunk conductor 72 by way of contacts 226. Relay 209 connects the trunk conductor through to three position relay 271′ at contacts 248. Relay 271′, incidentally, is a relay of the type disclosed in United States patent to Field No. 1,672,976 of June 12, 1928, having a normal position and two operated positions. Relay 271′ closes its contacts 268 and 269 at this time thereby completing a circuit for relay 210 and connecting up the high voltage current required for refunding the coin. Relay 210 operates and applies the refunding current to the two incoming talking conductors in parallel by closing contacts 250 and 255. This current serves to operate the paystation repeater associated with the calling line which refunds or collects the coin in the usual way.

The reversal of current on the calling line when the toll operator answers the call serves to position the paystation repeater so that the coin will be automatically collected or refunded as required in case the operator neglects to apply the control current as set forth above.

When the collecting or refunding operation is successfully completed, relay 272 operates to signal the operator to this effect by shunting relays 209 and 271′ by a relatively low resistance. This increases current flow over the trunk and operates a signal lamp at the toll board in the well known manner.

The operation when collect current is applied to the trunk is substantially the same as described in the foregoing paragraphs except that in this case relay 271′ operates to its alternate position and closes contacts 270 and 271. Relay 210 is operated as before and high voltage current of the polarity required for collecting the coin is applied to the line.

Calls to the recording position from subscribers in the main exchange are handled in a somewhat different manner than the calls just described. Subscriber T2, for example, in initiating a call operates the lineswitch LS2 to seize an idle first selector, such as selector S1. The toll recording code number 110 is then dialled, operating selectors S1 and S4 to the first level and selector S5 to the tenth level on which an idle trunk, such as trunk comprising conductors 431—433, is connected with. The calling line is thus extended over conductors 431 and 433, through the left-hand windings of the repeating coil, upper and lower windings, respectively, of relay 504, to ground and battery. Relay 504 operates, completes a circuit for relay 503 at contacts 522, disconnects battery and ground from the right-hand windings of the repeating coil at contacts 521 and 523 and prepares the line lamp circuit at contacts 520. Relay 503 is slow-to-operate and after an interval completes a circuit for relay 502 at contacts 518, and opens the line lamp circuit at contacts 517. Relay 502 which is also slow-to-operate, after an interval completes a locking circuit for itself by way of contacts 514 and 522, opens the circuit of relay 503 at contacts 513, closes a point in the line lamp circuit at contacts 512, and connects ring back tone to a talking conductor of the trunk via contacts 511 and 516 to inform the calling subscriber that the operator is being signalled. Relay 503 is also slow-to-release and after an interval restores and completes the line lamp circuit at contacts 517. The line lamp L is thus lighted after a delay to inform the operator of the incoming call. The purpose of this delay arrangement is to prevent the operation of the line lamp on calls extended from the satellite exchange, as previously described.

On noting the lighted condition of the line lamp, the operator will answer the call by inserting the plug of a regular toll cord circuit into jack J, thereby completing a circuit from battery over the sleeve of the plug and jack, resistance 531, contacts 528, lower winding of relay 501 to ground. Relay 501 operates and at contacts 508 complete a locking circuit for its upper winding, opens the circuit of the line lamp at contacts 507, and removes the short-circuit from the lower winding of induction coil 505 at contacts 510. It will be noted that release trunk conductor 432 now extends through the lower winding of induction coil 505 to ground at contacts 524 and 509. In case the calling line is a restricted line, there will be a characteristic tone

on the release trunk, as previously described, and this tone will induce a similar tone in the upper winding of induction 505 which is bridged across the talking conductors of the trunk. The operator on actuating the listening key of the associated cord circuit will be informed by this tone as to the character of the calling line. To remove the tone the operator actuates key K, thereby closing a circuit for the upper winding of relay 506. Relay 506 on operating removes the short-circuit from its lower winding by opening contacts 528, and short-circuits resistance 531 to complete a holding circuit for its lower winding in series with relay 501 at contacts 527. Relay 506 also disconnects the upper winding of induction coil 505 by opening contacts 525 and 530, and at contacts 526 and 529 extends the connection through the right-hand windings of the repeating coil.

