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TELEPHONE EXCHANGE SYSTEM

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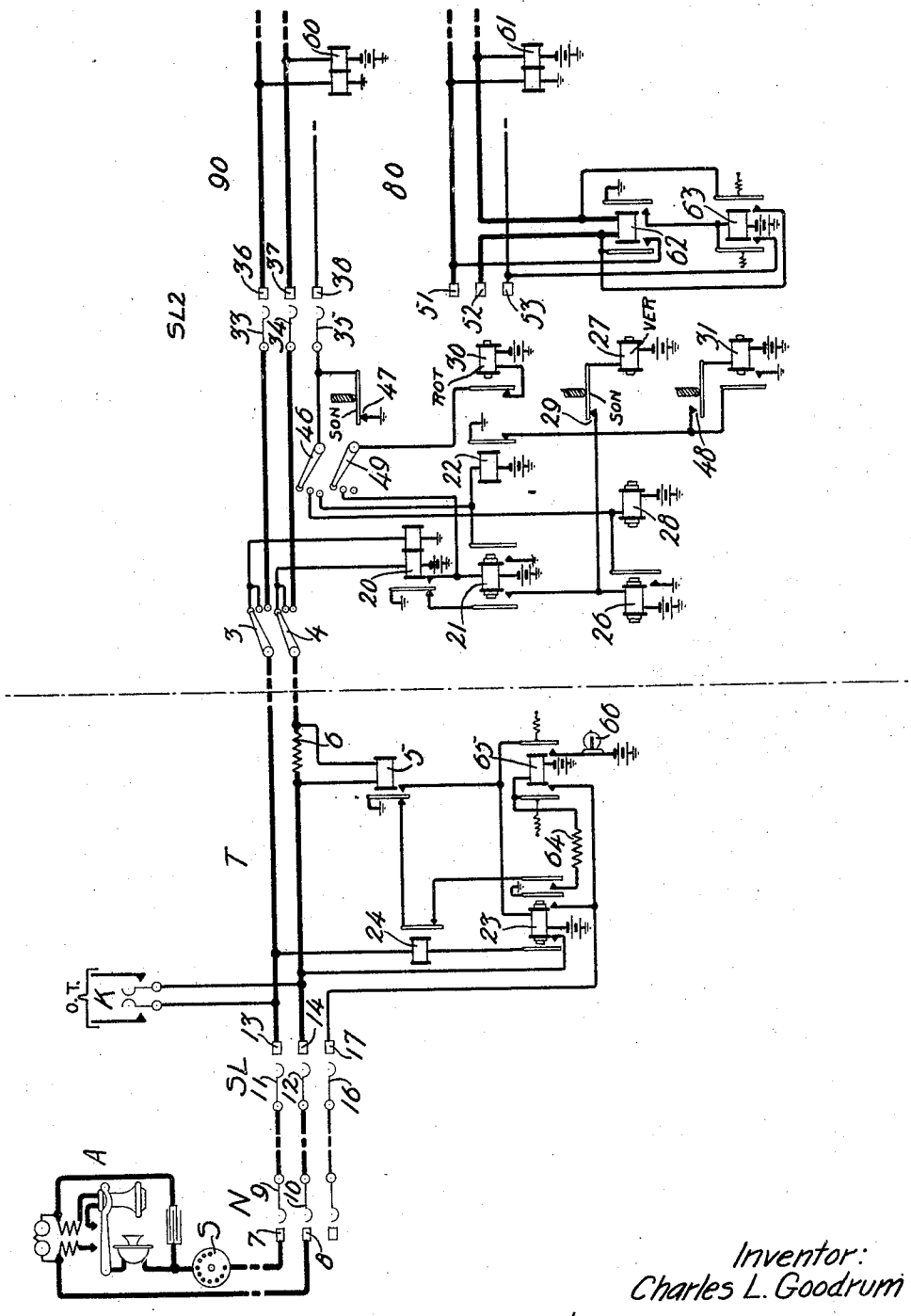

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CHARLES L. GOODRUM, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

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To all whom it may concern:

Be it known that I, CHARLES L. GOODRUM, a citizen of the United States, residing at New York, in the county of New York, State of New York, have invented certain new and useful Improvements in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telephone exchange systems and has particular reference to systems involving private branch exchanges and main central offices employing machine switching apparatus for establishing connections.

