

April 7, 1925.

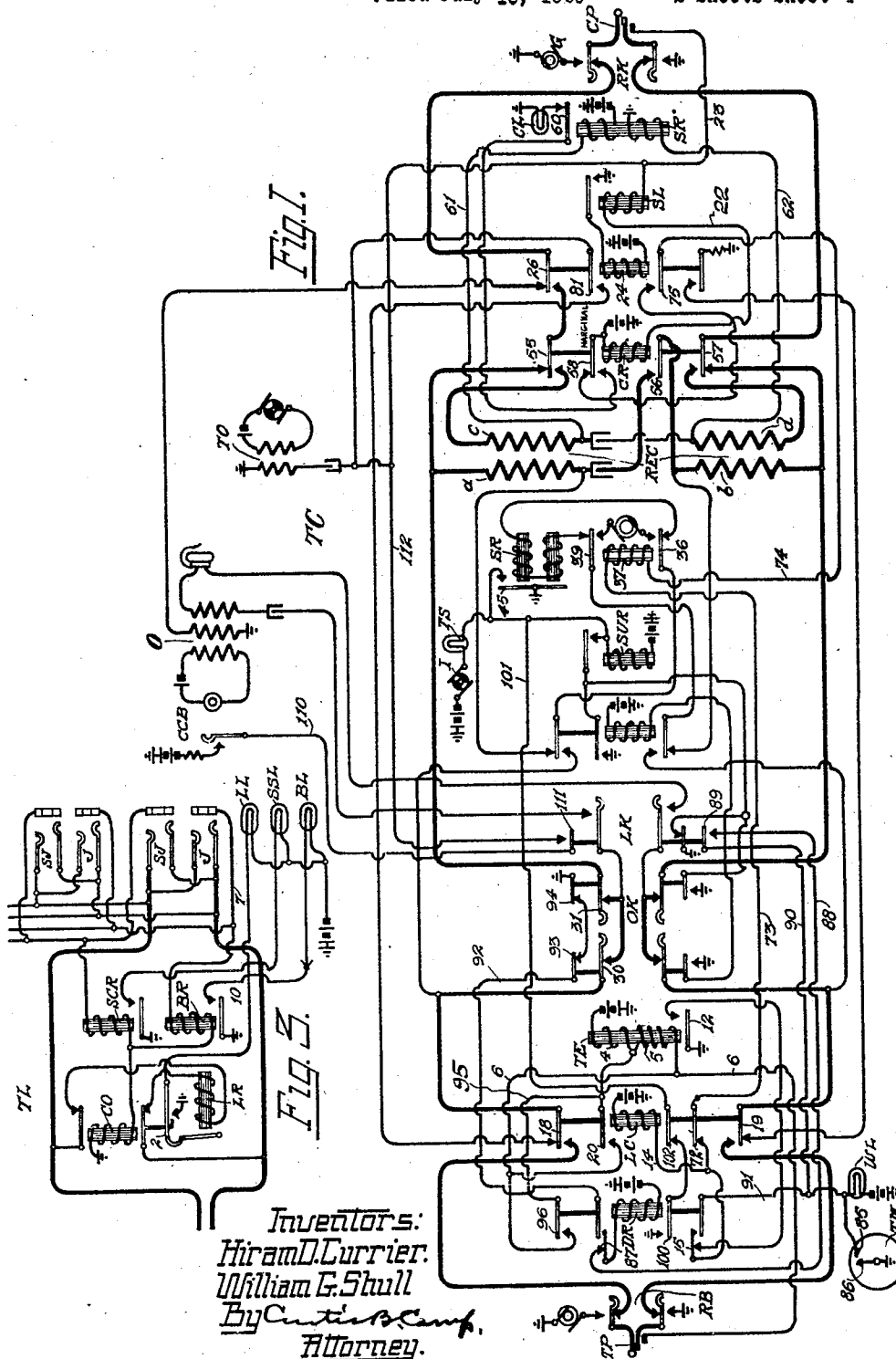
1,532,888

H. D. CURRIER ET AL.

TELEPHONE SYSTEM

Filed July 15, 1920.

2 Sheets-Sheet 1



April 7, 1925.