The recording operator may now extend the call by means of the regular toll cord in the well known manner. At the end of the conversation the called subscriber on hanging up will operate the usual supervisory signal of the cord circuit, and the calling subscriber on hanging up will open the circuit of relay 504. Relay 504 on restoring connects battery and ground to the two windings of the repeating coil at contacts 521 and 523, thereby operating the disconnect lamp of the cord circuit in the well known manner. Relay 504 also opens the locking circuit of relays 501 and 502 and disconnects ground from the release trunk at contacts 524. Relay 501, however, remains operated in series with relay 506 over the sleeve of the toll cord and maintains the holding ground on the release trunk at contacts 509. To release the connection the operator removes the plug from the jack thereby opening the circuit of relays 501 and 506 which restore. Relay 501 disconnects the holding ground from the release trunk, thereby permitting the preceding switches to restore in the usual way.

A subscriber in the main exchange may call a satellite exchange subscriber over the same group of trunks used for the previously described connections. A subscriber at substation T2, for example, calling the subscriber at substation T1 on initiating the call is connected an idle first selector, such as the selector S1. Selector S1 responds to the first digit of the called number and selects an idle outgoing trunk on the called level, for example, the trunk terminating in the repeater TR which is associated with the interoffice trunk comprising conductors 72 and 73. The calling loop is extended over the upper and lower wipers of the selector, normally closed contacts 425 and 427, upper and lower windings, respectively, of relay 405, to battery and ground. Relay 405, operates, closes a circuit for relay 404 at contacts 423, and prepares the impulsing circuit at contacts 424. Relay 404, operates, closes a point in the impulsing circuit at contacts 418, connects ground to conductor 430 at contacts 419 to hold up the preceding switches and to mark the trunk busy at the toll board, completes a circuit for relay 401 at contacts 420, and prepares a circuit for relay 403 at contacts 421. Relay 401 operates and at contacts 411 and 412 extends trunk conductors 72 and 73 to the control loop of the repeater which may be traced from the above referred to contacts of relay 401, contacts 424, low resistance left-hand winding of impedance 407, contacts 435, lower winding of polarized relay 402, contacts 416 and 418.

Referring now to the toll trunk TT (Fig. 5) ground on conductor 430, extends by way of contacts 567 and 569, winding of relay 595, to battery. Relay 595 operates and at contacts 571 completes a circuit for operating the busy visual signal to mark the trunk busy at the toll board.

The closure of the loop circuit at repeater TR completes a circuit for relay 301 of connector IC (Fig. 3) at the satellite exchange. The circuit extends from trunk conductor 72, contacts 215, 223, 231 and 253, conductor 265, lower winding of relay 301, conductor 264, lower winding of impedance 208 to ground, and from trunk conductor 73, contacts 212, 221, 217, 229 and 251, conductor 262, upper winding of relay 301, to battery. Relay 301 operates and completes a circuit for relay 302 at contacts 324. Relay 302 operates and connects ground to the local holding circuit at contacts 326, completes a circuit for relay 207 of repeater R via contacts 327 and conductor 263, prepares the impulsing circuit at contacts 328, and prepares the ringing circuit at contacts 330. Relay 207 of repeater R, operates, connects a busying ground to conductor 74 at contacts 242 to mark the trunk line busy to lineswitches, such as lineswitch LS1, closes a circuit for the upper winding of relay 203 at contacts 243, connects the upper and lower left-hand windings of the repeating coil at contacts 244, prepares a holding circuit for relay 206 at contacts 246, and at contact 247 connects direct ground to the lower winding of line relay 301 via conductor 264. Relay 203 operates, its only function at this time being the switching over of the loop circuit to include the left-hand windings of the repeating coil and the reversing contacts of relay 204.

The calling subscriber now dials the second digit of the called number and line relay 405 or repeater TR responds. A circuit for relay 403 is closed each time relay 405 drops back and the relay operates to short-circuit impedance 407 and the lower winding of relay 402, contacts 417. Relay 405 interrupts the previously described loop circuit at contacts 424 and relay 301 of connector IC responds accordingly. When relay 301 drops back in response to the first impulse, a circuit is closed

from ground, contacts 325, 332 and 328, off-normal contacts 315, winding of relay 304, winding of vertical magnet 312, to battery. Magnet 312 operates and raises the wipers one step. Relay 304 operates in series with the magnet and prepares a new impulsing circuit at contacts 333. On the first vertical step of the wipers off-normal contacts 316 close and contacts 315 open, thereby transferring the impulsing circuit to contacts 333 of relay 304 which operated responsive to the first impulse and remains operated throughout the series due to its slow-to-release characteristics. Subsequent impulses are transmitted over the new impulsing circuit and the wipers of the connector are thus stepped to the level corresponding to the digit dialled. Relay 304 deenergizes shortly after the last impulse of the series and extends the impulsing circuit by way of contacts 334 and 343, winding of slow-acting relay 307, contacts 367, winding of rotary magnet 313, to battery.