An object of the invention is to provide improved means for causing the actuation of a signal at an attendant's position at the private branch exchange when a connection is automatically extended, over a trunk circuit interconnecting the private branch exchange and the main central office, to a toll trunk circuit at the main central office.

One feature of the invention consists in the provision of electromagnetic means, associated with the toll trunk circuit at a distant exchange, operating upon the seizure of said trunk circuit to cause a signal to be actuated at the attendant's position.

Another feature of the invention consists in providing such an arrangement of circuits in a system of this nature, whereby talking battery for the subscriber at the private branch exchange is fed from the distant exchange over the selected trunk circuits.

Other features will appear from the detailed description given hereafter and from the appended claims.

Referring to the drawing which illustrates one embodiment of the invention, there is shown to the left of the vertical broken line the station of a subscriber at the private branch exchange, a schematic representation of a non-numerical switch and a selector switch for extending a connection from the station, and a trunk circuit extending from the private branch exchange to the main central office. To the right of the broken vertical line, there is shown a selector switch SL^2 at the main central office and a portion of a local trunk circuit and a portion of a toll trunk circuit to which the selector switch SL^2 has access.

The automatic switches shown schematically at the private branch exchange may be of any desired character, but are preferably of the well known step-by-step type. The automatic selector switches at the main central office, the circuit arrangement of one of these switches being shown in detail in the drawing, may likewise be step-by-step switches of any suitable and approved type.

The subscribers at the private branch exchange in addition to being able to make calls local to the central office can also make calls to subscribers' lines which must be reached by means of toll or interoffice trunks. Whichever class of call the private branch exchange subscriber wishes to make, he first extends his line automatically by means of a dial such as shown at S, through a selector switch at the private branch exchange which selects an idle trunk circuit such as T outgoing to the central office. The connection having been extended to an incoming selector switch SL^2 at the central office, the next digit or digits will determine the positioning of the switch or switches in the central office to route the call either to a local subscriber's line or to a toll or interoffice trunk circuit, as the case may be. In the case of a local call, the selector switch SL^2 will be operated to select one of a plurality of groups of trunks such as the group illustrated at 90. An idle trunk is then selected in this group and an extension of the connection is continued to select a called subscriber's line. On an interoffice or toll call, however, the selector switch SL^2 will be operated to choose the proper one of a plurality of groups of toll trunks, one of which is illustrated at 80. The hunting movement of the switch thereafter chooses an idle trunk in this group and the connection is extended to the distant office.

The detailed operation involving the establishment of a connection between the station A and a local trunk circuit of the group 90 at the main central office will first be considered.

Upon removing the receiver from the switchhook at substation A, the non-numerical switch N will be actuated in a manner well known in the art to extend the line of the calling station A to the selector switch SL at the private branch exchange. Thereafter the calling subscriber may manipulate his impulse sender S to send a series of impulses in order to select an idle trunk circuit leading to the central office. This series of impulses causes the primary operation of

the selector switch SL, the brushes of which are shown at 11, 12 and 16. Following the group selecting movement of the selector switch SL, the brushes 11, 12 and 16 are moved automatically to search and make connection with the terminals 13, 14 and 17 of an idle trunk circuit leading to the main central office.

Relay 20 of the selector switch SL^2 of the main central office and relay 5 of the trunk circuit T are then operated over a path extending from grounded battery, left-hand winding of relay 20, first contact of side-switch arm 4, side-switch arm 4, through the winding of relay 5, and non-inductive resistance 6 in parallel, terminal 14 and brush 12 of switch SL, brush 10 and terminal 8 of switch N, through the substation loop, terminal 7 and brush 9 of switch N, brush 11 and terminal 13 of switch SL, side-switch arm 3 and its first contact, and right-hand winding of relay 20, to ground. Relay 20 in operating, completes an obvious circuit through its armature and front contact for slow-to-release relay 21. Relay 5 in operating, completes an obvious circuit through its armature and front contact for slow-to-release relay 23. Relay 21 in operating completes an obvious circuit through its front contact and right-hand armature for relay 22. Relay 23, in operating, through its inner right-hand armature and front contact, places ground potential upon the test terminal 17 of the trunk T, in order to render this trunk non-selectable to other switches in the private branch exchange. Relay 23 in attracting its left-hand armature bridges the high resistance relay 24 across the talking conductors of the trunk circuit T, whereupon relay 24 may operate. Relay 20 in operating prepares a circuit for the primary stepping magnet 27.