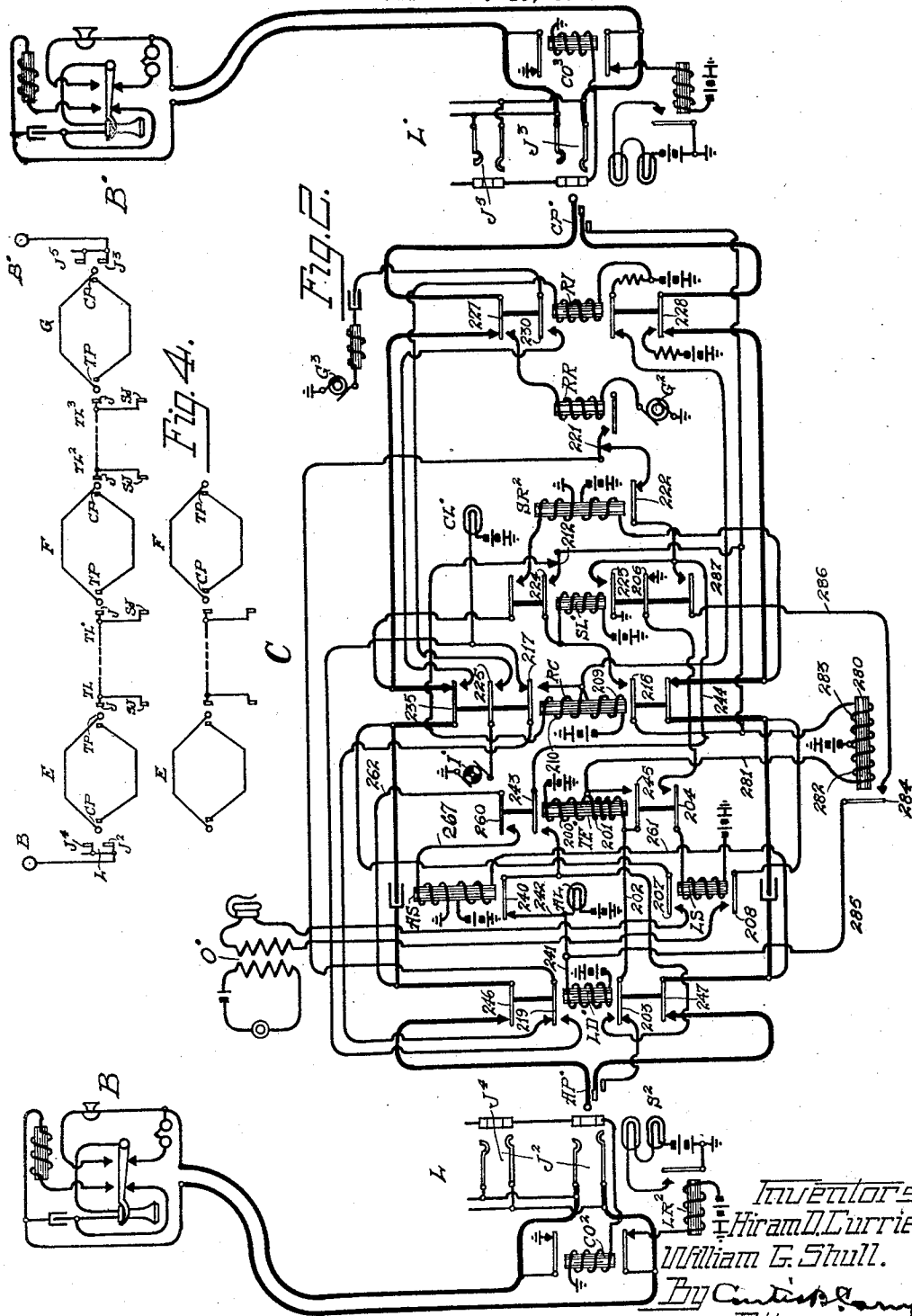
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2 Sheets-Sheet 2



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TELEPHONE SYSTEM.

Application filed July 15, 1920. Serial No. 396,401.

To all whom it may concern:

Be it known that we, HIRAM D. CURRIER and WILLIAM G. SHULL, citizens of the United States of America, residing at Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification.

Our invention relates to telephone systems and has to do more particularly with systems in which link and trunk circuits are used for interconnecting subscribers' lines, such as toll to toll connections and toll to local connections, and an object of our invention is the provision of an improved circuit arrangement of the above character which will embody desirable features in a simple, efficient and economical manner.

Toll switchboards as now used are provided with toll cord circuits and in addition are provided with multiple jacks of local lines so that connection may be made therewith. When an incoming toll connection must be extended to some other point over a toll line and the toll line to the point wanted is found in use, the original calling operator must be notified of it and the connection re-established at another time. A feature of our invention is the provision of paired jacks for each toll line terminating at the toll board, one being the usual answering jack and the other a seizure jack. This seizure jack is used for seizing a busy toll line so that the line automatically comes under control of a distant operator the instant the toll line becomes available. Means are also provided in the cord to prevent the same from interfering with the first established connection when connected to the seizure jack, but the instant the seized toll line becomes available, means in the cord are actuated to place the second connected cord (whose plug is in the seizure jack) in effective connection with the wanted toll line, and when this condition is established, means automatically send current in both directions to signal that the line is now available.

Another feature of our invention is the provision of busy lamps associated with toll lines, one for each multiple toll jack, which are lighted when a connection is established,

and seizure lamps which are also provided one for each multiple seizure jack, which are lighted the instant the plug of a toll cord is inserted into the seizure jack to give the other toll operators indication that a plug is in the seizure jack of the toll line so that another operator will not use her seizure jack of that line.

Still another feature of our invention is the provision of a timing meter for toll connections, so arranged that a contact is closed after a predetermined lapse of time for a few seconds to signal the operator that the time of conversation is almost over. When the contact breaks, means provided in the cord are actuated to sever the connection and a disconnect signal is given.

Still another feature of our invention is this: Should the toll call for a local substation be of special importance and the said local station be busy, the calling plug of the toll cord is inserted in a multiple jack of the station, and battery connected by the actuation of a special key will operate means in the local cord which will sever the connection and give the local operator a signal notifying her that an urgent call is being extended.

The features as outlined above, as well as others, will be more fully described in the ensuing specification and appended claims.

For a more complete understanding of our invention reference may be had to the accompanying drawings, which illustrate circuit arrangements which embody the features of our invention, in which—

Fig. 1 illustrates a toll cord circuit of our invention;

Fig. 2 illustrates a local cord circuit for interconnecting local lines and adapted to operate in connection with the toll cord of our invention and two local subscribers' line circuits;

Fig. 3 illustrates a toll line circuit; and

Fig. 4 schematically a toll line connection.

Referring first to Fig. 3, we illustrate a toll line circuit TL, which has a line relay LR, a cut-off relay CO and line lamp LL and answering jack J. In addition to the apparatus just described, we provide a busy lamp control relay BR, which is energized when a plug is inserted in the answering

jack J of the line to light the busy lamps BL to indicate the busy condition of the line. A seizure lamp control relay SCR is provided which is energized when a plug is inserted into the seizure jack SJ to light the seizure signal lamps SSL. Each end of the toll line has connected to it the above described apparatus.