The calling subscriber now dials the third digit of the called number, relays 405 and 301 responding as in the previous case and a corresponding series of impulses are transmitted over the previously described impulse circuit to rotary magnet 313 which operates to step the wipers of the connector onto the contacts of the called line. Relay 307 operates in series with the rotary magnet and, due to its slow-to-release characteristics, remains operated throughout the series of impulses. During the rotary operation of the switch, a circuit is closed for relay 308 at contacts 349, and an auxiliary path around contacts 343 of busy test relay 306 is provided by way of contacts 350 in order to prevent momentary interruption of the impulse circuit as the wipers of the switch pass over busy lines. Relay 308 operates and prepares the busy test circuit at contacts 353.

It may be assumed, for example, that the called line is busy at this time, in which case wiper 374 will encounter a ground on the test contact of the line. A circuit is thereby closed for busy relay 306 extending from ground on the test wiper, contacts 363, 353 and 371, winding of relay 306, to battery. Relay 306 operates and prepares a locking circuit for itself at contacts 342 which will become effective following the release of relay 308 which occurs after a slight delay and results the closure of contacts 352. Relay 306 also opens the impulsing circuit at contacts 343 and closes a point in the busy tone circuit at contacts 346. Relay 308 on restoring as stated, completes the circuit for applying busy tone to the line by way of contacts 369, 355 and 346. This tone is transmitted over the trunk line and informs the calling subscriber that a connection cannot be obtained with the called subscriber at this time, whereon the subscriber is expected to release the connection.

Assuming that the called line is idle at the time the wipers are set on the associated contacts, wiper 374 will find battery potential through the cutoff relay of the associated line-switch, and relay 306 consequently does not operate. When relay 308 restores shortly after the last impulse of the series, a circuit is closed from battery on test wiper 374, contacts 363 and 351, lower winding of relay 311, contacts 341 and 326, to ground. Relay 311 operates and completes an energizing circuit for the upper winding at contacts 365 to ground on the local holding conductor. The talking conductors of the switch are extended through to wipers 372 and 375, respectively, at contacts 361 and 370, test wiper 373 is disconnected at contacts 362, test wiper 374 is disconnected from the winding of relay 311 and connected to the grounded holding conductor at contacts 364, the impulsing circuit is disconnected from the rotary magnet at contacts 367 and extended to stepping magnet 319 of the ringing current selecting switch at contacts 366, a point in the circuit of relay 309 is closed at contacts 368, and the busy tone circuit is opened at contacts 369.

The calling subscriber now dials the final digit of the called number to select the ringing current code to be applied to the line. Relays 405 and 301 respond as before, and impulses are transmitted over the impulsing circuit to stepping magnet 319 which advance wipers 321 and 322 to the proper contacts. Relays 307 and 308 again operate during the series of impulses and, when relay 308 restores shortly after the last impulse of the series, a circuit is closed from ground, off-normal contacts 320 which close on the first off-normal step of the wipers 321 and 322, contacts 354, winding of relay 306, to battery. Relay 306 operates and connects the pick-up conductor through to relay 309 by way of contacts 345, 368 and 357. The point in the busy tone circuit previously referred to is also closed but this is not effective at this time since the circuit is opened at contacts 369. The pickup lead is associated with the ringing current interrupter in such a manner that a ground impulse is transmitted thereover at the start of each ringing code. This ground impulse operates relay 309 which locks to the local holding conductor at contacts 358 and prepares a ringing circuit by closing contacts 356 and 376. Assuming that the final digit dialled is the digit 3, wipers 321 and 322 engage the third contact of their respective banks. Ringing current of the proper code is now transmitted to the called line over a circuit extending from wiper 322, contacts 356, 355 and 361, wiper 372, conductor 1', through the bells and condensers of the substations adapted to be signalled over this side of the line, to ground. This current oper-