The calling subscriber operating his impulse sender S sends out another series of impulses corresponding to one of the digits of the desired number, in order to set the switch SL^2. Upon the first interruption of the line circuit in response to this series of impulses, relay 20 releases its armature and opens the circuit for relay 21. This relay, however, being slow to release, does not deenergize in the brief interruptions of its circuit during the transmission of this series of impulses. Relay 5 retracts its armature at each interruption of the line circuit, thereby opening the circuit for relay 23. Relay 23, however, being of the slow-to-release type, does not deenergize in the brief interruptions of its circuit during the transmission of a series of impulses. Relay 24, therefore, remains bridged across the talking conductors of the trunk circuit T. The resistance of relay 24 is of such a value as to permit the deenergization of the impulse relay 20 or impulse relays associated with succeeding switches in response to impulses from the dial S. Relay 20 upon deenergizing completes a circuit from ground, through its armature and back contact, left-hand armature and front contact of relay 21, off-normal contacts 29, and winding of primary stepping magnet 27, to grounded battery. In parallel thereto, a circuit is also completed through the winding of slow-to-release relay 26, to grounded battery. Relay 26 at its armature and contact closes a circuit for the energization of escape magnet 28. Escape magnet 28 operates and prepares to release the side switch into position 2 when the energizing circuit of said magnet is opened.

The primary stepping magnet 27 operates to advance the brushes 33, 34 and 35 of the switch SL^2 through one step in the primary direction. When the line circuit closes at the end of the first impulse, relay 5 attracts its armature and again closes a circuit for slow-to-release relay 23, and relay 20 opens the circuit of stepping magnet 27 and relay 26 and again closes the circuit for slow-to-release relay 21. Relay 26 being of the slow-to-release type, remains energized during the sending of a series of impulses to the relay 20. For each succeeding impulse of the series, the magnet 27 moves the brushes 33, 34 and 35 through one step in the primary direction, finally bringing said brushes to rest in operative relationship to the group of trunks 90, containing the trunk having the terminals 36, 37 and 38.

After an interval has elapsed following the transmission of the last impulse of this series, relay 20 remains energized long enough to permit the release of slow-to-release relay 26. Relay 26 opens the circuit of the escape magnet 28 which immediately deenergizes and advances the side-switch arms 3, 4, 46 and 49 to their second position terminals. In this position of the side switch the escape magnet 28 is immediately energized in a circuit extending from grounded battery, winding of magnet 28, second contact of side-switch arm 46, side-switch arm 46, and off-normal contact 47, to ground. Magnet 28 operates preparatory to releasing the side switch into its third position upon deenergization. A circuit is also established for the secondary stepping magnet 30 over a path extending from grounded battery, winding, back contact and armature of magnet 30, side switch 49 in its second position, and the front contact and armature of relay 20, to ground. The stepping magnet 30 is energized, interrupts its own circuit and advances the brushes 33, 34 and 35 on to the first set of terminals in the selected group 90. As the brush shaft takes its first step in the secondary direction, the off-normal contacts

47 and 29 are opened. Contact 47, however, does not open until shortly after the test brush has made engagement with the test terminal of the first trunk of the selected group. If the first trunk in the selected group is busy, ground potential will be present on the test terminal thereof, and a circuit is completed as follows for maintaining the energization of escape magnet 28—grounded battery, winding of magnet 28, second contact of side-switch arm 46, side-switch arm 46, brush 35, to the grounded test terminal. The side-switch arm remains in position 2, and the stepping magnet 30 continues to advance the brushes until the first idle trunk, such as the one having the terminals 36, 37 and 38, is reached. At this time the escape magnet 28 becomes deenergized due to the absence of ground potential at terminal 38, and advances the side switch from its second to its third position. Side-switch arm 49 in leaving position 2, opens the circuit of the stepping magnet 30 to prevent any further operation of the switch. The test terminal 38 is immediately rendered busy to prevent selection by other switches by means of the following circuit—ground, through the front contact and right-hand armature of relay 21, third contact of side-switch arm 46, side-switch arm 46, brush 35, to the test terminal 38.

The side switch in passing out of position 2 opens at its arms 3 and 4 the circuit including the winding of relay 20. Relay 20 thereupon releases, thereby causing the release of relay 21. Relay 21 in releasing removes ground at the right-hand contacts of said relay 21 from the test terminal 38. Before relay 21 has had time to deenergize, however, ground from the succeeding selector switch is placed upon test terminal 38 to maintain the trunk busy and to hold the relay 22 energized, in the manner well known in the art, due to the energization of relay 60. Relay 60 is energized over an obvious circuit and battery at the main central office connected through the windings of relay 60 serves to maintain relay 5 and relay 24 of the trunk circuit T energized.