The toll cord circuit TC is provided with a toll plug TP and a combination plug CP, the said plugs being connected by the heavily marked conductors. The toll end of the cord circuit is for connecting to toll lines only and is provided with a ringback key RB, for the usual purposes. A test relay TE is also provided, which is energized when connection is made with a calling toll line but fails to operate when the cord is associated with a seizure jack SJ, and a link control relay LC is also provided for establishing the continuity of the talking conductors, for purposes as will be more fully hereinafter described. A timing meter TM is also provided, as is also a disconnect relay DR, the timing meter being used for timing a conversation, and the relay DR in association with the meter TM controls the termination of conversation at the end of a predetermined period. A listening key LK is provided which, when actuated, connects the operator's set to the cord conductors. A double cut-out key OK is also provided for the usual monitoring purposes. A supervisory relay SR is provided which is energized, when the disconnect current is transmitted to the cord, to close the circuit for the flashing toll supervisory lamp TS, giving the operator a disconnect signal. A supervisory signal control relay SUR is also provided, which energizes upon the actuation of relay SR and locks up to hold the signal TS in circuit until restored by the actuation of the listening key LK. The right hand end of the toll cord circuit TC, the combination end, can be used either for connection to a toll line or to a local common battery line. It is provided with a supervisory relay SR' which is only brought in circuit when the combination cord plug CP is in the jack of a local line, and a calling supervisory signal CL is also provided and is in association with the relay SR' for the usual supervisory purposes. A sleeve relay SL is also provided which is energized when the combination plug CP is inserted into either a toll or local line, and a repeating coil control relay CR is also provided, which is energized when connection is made with a local line only to connect the repeating coil REC, which comprises windings a, b, c and d, in circuit. Relay CR remains at normal when connection is made with a toll line, and the repeating coil REC is not connected in circuit. A special tone TO is also provided for purposes as will be

more fully hereinafter described, and a ringing key RK is also provided which, when actuated, connects the generator G to ring the call bell of the called for substation or signal over a connected toll line.

Referring now to Fig. 2, we illustrate a local cord circuit C, and to the left of the drawing we illustrate a calling substation B, terminating at the exchange in a line circuit L, comprising the usual line relay LR², cut-off relay CO², multiple jacks J² and line signals S². The line circuits as illustrated are known as multiple line lamp circuits, in which a line lamp is provided for each line jack so that when a call is initiated, a lighted line signal appears at each of the multiple line jacks and any one of a plurality of operators may seize the call to the exclusion of the others.

The cord circuit C comprises an answering plug AP' and a calling plug CP' connected by the heavily marked talking conductors. Upon the initiation of a call, the operator answers by inserting an answering plug into the jack J², causing the energization of the test relay TE', and the relay TE' upon energization closes an energizing circuit for the listening relay LS, which relay operates to connect the operator's set O' to the cord conductors. The answering supervisory relay AS is also energized upon the energization of relay TE', which relay AS prevents, at this time, the lighting of the supervisory lamp AL. Upon the insertion of the calling plug CP' into the jack of the called line, the ringing control relay RC is energized, which relay in turn brings about the energization of the sleeve relay SL'. The relay RC upon energization connects the interrupter I' in circuit with the ringing interrupter relay RI, which relay RI is intermittently energized and de-energized to connect the ringing generator G² through the ringing relay RR to the cord conductors to operate the call signal at the called substation. A supervisory relay SR² is energized when the called subscriber answers to efface the calling supervisory signal CL'. Should the called subscriber answer during the ringing period, relay RR energizes to discontinue the application of ringing current, and if the subscriber answers during a silent period, the relay SR² energizes to open the ringing circuit.

When the calling subscriber replaces his receiver after the termination of the conversation the relay AS is de-energized and consequently the link disconnect relay LD' is energized and causes the disconnection of the cord conductors from the calling line which returns the apparatus of the calling subscriber's line circuit to normal. If the calling subscriber desires to recall before the plugs have been removed from their respective jacks he will be able to actuate his

associated apparatus to light the line signal S^2 because his line circuit has been returned to normal by the previous action of the link disconnect relay LD'.

made clear. By key RB the operator now projects ringing current over the toll line to F, operating line relay LR of circuit TL' at F. LR is of latching type and its contact 2 locks lighting lamp LL.

A differential relay 280 associated with the cord circuit is provided so that, should the cord circuit C be in use during a conversation between a calling and called local subscriber and should it happen that one of the talking subscribers was wanted by a toll operator and that the call was very urgent, the toll operator may sever the connection between the two talking local subscribers by applying battery to the sleeve of the multiple jack, and thus battery extends to the relay 280. The relay is unbalanced and operates to close a circuit for the link disconnect relay LD, which relay is energized and severs the link conductors and also closes the circuit for signal AL, and the operator noting the lighted signal takes down the connection, as will be more fully hereinafter described.

Having described in general the apparatus embodying our invention, we will now describe in detail the operation of the circuit arrangement as illustrated, and first in order will come the explanation of the toll apparatus, reference being had to Figs. 1, 3 and 4.

To properly explain our invention, we shall describe the putting through of a call from a local subscriber at place E to a similar subscriber at place G, and shall assume there are no through lines from E to G, but that there are toll lines from both E and G to a place F and that the toll operator at E calls the toll operator at F and the latter connects the line from E to F to the line from F to G, where the toll operator completes the connection.

This is schematically indicated in Fig. 4, where B is the local calling line in exchange E, and B' the local called line in exchange G.

The call comes to the toll operator at E in the form of a written message, stating that subscriber B at E wishes to talk with subscriber B' at G. The toll operator has before her a number of toll lines leading to F and these terminate both at E and F in circuits like that at TC in Fig. 1. She inserts toll plug TP into the jack J of such a line whose lamps LL, SSL and BL are all unlighted, closing circuit from battery through windings 4-4 of relay TE, sleeve contact TP-J, relays BR and CO to ground. Relay CO disconnects line relay LR. Relay BR closes contact 10, lighting the busy lamps BL at the various positions. Closed contact 12 of relay TE energizes link control relay LC by current through contact 15, and LC by contacts 18 and 19 extends the cord conductors, while alternate contact 20 shunts out the high resistance winding 5 of TE for purposes hereafter