ates the substation bells, the code identifying the particular station wanted. When the called subscriber answers a direct current loop is closed for operating relay 305 in the usual way. Relay 305 opens the ringing circuit at contacts 335 and 339 and extends the called line loop via contacts 336 and 338, conductors 261 and 267, contacts 249 and 256, upper and lower windings, respectively, of relay 205, to battery and ground. Relay 205 operates over the called subscriber's loop and completes circuits for relays 206 and 204 which also operate. Relay 206 has no particular function to perform in this connection but connects a busying ground to conductor 74 at contacts 238 in place of the ground previously connected to the conductor at contacts 242. Relay 204 reverses the trunk conductors with respect to line relay 301 of connector IC. Current flow being reversed over the trunk, polarized relay 402 of repeater TR operates and closes a circuit for relay 406. Relay 406 connects the high and low resistance windings of impedance 407 across the trunk to improve transmission and reverses the direction of current flow over the calling line loop.

The calling and called loop are connected for talking through the repeating coil of repeater R. Relay 301 of connector IC supplies talking current to the calling loop and relay 205 supplies talking current to the called loop.

At the termination of the conversation both subscribers will restore their receivers. The opening of the calling loop releases relay 301 which opens the circuit of relay 302. Relay 302 removes ground from conductor 263 and from the local holding conductor, and completes a circuit for release magnet 303 via off-normal contacts 317 which close when the wipers are out of normal position. Relays 305 and 311 restore following the removal of ground from the local holding conductor. A branch of the previously traced release circuit extends by way of contacts 344 to release magnet 318 of the ringing current selecting switch. This magnet operates in parallel with the release magnet of the connector, and the wipers of the connector and of the ringing current selecting switch are restored to normal position. The circuit of magnet 314 is opened at contacts 317 when the wipers reach normal position and the circuit of relay 306 is opened at contacts 320 when the wipers of the ringing current selecting switch reach normal position. Relay 306 consequently deenergizes and opens the circuit of magnet 318 at contacts 344. In repeater R relay 207 restores following the release of relay 302 and this relay opens the circuit of relay 203. The opening of the called loop permits relay 205 to restore and open the circuit of relay 206 which removes ground from conductor 74 to render the trunk selectable to lineswitches, such as LS1. In repeater TR at the main exchange, relay 405 restores and opens the circuit of relay 404 which removes the busying ground from conductors 429 and 430. Relay 401 restores and again extends the trunk to incoming selector S3. Selector S1 and the lineswitch release in the regular way and all apparatus is returned to normal in readiness for the next call.

It will be noted that connector IC is provided with an additional test wiper 373 which performs no function whatever in the connection just described. This wiper is used to provide a rotary hunting feature when some subscribers in the system have several lines listed under one number. In large systems it is customary to provide a separate group of rotary connectors for this purpose. In small exchanges, however, the number of subscribers having a plurality of lines is sometimes not enough to warrant the installation of a separate group of connectors, in which case a connector of the present type is used. When there are several lines in the group the two tests contacts of the line engaged, respectively, by wipers 273 and 274 are strapped for each line except the last in the group, these contacts being left unconnected as shown. Thus when a call is extended to the first line of a group and this line is in use, busy relay 306 will operate exactly as described in the previous connection, and when relay 307 restores shortly after the last impulse of the series, a circuit will be closed from ground encountered by wiper 373, contacts 362, 347 and 340, interrupter contacts 371 of the rotary magnet, winding of relay 310, to battery. Relay 310, operates, completes a holding circuit for itself at contacts 359 and closes a circuit from ground at contacts 330, contacts 360 and 367, winding of rotary magnet 313, to battery. The rotary magnet operates and steps the wipers to the next set of contacts and interrupts the circuit of relay 310 at interrupter contacts 371. Relay 310 restores and in turn opens the circuit of the rotary magnet which also restores. With each step as above described a parallel circuit is closed by way of contacts 348 to maintain relay 308 operated. Relay 308 maintains the testing circuit so that in case the next set of contacts is also busy relay 306 will again operate as will relay 309 and the wipers will be advanced another step. When the last set of contacts of the group is reached the test contacts are not strapped as stated, hence, wiper 373 will encounter no ground even though the line is busy, and relay 310 will not be operated. In this case the busy tone will be returned to the calling subscriber in the same manner as if it were a call to a busy individual line. In case any of the lines are idle busy relay 306 will not operate but switching relay 311

will, and a connection will be extended as previously described.