From this point on, the extension of the connection is continued under the control of the calling subscriber and as many succeeding switches are operated as are necessary to extend the connection to the called subscriber's line. When the last automatic switch has been actuated battery will flow from the main central office over the talking conductors of the trunk circuit T, thereby serving to maintain relays 5 and 24 of trunk circuit T energized and to provide the calling substation with talking battery.

At the termination of the conversation, the called subscriber by replacing his receiver on the switchhook brings about the release, in any well known manner, of the switches succeeding those shown in the drawing. The release of the switch succeeding switch SL^2 causes the removal of ground potential from the test terminal 38 and the resultant deenergization of relay 22. The release of relay 22 causes the closure of a circuit from grounded battery, winding of release magnet 31, off-normal contacts 48, and back contact and armature of relay 22, to ground. Magnet 31 energizes and locks up through its armature and front contact and the off-normal contacts 48. The brushes 33, 34 and 35 are restored to their normal position at which time the off-normal contacts 48 are opened and the release magnet 31 becomes deenergized. Switch SL^2, in releasing, releases relays 5, 23 and 24. The calling subscriber by replacing his receiver on the switchhook brings about the release of the automatic switches in the private branch exchange.

It will next be assumed that the subscriber at the private branch exchange wishes to obtain a connection with a subscriber's line over a toll trunk circuit, necessitating the use of an interoffice trunk interconnecting the distant office with the central office illustrated in the drawing. The operation of the apparatus at the private branch exchange takes place in the manner previously described. The digit of the called number necessary for actuating the switch SL^2 in the main central office in the present case, however, differs from the corresponding digit of the number previously considered. The result is that the brushes 33, 34 and 35 of the selector switch will be moved first to select one of a plurality of groups of trunks such as the group 80 leading to the desired distant office, and thereafter to select an idle trunk of the selected group.

Assuming that the brushes 33, 34 and 35 have been brought to rest upon the terminals 51, 52 and 53 of an idle toll trunk of the group 80, relays 61, 62 and 5 will be energized as soon as the side-switch brushes 3 and 4 of the switch SL^2 are moved into their third positions over a path extending from ground, left-hand winding of relay 61, terminal 51, and brush 33 of switch SL^2, third contact of side-switch arm 3, side-switch arm 3, terminal 13, brush 11 of switch SL, brush 9, and terminal 7 of switch N, through the substation loop terminal 8, and brush 10 of switch N, brush 12, and terminal 14 of switch SL, through the winding of relay 5, and non-inductive resistance 6 in parallel, side-switch arm 4 and its third contact, brush 34, and terminal 52 of switch SL^2, winding of relay 62, and right-hand winding of relay 61, to grounded battery. Relay 61, in operating, causes a ground to

be placed upon test terminal 53 in place of the ground at the contact of relay 21, to render the toll trunk circuit non-selectable and to maintain relay 22 energized as heretofore described. Relay 62 in operating, through its left-hand armature, short circuits the talking conductors of the toll trunk circuit momentarily. This momentary short circuit across the talking conductors causes the momentary release of relays 5 and 24 of the trunk circuit T. Relay 62 in attracting its right-hand armature completes an obvious circuit for slow to operate relay 63. Relay 63, in operating, locks up through its left-hand armature to ground on test terminal 53, and through its right-hand armature short circuits relay 62, whereupon said relay 62 releases thereby removing the short circuit from the talking conductors of the trunk circuit.

Relays 5 and 24, in retracting their armatures due to the momentary short-circuiting of the toll trunk circuit, complete a circuit for relay 65 over a path extending from ground, armature and back contact of relay 5, armature and back contact of relay 24, right-hand armature and front contact of relay 23, resistance 64, and winding of slow-to-operate relay 65, to grounded battery. Relay 65 is preferably slow-to-operate to prevent false actuation of the signal 66. Relay 5 in retracting its armature momentarily opens the circuit for relay 23, but relay 23 being of the slow-to-release type, does not deenergize. Relay 65 in operating locks up through its left-hand contacts to ground under control of slow-to-release relay 23. Relay 65 in attracting its right-hand armature prepares an obvious circuit for the lamp signal 66 which circuit is completed as soon as relay 5 attracts its armature at the end of the momentary short circuit of the toll trunk circuit. As soon as the short circuit from the toll trunk circuit is removed, relays 5 and 24 again energize and lamp signal 66 lights.