The toll operator at F noting the lighted line lamp LL, inserts the toll plug of one of her toll cords in jack J of the toll line from E, thus closing a circuit from battery through windings 4 and 5 of relay TE, sleeve contacts of plug TP and jack J, conductor 7, relay BR, to ground through relay CO. Relay CO, upon energization, disconnects relay LR and unlatches contact 2 to efface the line lamp LL. Relay BR upon energization closes its alternate contact 10, lighting the busy lamps BL. The busy lamps BL at all positions at F are thus lighted to indicate the busy condition of the toll jacks J, and their line. Contact 12 of relay TE energizes the link control of LC relay by current via normal contact 15 of relay DR to ground at contact 12. Relay LC upon energization closes its alternate contacts 18 and 19 to extend the toll cord conductors. The closure of alternate contact 20 of relay LC shunts out the high resistance winding 5 of relay TE and the circuit of relay TE now extends from battery through the low resistance winding 4 of relay TE, alternate contact 20 of relay LC, conductor 6, the sleeve of plug CP to ground, through cut-off relay CO. The operator now actuates her listening key LK and inquires the want of the calling toll operator at E and learns the call is for G. She inserts the calling plug CP into the jack of an idle toll line extending to G which has a toll line circuit similar to TL, and circuit may be traced through the connecting relay CR, sleeve relay SL, conductor 23, sleeve contacts of the connected plug CP and jack of the called toll line, through its busy relay and the cut-off relay to ground. The relay CR of the toll cord is so adjusted and constructed that it does not operate when the calling plug CP is inserted into the jack of a toll line, but the busy relay BR and cut-off relay CO of the toll line circuit do, for the purpose similar to those already described and the sleeve relay SL is energized to energize relay 24. Relay 24 then closes contact 26 to extend the cord to the toll line since the relay CR remains at normal. When the calling plug CP is inserted in the jack of a called toll line, the repeating coil REC is not connected in circuit. The operator at F, by key RK, connects generator G to signal the operator on the connected toll line at G. The operator at G gets the signal on line lamp LL of a circuit TL in which the toll line ends and inserts the plug TP of one of her cords with results as when the operator at F plugged into the toll line.

The operator at G now receives the number of the wanted subscriber from the operator at E, tests the local line, finds it idle, plugs into its multiple jack with the combination end of her toll cord CP. She thus closes battery through the relay CR, conductor 22, sleeve relay SL, the sleeve contacts of the connected plug CP and jack J³ to ground through the winding of the cut-off relay CO². The relay CR of the cord TC is so constructed and adjusted that (being now in a circuit of less resistance than when connected to the toll line as previously described) when said cord is connected to a local subscriber's line, it operates contacts 55, 56 and 57, and bridges the windings *a*, *b*, *c* and *d* of the repeating coil REC across the cord conductors. The closure of alternate contact 58 lights calling supervisory lamp CL, the said lamp remaining lighted until the called local subscriber answers. The operator now actuates her ringing key RK to connect ringing generator G to ring the bell at the called substation, and in response to his call signal the subscriber at B' removes his receiver from the switch hook and closes an energizing circuit for the supervisory relay SR', traced from battery through the upper winding of said relay SR', conductor 61, the winding *c* of the repeating coil REC, alternate contact 55, alternate contact 26, the now closed contacts of the ringing key RK, the tip contacts of the connected plug CP and jack J³, through the substation, back through the ring contacts of the connected plug CP and jack J³, contact key RK, alternate contact 57, winding *d* of the coil REC, conductor 62 to ground through the lower winding of the supervisory relay SR'. The relay SR' then opens normal contact 60, effacing calling supervisory signal CL. The toll operator at G tells the called-for party at B' to hold the line, advises the toll operator at E that she has the party. The operator at E with her plug CP connects with the calling line and rings just as described for the operator at G. Subscriber B answers and the two local subscribers are in conversation.

By referring to Fig. 4 the relation of the subscribers' lines, cord circuits and toll lines will be immediately apparent.

When the subscribers finish their talk, they replace their receivers, opening the circuits of the relays SR', respectively connected to their lines and supervisory lamp CL at E as well as that at G are lighted.

The operators at E and G listen in, find conversation is finished, withdraw the plugs from the local lines and, before withdrawing the toll plugs of their cords, depress their ringing keys RB for a moment. Suppose the operator at E operates her key RB first. Alternating current will flow (referring to Fig. 3) through plug TP at E, over

the toll line to F, through toll plug TP at F to circuit TC' at F, through winding *a* of REC, relay SR, winding *b* and back to ground at key RB at E. Relay SR momentarily energizes and by contact 45 operates relay SUR, which locks, and lamp TS flashes by current through constantly rotating interrupter I. Furthermore, the current from RB at E passes on through the cord at F over the toll line to G, through the toll plug TP, through winding *a* of coil REC at G, relay SR there, back through winding *b* to E, with the result that the lamp TS at G also flashes. The operators at F and G listen in (unlocking relays SUR) and withdraw the plugs of their cord circuits and all apparatus is at normal.

Let it be assumed that while the subscribers B and B' were conversing, some operator at E had a call for exchange G, which she passes to the operator at F over an idle toll line in a manner obvious from the preceding. The operator at F has no idle toll line to G at this moment, so she seizes the one B and B' are talking over. The operator at F will have answered the call from E with the toll plug TP of a cord pair and would ordinarily use plug CP to connect to the toll line to G. For seizure purposes however, a plug TP must be connected to the line to be seized, so the operator at F reverses plugs of the cord she is now using, putting the calling plug in the jack of the line from E and TP in a multiple seizure jack of the busy toll line to G. Current then passes from battery through windings 4-5 of relay TE of the seizing cord, through the sleeve plug contact, sleeve of seizure jack SJ relay SCR of the busy toll line, its relay CO to ground. Relay SCR lights the seizure lamps SSL and other operators waiting for a toll line to seize are warned off. Since a combination plug CP is already in a jack J of this toll line, the relay TE of the seizing plug is shunted by the circuit including relays CR and SL of the combination plug already in the jack of the toll line to G, and this shunt is low enough so that relay TE of the seizing cord remains inert for the time being, the cord conductors remain open at 18 and 19 and existing conversation is in no way affected. The operator at E who will be in on the toll line gets a tone advising her of the seizure from TO, through contacts 81, 18, 30, 31, normal 55, alternate 26, through plug and jack to line, and this tone remains on the line until the seized line reverts to her. When the existing conversation is ended and the operator at F has disconnected the plugs of the cord first used, relay TE of the seizing cord is no longer shunted and it actuates, its armature 12 closing circuit simultaneously through relays LC and 37, which energize. Circuit for 37 may be

traced from ground at 12, contacts 15, 72, conductors 73—74, contacts 75, 58 to battery. LC instantly cuts off 37, but as the latter is of the slow release type, it for a short time remains energized and holds generator over a circuit that may be traced through alternate contacts 39, 36 and windings *b* and *a* of coil REC across the main cord conductors, and this current will pass over the toll line to G and also over the other toll line to E. At E it will cause relay SR to energize, resulting in lamp TS flashing, and the operator will know the seizure has become effective, and she will cut her telephone set in on the line. At G the current will operate the line relay LR to light lamp LL, if the operator there has plugged out, who will in that case plug in again and take the order from the operator at E, and the second call will be completed in a way apparent from the description of the first call.