It will be appreciated of course, that lines of the foregoing type will ordinarily not be provided with more than one substation and code ringing will not be required in this case, the calling subscriber will merely dial a digit, such as 1, which selects the simplest code, possibly a single ring code depending on the particular code used. On single party lines of this type, the bells will usually be bridged across the two line conductors instead of to one line and ground as for party lines. The ringing circuit previously traced over conductor 1′ will extend over conductor 3′, wiper 375, contacts 370, 339 and 376, wiper 321, lower winding of relay 305 to ground at contacts 30. The operation in other respects will be exactly the same as for previously described connections.

Toll calls to subscribers' lines in the satellite exchange will be completed over the regular interoffice trunk lines and toll trunk apparatus TT. The toll operator will insert the calling plug of the toll cord used for answering the call over the toll line into the jack J2 of an idle trunk. Relay 557 operates over the cord circuit loop and connects ground to a local holding conductor at contacts 585. This ground by way of contacts 567 and conductor 430 marks the trunk line busy in the banks of the main exchange second selectors. A circuit is also completed via contacts 569 for relay 595 which operates, closes the busy visual circuit at contacts 571, closes a circuit for relay 553 at contacts 572, completes a holding circuit for itself at contacts 573 and opens the bridge across the trunk conductors at contacts 574. Relay 553 operates and prepares certain circuits which will become effective at a later stage of the connection. Relay 555 operates from ground at contacts 585 and battery via the sleeve of the jack and plug, and closes a point in the control loop at contacts 581.

To extend the call to the wanted line, the operator will insert the plug of a dialling cord into jack J1 and then dial the number of the line. The dialling cord which as before stated, may be of the type disclosed in the Tharp et al. patent previously referred to, is so arranged that the off-normal movement of the calling device completes a circuit over the ring contacts of the plug and jack and conductor 592 for relay 551. Relay 551 operates and remains locked over the above circuit which is maintained by a relay in the cord circuit energized in series with relay 551. The trunk conductors are disconnected from the trunk relay group at contacts 560 and 562 and at contacts 561 and 563 are extended by way of conductors 591 and 593 and the tip and sleeve contacts of the jack and plug to a control loop in the dialling cord which includes the impulse contacts of the calling device. Relay 551 also closes a circuit at contacts 564 for relay 556 which operates, completes the control loop at contacts 582 and locks to the local holding conductor at contacts 583.

The extension of the trunk conductors to the loop of the dialling cord completes an operating circuit for relay 301 of connector IC (Fig. 3) as in a previously described local call. When the calling device rotates back to normal position, the loop circuit is interrupted in the usual manner and relay 301 responds accordingly. Three digits are transmitted in this manner as connector C operates in exactly the same manner as described for a local connection to set the wipers on the contacts of the called line. If the line is busy, the connector will apply the busy tone to the trunk. If the line is idle, the connector will send out ringing current in the usual manner and, when the called subscriber answers, will reverse the direction of current flow over the trunk line.

Referring now to the trunk relay group TT, after the connection has been set up, the operator will withdraw the plug of the dialling cord from the dialling jack, thereby opening the circuit of relay 551. This relay restores and transfers the trunk circuit back to the loop including contacts 581, left-hand windings of the repeating coil, contacts 582 and windings of polarized relay 558. The line relay of the connector at the satellite exchange is now energized in series with polarized relay 558 of the trunk relay group. This latter relay does not operate at this time, however, due to the direction of circuit flow over the trunk line.

In case the called line is busy, the busy tone applied to the trunk by the connector will be audible to the operator. If the called line is idle, the operator will hear the usual ring-back tone which indicates that the called subscriber is being signalled. When the called subscriber answers, the direction of current flow over the trunk is reversed, as previously stated, and relay 558 operates to disconnect relay 557 from the tip and ring conductors extending to the cord circuit. The disconnection of relay 557 operates the usual supervisory apparatus of the toll cord to give the operator answering supervision.

When the call is terminated, the subscribers will restore their receivers. The connector at the satellite exchange reverses the direction of the current flow back to normal when the called subscriber hangs up, and relay 558 restores. Relay 557 is again connected to the tip and ring conductors of the trunk to give the usual disconnect supervision. The operator may then release the connection as previously described by withdrawing the plug of the toll cord from the jack.

Toll calls to pay station lines may be completed in the same manner as calls to regular

subscribers' lines. The coin apparatus is controlled over the dialling cord substantially as described for incoming calls from lines of this class. In this case, however, the two position relay in repeater R connects the coin control current directly to the line conductors via the wipers of the connector, since the pay station repeater is not included in connections of this kind.