The attendant at the private branch exchange observing the signal 66 knows that some subscriber of the private branch exchange is making a central office call over a toll trunk circuit. She may thereupon depress her listening key K which places her headset in talking relation with the calling line. By inquiring from the calling subscriber, the attendant learns of the nature of the call being extended and the name of the party and the number of the station calling so that the necessary charge in case of a successful call may be made against the proper person or station. After having obtained the necessary information the attendant releases the listening key K and retires from the connection.

It will be noted that the calling subscriber is in this case supplied with talking battery from the main central office. It is obvious that any number of switches may be employed succeeding the switch SL^2 for building up any desired connection. The release of the connection is effected in a manner similar to that previously described.

What is claimed is:

1. In a telephone exchange system, a first exchange, a second exchange, a trunk circuit interconnecting said exchanges, trunk circuits of different characters at said second exchange, a calling line at said first exchange, means under the control of the subscriber of the calling line for extending the line over said trunk circuit and an idle one of either of said characters of trunk circuits, a signal at said first exchange, electromagnetic means associated with trunk circuits of one character only for actuating said signal, and means for automatically operating said electromagnetic means when an idle trunk of that character is selected.

2. In a telephone exchange system, a first exchange, a second exchange, a trunk circuit interconnecting said exchanges, an automatic selector switch at the second exchange local trunk circuits and toll trunk circuits accessible to said switch, means for extending a talking connection over said trunk circuit to the switch at the second exchange, means for operating the switch to select an idle trunk circuit, a signal at said first exchange, means for actuating said signal, electromagnetic means associated with each toll trunk for rendering said actuating means effective, and means for automatically operating said electromagnetic means when an idle toll trunk is selected.

3. In a telephone exchange system, subscribers' lines, a trunk circuit, a selector switch, trunk circuits of different characters for establishing talking connections between said lines, accessible to said selector switch, means for extending a talking connection over said trunk circuit to said selector switch, means for operating said switch to select an idle trunk circuit of either character, an operator's position, a signal thereat, electromagnetic means for operating the same, and means for actuating said electromagnetic means only when said switch is operated to select a trunk of one character.

4. In a telephone exchange system, a first exchange, a second exchange, a trunk circuit interconnecting said exchanges, a selector switch at said second exchange, local and toll trunk circuits accessible thereto, a source of battery supply connected to said trunk circuits at said second exchange, means for extending a talking connection over said trunk circuit to said switch, means for operating said switch to select an idle local or an idle toll trunk circuit, a relay connected in series with the talking conductors of said trunk circuit, a signal at said

first exchange, a relay associated with each toll trunk circuit operating in series with said first mentioned relay over a circuit including said source of battery supply to momentarily short circuit said first mentioned relay when a toll trunk circuit is selected, and a local circuit completed for said signal upon the momentary deenergization of said first mentioned relay.

5. In a telephone exchange system, a first exchange, a second exchange, a trunk circuit interconnecting said exchanges, local and toll trunk circuits at said second exchange, a selector switch at said second exchange, means for operating said switch to extend a connection over said trunk circuit to an idle one of either of said classes of trunk circuits, a signal at said first exchange, actuating means therefor, a source of battery supply at said second exchange, electromagnetic means associated with said toll trunk circuits and means for automatically actuating said electromagnetic means when an idle toll trunk is selected to operate said signal actuating means, said actuating means and said electromagnetic means being controlled by said central source of battery supply.

6. In a telephone exchange system, a first exchange, a second exchange, a trunk circuit extending between said exchanges, a relay connected in series with the talking conductors of said trunk circuit and a relay bridged across the talking conductors of said trunk circuit, a signal at said first exchange, toll trunks and local trunks at said second exchange, means including automatic switches for selecting an idle toll trunk or an idle local trunk, a source of talking battery at said second exchange for actuating said series and said bridged relays, means associated with a selected toll trunk for momentarily deenergizing said relays, a local circuit completed upon deenergization of said relays to actuate said signal, and a locking circuit for said signal.

In witness whereof, I hereunto subscribe my name this 22nd day of December A. D., 1920.

CHARLES L. GOODRUM.