It will be observed the energization of relay LC has cut off tone TO, which has remained on the toll line to E, so that until the seizure did become effective the operator at E, listening in, could assure herself that the holding process was still going on.

Although the foregoing description had the seizing toll plug TP put in a jack to which toll plug TP had been connected, seizure would have worked equally well if the seizing toll plug had been put in the seizure jack of a line that had a toll plug in its jack, as in that case the relay TE of the seizing plug would have been shunted by the low winding 4 of a previously connected relay TE and TE of the seizing plug would not have energized till the previous connection was taken down.

It is also to be observed that a toll line can be seized when it is rendered busy by a plug inserted in its seizure jack. In such case the operator, looking for a toll line and noting one with lamp SSL lighted and lamp BL not lighted, will plug into a jack J and effect seizure perfectly well. In fact, jacks J and SJ are interchangeable in function, as are lamps BL and SSL.

We will next describe the operation of the timing meter TM. Assume the connection between B and B' has just been established and conversation is about to commence. Each toll cord has a meter TM and the originating operator, the one at E in this case, has charge of the timing of the call. Working under the assumption that the toll time is three minutes, the instant that the conversation starts, the operator of the toll cord at E starts the timing meter TM, a clock-work device, and this meter is so arranged that at some lapsed period of time, say two minutes and forty seconds of conversation, the indicator or pointer 86 engages a conducting strip 85, which closes an energizing circuit for the warning lamp WL from battery, through the lamp WL conducting strip 85 to ground at the indicator 86. The operator of the connected toll cord circuit TC observing the lighted signal WL now actuates her listening key LK to connect her operator's set O to the cord conductors and notifies the subscribers that their time is almost up, and this actuation of the listening key LK closes an energizing circuit for the relay DR, traced from battery through the winding of the relay DR, normal contact 87 of relay DR, conductor 88, alternate contact 89 of listening key LK, conductor 90, conducting strip 85, to ground at the indicator 86. The relay DR, upon energizing, opens its normal contact 15, opening the initial energizing circuit of relay LC at the now open contact 15, but the relay LC is held energized during this twenty second period over a circuit traced from battery through the winding of relay LC, conductor 14, alternate contact 15 of relay DR, conductor 91, the conducting strip 85 to ground at the indicator 86 of the timing meter TM. The closing of alternate contact 87 of relay DR establishes a locking circuit for the said relay DR from battery through the winding of the said relay DR, its alternate contact 87, conductor 92 to ground through the normal contacts 93 and 94 of the double cut-out key OK. At the end of the twenty second period, the indicator 86 disengages the conducting strip 85, which now opens the holding circuit of relay LC, which relay LC now deenergizes and opens its alternate contacts 18 and 19 to destroy the continuity of the cord conductors, and the connection is thus interrupted. The relay TE is held energized when the relay LC restores over a substitute circuit, traced from battery through winding 4 of relay TE, conductor 95, alternate contact 96 of relay DR, conductor 6 to ground at the cut-off relay CO of the connected toll line circuit with which the plug TP is connected. The closure of alternate contact 100 of relay DR establishes a circuit through the flashing signal TS, traced from battery through the interrupter I, through the lamp TS, conductor 101, normal contact 102 of relay LC to ground at alternate contact 100 of relay DR. The constantly rotating interrupter I now flashes the signal TS, notifying the operator that the conversation has been interrupted at the end of the three minute period. The operator may again converse with the subscribers by actuating the key OK, which opens its normal contacts 93 or 94, depending upon which way the key is thrown, to open the circuit of relay DR, which relay deenergizes and again closes the circuit for relay LC through its contact 15 and LC energizes, and contacts 18 and 19 again

close the continuity of the talking conductors so the subscribers may again carry on the conversation for an additional period of three minutes. Should the operator not
 5 notify the subscribers of the limited period of time in which to finish their conversation, the operator will then have to actuate her listening key LK and tell the conversing subscribers that their period of time is up,
 10 and to break the conversation she may actuate her key OK, which will sever the connection.

Referring now to the cord circuit illustrated in Fig. 2, we will describe briefly its
 15 general operation and then refer in more detail to its peculiar feature, the provision of differential relay 280, which serves under control of a toll operator to break down an existing local connection in favor of a
 20 toll call. With such an arrangement all toll calls can, if desired, be given full preference over local calls, and the holding of local lines as now practiced in many exchanges pending completion of toll calls
 25 can be dispensed with, the break-down system permitting a toll operator to immediately secure any wanted local line whatever, whether idle or busy.