What is claimed is:

1. In a telephone system, two exchanges, a recording switchboard and a toll switchboard in one of said exchanges, subscriber controlled means for extending connections from calling lines in either exchange to the recording switchboard, and means automatically operative when the calling line is in the other of said exchanges for releasing the connection to the recording switchboard and for establishing a connection to the toll switchboard.

2. In a telephone system, a main exchange and a branch exchange, a recording switchboard and a toll switchboard at the main exchange, a train of automatic switches at the main exchange for extending calls originating in either exchange to the recording switchboard, and means for automatically releasing the switch train on calls extended from the branch exchange and for transferring such calls to the toll switchboard.

3. In a telephone system comprising a main exchange and a branch exchange, a trunk line connecting the exchanges and having two branches at the main exchange, means at the branch exchange for extending a connection over the trunk line and one of said branches to a subscriber's line or to a manual switchboard in the main exchange, and means responsive to establishment of a connection to the switchboard for disconnecting said one branch of the trunk line and for extending a connection over the other branch of the trunk line.

4. In a telephone system, a trunk line connecting two exchanges and having two branches in one exchange, an automatic switch terminating one of said branches, a manual circuit terminating the other of said branches, means for directively operating said switch over the trunk line to extend a connection, and means responsive to the establishment of the connection for transferring the connection to said manual circuit and for releasing said switch.

5. In a telephone system, a trunk line connecting two exchanges and having two branches in each exchange, means for establishing a connection over the trunk line and one branch in each exchange, and means for transferring the connection to the other branches of the trunk line and for excluding said first branches therefrom.

6. In a telephone system, a trunk line accessible over one path via a non-numerical switch and over another path via a numerical switch, means for establishing a connection over the trunk line via said first path, and means controlled over the trunk line for disconnecting said first path and for re-establishing the connection over said second path.

7. In a telephone system, a trunk line having two branches, means for extending a connection to the trunk line over the two branches simultaneously, means for controlling switching mechanism over the trunk line and one branch to further extend the connection, and means for excluding said one branch from the connection and for establishing a talking connection over the other branch.

8. In a telephone system, a numerical switch and an associated non-numerical switch, means responsive to the seizure of the first switch for initiating the operation of the second switch to connect with a trunk line, means for operating the first switch to connect with the same trunk line, and means controlled over the trunk line for disabling said first connection and for rendering said second connection effective.

9. In a telephone system, a calling line, a numerical switch and an associated non-numerical switch means responsive to the initiation of a call for seizing said first switch, means responsive to the seizure of said first switch for operating said second switch to connect with a trunk line, means controlled over the calling line for setting up a connection via said second switch and the trunk line and for operating said first switch to establish an auxiliary connection to the trunk line, and automatic means for excluding said second means from the connection and for rendering said auxiliary connection effective.

10. In a telephone system, a selector repeater having access to a trunk line via an associated lineswitch and also via a set of wipers, means responsive to the seizure of the selector repeater for operating said lineswitch to extend a connection to the trunk line, means for operating the selector repeater to establish a connection with the same trunk line, and means controlled over the trunk line for determining which of said two connections shall be effective.

11. In a telephone system, a trunk line having two branches accessible, respectively, to a selector repeater and to a lineswitch, means in the selector repeater for operating the lineswitch to establish a connection with the trunk line over one branch, and means for operating said selector repeater to establish a connection with the trunk line over the other branch and for releasing said first connection.

12. In a telephone system, a selector repeater and an associated lineswitch, a trunk line accessible to both switches, means for setting up a connection over the trunk line and said lineswitch and excluding the wipers

of the selector repeater, and means for excluding the lineswitch from the completed connection and for including the wipers of the selector repeater therein.

13. A partially established connection including a primary lineswitch, a selector repeater, a secondary lineswitch, a trunk line, and a train of switches, an auxiliary connection including the same primary lineswitch, selector repeater, trunk line, and a trunk repeater, and means responsive to the completion of said partially established connection for disabling the same and for rendering said auxiliary connection effective.

14. In a telephone system in which the dialled impulses for operating a switch are repeated simultaneously over a trunk line by means of the switch, means responsive to a particular digit for disabling the switch, means responsive to a different digit for disabling the impulse repeating means, and means responsive to a still different digit for operating the switch to establish a new connection with the same trunk line over which the impulses are repeated.