Assuming that the subscriber B initiates a
 30 call, removal of the receiver energizes the line relay LR², which lights line signals S². An operator inserts answering plug AP' into a multiple jack J² and energizes test relay TE and the cut-off relay CO², by current traced
 35 from battery through the low (200) and high (201) resistance windings of relay TE', normal contact 203 of relay LD', the sleeve contacts of plug AP' and jack J², cut-off relay CO² to ground. The closure of alternate
 40 contact 245 of relay TE' now closes a locking circuit for the relay TE', traced from battery through the low winding 200 of relay TE', its alternate contact 245, conductor 202, normal contact 203 of relay LD',
 45 sleeve contacts of jack J² and plug AP' to ground through the cut-off relay CO². This low resistance path shunts out the high resistance winding 201 of relay TE' for purposes as will presently be described. The
 50 closure of alternate contact 260 of relay TE' establishes an energizing circuit for the answering supervisory relay AS, traced from battery through the lower winding of relay AS, conductor 261, normal contact 247 of
 55 relay LD', ring contacts of the connected plug AP' and jack J² through the closed contacts of the substation switchhook back through the tip contacts of the jack J² and plug AP', normal contact 246 of relay LD',
 60 conductor 262, alternate contact 260 of relay TE', conductor 267 to ground through the upper winding of relay AS, and the opening of its normal contact 240, upon its energization, prevents the premature lighting of the answering supervisory lamp AL.

The closure of contact 204 of relay TE' energizes the listening relay LS, by current through the said relay LS, contact 204, to
 ground at contact 206. Contacts 207 and
 70 208 now connect the operator's set O' to the cord. Should a second operator attempt to answer the initiated call, the low winding of relay TE' of the first cord prevents relay TE' of the second cord from operating by
 75 shunting it, and the second operator finds she is shut out and disconnects. Assuming the connected operator finds substation B' is
 wanted, she tests and, finding it idle inserts calling plug CP' into multiple jack J³ of
 80 substation B'. This energizes ringing control relay RC by current through its windings 209 and 210, normal contact 212, sleeve contacts of plug CP' and jack J³, to ground
 85 through cut-off relay CO³. The closing of contact 215 of relay RC energizes sleeve relay SL' by current traced from battery through the winding of said relay SL', contact 215 of relay RC and through plug CP' and jack J³, to ground through relay CO³.
 90 Alternate contact 217 of relay RC locks said relay, tracing from winding 209, contact 217, normal contact 219, normal contact 221, contact 222 to ground at contact 223. The
 closing of contact 224 of sleeve relay SL' locks it to ground through cut-off relay CO³.
 95 The relay SL' upon energization opens the energizing circuit of relay LS, which restores to open its alternate contacts 207 and 208 to disconnect the operator's set O' from
 100 the cord conductors. Contact 225 of the relay RC now connects interrupter I' to the ringing interrupter relay RI. The relay RI is thus intermittently energized and de-energized by interrupter I', and ringing
 105 current from G² intermittently rings the bell at B'. The calling subscriber at the substation B is also given an audible signal during the ringing of the called for subscriber to notify him that the called substation is being signaled. The audible tone
 110 may be traced from the generator G³, contact 230, to alternate contact 235, back to the calling substation B.

Assuming that the subscriber at the calling
 115 substation B replaces his receiver upon the switchhook before the subscriber at the called substation B' answers, the replacing of the receiver opens the energizing circuit through relay AS, and the relay AS restoring closes its normal contact 240, establishing an energizing circuit for the link
 120 disconnect relay LD' from battery through the winding of said relay LD', conductors 241 and 242, normal contact 240 of relay AS, alternate contact 243 of relay TE', conductor 244 to ground at alternate contact
 125 223 of relay SL'. The relay LD' upon energization opens its normal contact 219, which opens the energizing circuit of the ringing control relay RC, which relay RC
 130

restores, and upon its restoration its alternate contact 225 is opened to disconnect the interrupter I' from relay RI, and relay RI now remaining at normal, further application of ringing current is prevented. Answering lamp AL lights and the operator pulls down the plugs.

Assuming the subscriber at the substation B' removes his receiver from the switch-hook during a ringing period, the combined generator and battery flow through the relay RR energizes the said relay RR, which opens contact 221, unlocking relay RC, which latter opens contact 225, disconnecting interrupter I' from relay RI, which prevents further application of ringing current to the called substation B'. The closing of normal contacts 227 and 228 now causes the supervisory relay SR² to energize in an obvious manner by current through substation B'. The calling subscriber at the substation B and the called subscriber of the substation B' are now in conversation, talking circuit being traced over the heavily marked conductors.

The subscribers completing their conversation replace their receivers upon the respective switchhooks, and at substation B this opens the energizing circuit of supervisory relay AS. Relay AS closes its normal contact 240, energizing the link disconnect relay LD' over a circuit traced through the said relay LD', conductors 241, 242, normal contact 240 of the relay AS, alternate contact 243 of relay TE', conductor 244 to ground at alternate contact 223 of relay SL'. The relay TE' is held energized upon the energization of relay LD' over a circuit traced from battery through the upper winding 200 of relay TE', its alternate contact 245, conductor 202, alternate contact 203 of relay LD', alternate contact 243 to ground at contact 223. The opening of normal contacts 246 and 247 of the relay LD' interrupts the cord conductors, thus disconnecting the said cord circuit from the line of the calling subscriber. The closing of the normal contact 240 of the relay AS lights answering supervisory lamp AL. The replacing of the receiver at B' opens the energizing circuit of the supervisory relay SR², which relay restores and lights calling supervisory lamp CL'. The two supervisory lamps AL and CL' are now lighted to notify the operator that conversation has terminated.

Should at this time the subscriber at A wish to recall before the plugs have been removed, he again removes his receiver, energizing the line relay LR to again light the line signals S², and any operator observing the lighted line lamps may now insert an answering plug of a cord circuit and seize the recall.

The operator noting the two supervisory

signals AL and CL' now withdraws the plug CP'. The withdrawal of plug CP' from the jack J³ opens the locking energizing circuit for the relay SL'. Said relay SL' restoring to normal opens its alternate contact 223, which opens the circuits for the relays LD' and TE', restoring them to normal, the opening of contact 219 and contact 243 extinguishing the supervisory lamps.

The apparatus used in establishing the above described connection is now at normal and available for use in establishing other connections.

It will be observed that when the operator first inserts plug AP' into jack J², differential relay 280 energizes due to the closure of contact 245, but this does not affect relay LD' because conductor 286 is open at 287, when the operator plugs into the called line, current will flow through winding 283 of relay 280 simultaneously with the energization of relay RC, and since current is also flowing through the other winding 282 of relay 280 at the same time, relay 280, due to its differential construction will de-energize and open its contact 284 before the contacts 287 and 223 of relay SL' can close to establish an energizing circuit for relay LD' whereby relay LD' is prevented from operating at this time.

Assuming now that a subscriber as B wishes to converse long distance with a local subscriber and that the call is very urgent. The local line multiple appears before the toll operator, and assuming that the local line wanted is busy, the urgent call will be given preference over the local connection. The toll operator now inserts the combination plug of the toll cord circuit TC into the multiple jack, as J⁴, of the called local line that is busy and actuates the cord circuit break-down key CCB and her listening key LK, which establishes an energizing circuit for the differential relay 280 of the local cord circuit C that has been used in placing the two local subscribers in conversational circuit. The circuit is traced from battery through the now closed contact of the key CCB, conductor 110, alternate contact 111 of the listening key LK, conductor 112, the sleeve of the calling plug CP of the toll cord circuit TC, the sleeve of the multiple jack J⁴ and the sleeve of the jack J² and answering plug AP' of the local cord circuit C, the normal contact 203 of the link disconnect relay LD', conductor 202, alternate contact 245 of the relay TE', conductor 281, through the left-hand winding 282 of the relay 280 to battery. The relay 280 being a differential relay is unbalanced as a circuit extending through the right-hand winding 283 from battery, over conductor 214 to ground through the cut-off relay CO³ of the line circuit, brings about

this unbalancing effect. The said relay 280 actuates and the closure of its alternate contact 284 establishes an energizing circuit for the link disconnect relay LD', traced from battery through the winding of the relay LD', conductors 241 and 285 to alternate contact 284 of relay 280, conductor 286, through alternate contact 287 to ground at alternate contact 223 of the sleeve relay SL. The relay LD' upon energization opens its normal contacts 246 and 247, thus interrupting the talking conductors, severing conversational circuit between the two local subscribers. The closing of alternate contact 284 of the relay 280 closes an energizing circuit for the answering supervisory signal AL, traced from battery, through the lamp AL, conductors 241 and 285, alternate contact 284 of relay 280, conductor 286, alternate contact 287 of relay SL', to ground at alternate contact 223 of the said relay SL'. Relay LD' remains energized and lamp AL lighted until the operator noting the lighted supervisory signal AL, withdraws the answering plug and the calling plug from their respective connected jacks, thus clearing the line circuits of both subscribers, placing them in condition so that a conversation may be carried on between the calling subscriber and the local subscriber that the toll subscriber is urgently seeking. A tone is also placed upon the sleeve of the local jack whenever a calling plug CP of the toll cord circuit TC is inserted into a local jack, the said tone being traced from the said tone TO, over conductor 23, to the sleeve of the plug CP, so that the local operator or any of the toll operators desiring a local subscriber may know that the local line is being used for a toll call, and this tone is put on the toll sleeve as long as the toll calling plug remains in the local line spring jack.

It is also to be noted that if a called local line to which plug CP' is connected is the one a toll operator urgently wants, the operation of key CCR after the toll operator has plugged into jack J^s of the local called line, will unbalance relay 280 (but from the other side), the relay 280 operates, resulting in the local operator pulling down the connection.

While we have explained our invention as for a switching station use, it is by no means limited thereto in its broader aspects, as will be apparent to one skilled in the art, and in the claims we do not intend to so limit ourselves.

Having described our invention what we claim as new and desire to secure by Letters Patent is:

1. In a telephone trunking system including telephone lines terminating in different exchanges, a telephone line at one of said exchanges rendered busy, means including supervisory signals for rendering it addition-

ally busy and apparatus whereby an operator is electrically signalled to that effect.

2. In a telephone trunking system including telephone lines terminating in different exchanges, a line at one of said exchanges adapted to receive a double busy condition, and means including supervisory signals whereby a distant exchange operator can tell whether it is singly busy or doubly busy.

3. In a telephone trunking system, a telephone line having two link circuit connection terminals applied to multiple contacts at one end of the line for extending said line to other exchanges, one application being effective and the other ineffective, and means to automatically render said ineffective one effective and to extend signals to switchboard operators.

4. In a telephone trunking system having two telephone lines each terminating in different exchanges and effectively connected together, a third ineffectively cut in on the connection, and means automatically operating when the first two lines terminating at said different exchanges are disconnected to render effective the connection of the third line to a predetermined one of said two lines and to automatically signal over said third line and said predetermined line.

5. In a toll line system, a built-up toll line switched through at a switching station, means whereby disconnection at said switching station automatically builds up a different toll line therethrough and transmits signals to both ends of said different toll line.

6. In a telephone trunking system, a telephone line having multiple jacks so connected that one can be plugged into and used in a conversation, and a second plug inserted in the other jack, means including supervisory signals for automatically advising associated operators that two plugs are connected to the line, and relay means for the second plug operating automatically when the first connection is taken down to change the connections of the plug's circuit.

7. In a telephone system, a local cord circuit connecting two subscribers' lines for conversation, said circuit provided with a break down apparatus including a link disconnect relay and a differential relay, a toll cord circuit adapted for connection to one of said lines and also to the local circuit, and having means operable to render said apparatus active and secure a wanted one of said lines for a toll connection, said link disconnect relay also operable to free one of said subscribers' lines, when said one subscriber replaces his receiver, to permit said subscriber to initiate another call prior to the physical disconnection of said cord circuit and said subscriber's line.

8. In a telephone system including trunk lines, trunk circuits for interconnecting same, busyng means for indicating that one

of said trunk lines has been connected to, other busyng means for indicating that the same said trunk line has been connected to by another of said trunk circuits, the connection of said second trunk circuit with said trunk line rendered non-effective so long as said first connection exists.

9. In a telephone system including trunk lines, trunk circuits for interconnecting same, busyng means for indicating that one of said trunk lines has been connected to, other busyng means for indicating that the same said trunk line has been connected to by another of said trunk circuits, the connection of said second trunk circuit with said trunk line rendered non-effective so long as said first connection exists, and means for effecting a connection between said second trunk circuit and said trunk line when said first connection is withdrawn.