15. In a two-coordinate switch having a directive primary movement and an automatic secondary movement initiated responsive to the completion of the primary movement, means for stopping the secondary movement when the wipers of the switch encounter a trunk of one class marked by the absence of potential on an associated test contact, and means for stopping the secondary movement when the wipers of the switch encounter a trunk of another class marked by the presence of potential on an associated test contact.

16. In a two-coordinate switch having a directive primary movement and an automatic secondary movement initiated responsive to the completion of the primary movement, two test wipers, means responsive when the switch is primarily operated to a certain extent for rendering one of said wipers effective to stop the secondary movement of the switch when a contact marked by the absence of potential is encountered, and means responsive when the switch is primarily operated to a different extent for disabling said one wiper and for rendering the other wiper effective to stop the secondary movement of the switch when a grounded contact is encountered.

17. In a two-coordinate switch having a directive primary movement and an automatic secondary movement initiated responsive to the completion of the primary movement, a relay for controlling the secondary movement of the switch, a test wiper, a circuit for said relay including said wiper closed when the switch is primarily operated to a certain extent, and a circuit for said relay independent of said wiper closed when the switch is operated primarily to a different extent.

18. In a telephone system, two associated automatic switches, a trunk line accessible to both switches, means responsive to the seizure of one switch for operating the other switch to connect with said trunk line and the mark the same in the banks of said one switch, and means for directively operating said one switch to hunt for and connect with the marked trunk line.

19. In a telephone system, a numerical switch, a non-numerical switch, a control circuit connecting said switches, a relay in the first switch normally connected in said circuit, a second relay in the first switch normally excluded from said circuit, and means in the first switch responsive to the receipt of a particular directive digit for substituting said second relay for said first relay in said circuit.

20. In a telephone system, two automatic exchanges, subscribers' lines in both exchanges, a toll switchboard in one exchange, a trunk line over which connections may be established from a subscriber's line in the other exchange to subscribers' lines or to the switchboard on said one exchange, and means in said other exchange for applying a distinctive tone to the trunk line only when a connection is established with the switchboard.

21. In a telephone system, two automatic exchanges, subscribers' lines in both exchanges, a toll switchboard in one exchange, a trunk line over which connections may be establish from a subscriber's line in the other exchange to subscribers' lines or to the switchboard in said one exchange, means in said other exchange for applying a distinctive tone to the trunk line only when a connection is established with the switchboard, and means controlled over the trunk line from said switchboard for removing the tone from the trunk line.

22. In a telephone system, a two-way trunk line extending from an automatic exchange to a manual switchboard, means for establishing a connection over the trunk line in either direction between a subscriber's line in the automatic exchange and the switchboard, a relay associated with the trunk line at the automatic exchange, said relay having a normal position and two different operated positions, means at the switchboard for controlling said relay over the trunk line, and means controlled by said relay for connecting either of two sources of characteristic current to the subscriber's line depending on the position to which the relay is operated.

23. In a telephone system, a main exchange and a branch exchange, a recording switchboard and a toll switchboard in the main exchange, a two-way trunk line connecting the exchanges, switching apparatus in the

main exchange controlled by calling subscribers in either exchange for extending connections to the recording switchboard, means automatically operative on calls extended over the trunk line for releasing the connection to the recording position and for establishing a connection to the toll switchboard, and means at the branch exchange controlled over the trunk line from the toll switchboard for connecting a source of characteristic current to the calling subscriber's line.

24. In a two-motion party line connector switch, an auxiliary ringing current selecting switch, two test wipers adapted to engage contacts associated with called lines, means for directively operating the switch in both its primary and secondary movements to set the wipers on contacts associated with a line, means responsive when both wipers encounter contacts marked by a busying potential for further advancing the wipers of the connector in search of an idle line, and means responsive when said wipers engage contacts associated with an idle line for connecting up said auxiliary switch.

25. In a telephone system, a connector switch equipped with primary and secondary stepping magnets, groups of lines accessible to said switch, an auxiliary switch associated with said first switch, means for successively directively operating said magnets to select a group of lines, means for further operating said secondary magnet to select an idle line in the group, means for thereafter directively operating said auxiliary switch, and means including said auxiliary switch for applying signalling current to the selected line.

In witness whereof, I hereunto subscribe my name this 2d day of July, A. D. 1930.

VICTOR S. THARP.