10. In a telephone system including trunk lines, trunk circuits for interconnecting same, busyng means for indicating that one of said trunk lines has been connected to, other busyng means for indicating that the same said trunk line has been connected to by another of said trunk circuits, the connection of said second trunk circuit with said trunk line rendered non-effective so long as said first connection exists, means for effecting a connection between said second trunk circuit and said trunk line when said first connection is withdrawn, and signaling means for indicating that the said second connection has become effective.

11. In a telephone system including trunk lines, trunk circuits for interconnecting same, busyng means for indicating that one of said trunk lines has been connected to, other busyng means for indicating that the same said trunk line has been connected to by another of said trunk circuits, the connection of said second trunk circuit with said trunk line rendered non-effective so long as said first connection exists, and means for indicating that such a connection has been made, said last means rendered inoperative when said first connection has been withdrawn.

12. In a telephone system including trunk lines, trunk operators' positions, trunk circuits at each of said positions for interconnecting said trunk lines, busyng means for indicating that a connection has been made between one of said trunk lines and one of said trunk circuits, busyng means for indicating if a second trunk circuit is connected to the same said trunk line before said first connection is removed, said last connection non-effective but rendered effective when said first busyng means are removed.

13. In a telephone system including trunk operators' positions, trunk lines between said operators' positions, trunk circuits for connecting to said trunk lines, means for

busyng one of said trunk lines when a connection is made therewith by one operator, means for additionally busyng said trunk line when a second trunk circuit is connected to it, and audible means for indicating to a preceding operator that the second operator has connected to a busy trunk.

14. In a telephone system including trunk operators' positions, trunk lines between said operators' positions, trunk circuits for connecting to said trunk lines to interconnect said operators' positions, busyng means for said trunk lines operative when a connection is made with said lines, additional busyng means for said lines when a second connection is made therewith, audible means for indicating to preceding operators that a connection has been made with a busy line, and means for automatically indicating to the preceding operators that they are no longer connected to a busy line when said first connection is withdrawn.

15. A telephone line having multiple jacks so connected that one can be plugged into and used in a conversation, and a second plug inserted in the other jack, means for automatically advising associated operators that two plugs are connected to the line, relay means for the second plug operating automatically when the first connection is taken down to change the connections of the plug, and means for automatically advising all operators when one of the plugs has been removed.

16. A telephone line having multiple jacks so connected that one can be plugged into for conversational use, and a second plug inserted in the other jack for seizing that line for conversational use upon the removal of said first plug, automatic means for indicating to associated operators that a line has been connected to by two plugs, and automatic means for indicating to all operators that one of the plugs has been disconnected from said line.

17. A telephone line having multiple jacks so connected that a plug can be inserted and employ the line for conversational purposes to the exclusion of other connections with said multiple jacks, a second plug inserted into the other jack, said second connection non-effective upon said line for conversational purposes so long as said first connection remains, automatic means for notifying associated operators that said line has two plugs connected thereto, and automatic means for notifying all operators when one of the plugs is removed.

18. A telephone system having multiple jacks so connected that one plug may be inserted and used in a conversation, and a second plug inserted in the other jack, automatic means for notifying the operator calling for said line that two plugs are connected to said line and that it is not

available for conversation, and automatic means for notifying said calling operator when said line is available for conversation.

19. In a telephone system including an E exchange, an F exchange, and a G exchange, multiple jacks for each of said exchanges, trunk circuits at each exchange for connection with said multiple jacks, trunk lines appearing in said multiple jacks and adapted for interconnecting exchanges, automatic means for advising the operator at the E exchange when two trunk circuits at the F exchange have been connected to the same trunk line and to indicate that said trunk line is unavailable for conversation, and automatic means for advising the operator at the E exchange when one of said plugs is removed and that said trunk line is available for conversation.

20. In a telephone system including an E exchange, an F exchange, and a G exchange, multiple jacks for each of said exchanges, trunk circuits at each exchange for connection with said multiple jacks, trunk lines appearing in said multiple jacks and adapted for interconnecting said exchanges, automatic means for advising the operator at the E exchange when two trunk circuits at the F exchange have been connected to the same trunk line and to indicate that said trunk line is unavailable for conversation, automatic means for advising the operator at the E exchange when one of said plugs is removed and that said trunk line is available for conversation, and automatic means for indicating to the operator at the G exchange that a connection is desired.

21. In a telephone system including a number of exchanges, trunk circuits at each exchange, trunk lines appearing in multiple jacks at said exchanges and adapted to interconnect said exchanges, automatic means for advising the operator at the preceding exchange when the operator at the intermediate exchange has connected two

of her trunk circuits to the same trunk line and to notify her that the trunk lines leading to the last exchange are busy, and automatic means for advising the operator at said preceding exchange that the trunk circuit connected to the said trunk line first has been removed and that the line is available, and means for notifying the operator at the last exchange that a call is awaiting her attention.

22. In a telephone system including two subscribers' lines, a local cord circuit for interconnecting same in conversational circuit, a toll circuit adapted to be connected with one of said lines and said local cord circuit, means including a link disconnect relay and a differential relay in said cord circuit for automatically disconnecting said telephone lines during conversation and operable when said toll circuit is connected to one of said subscribers' lines, said link disconnect relay also operable to free one of said lines from said cord circuit, when said subscriber replaces his receiver, to permit said subscriber to initiate another call even though a physical connection remains between said one line and said cord circuit.

23. In a telephone system including telephone lines, a local cord circuit for interconnecting same, a toll circuit for connection with one of said lines and a local cord circuit interconnecting said lines, means in said local cord circuit for breaking up a conversation between local subscribers when said toll circuit is connected to one of said lines, permitting the subscriber on the line to which said cord circuit has been connected to converse with a subscriber connected to said toll circuit.

Signed by us at Chicago, in the county of Cook, and State of Illinois, this 12 day of July, 1920.

HIRAM D. CURRIER.
WILLIAM G. SHULL.