Sept. 9, 1930. V. S. THARP 1,775,146

TOLL SWITCHING SYSTEM

Original Filed Sept. 8, 1927 2 Sheets-Sheet 1

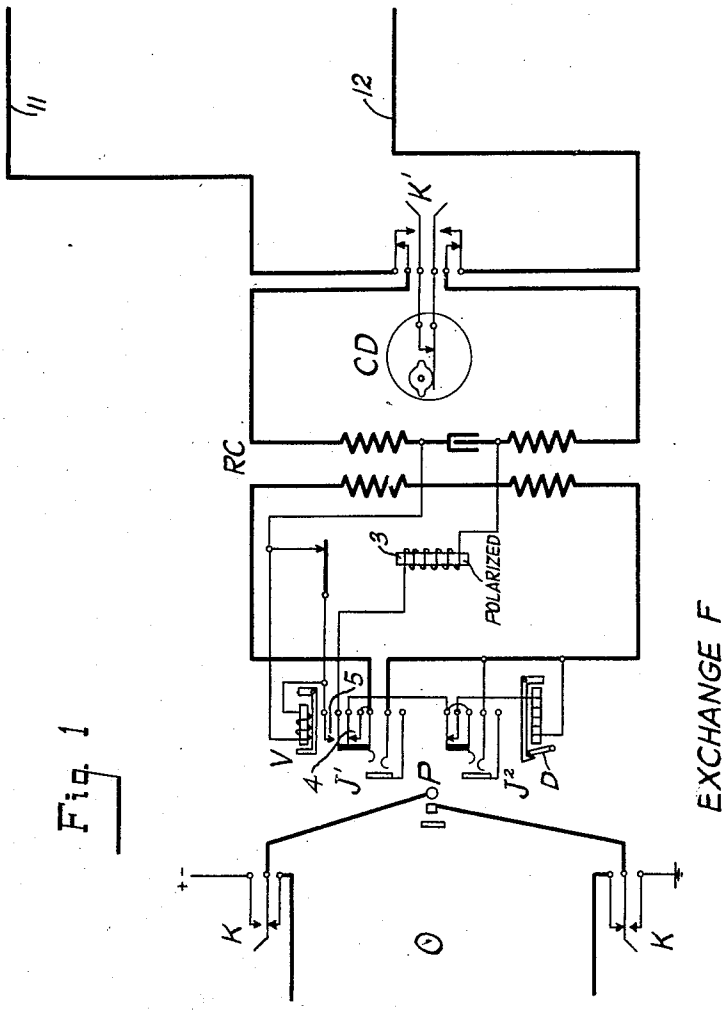


Fig. 1

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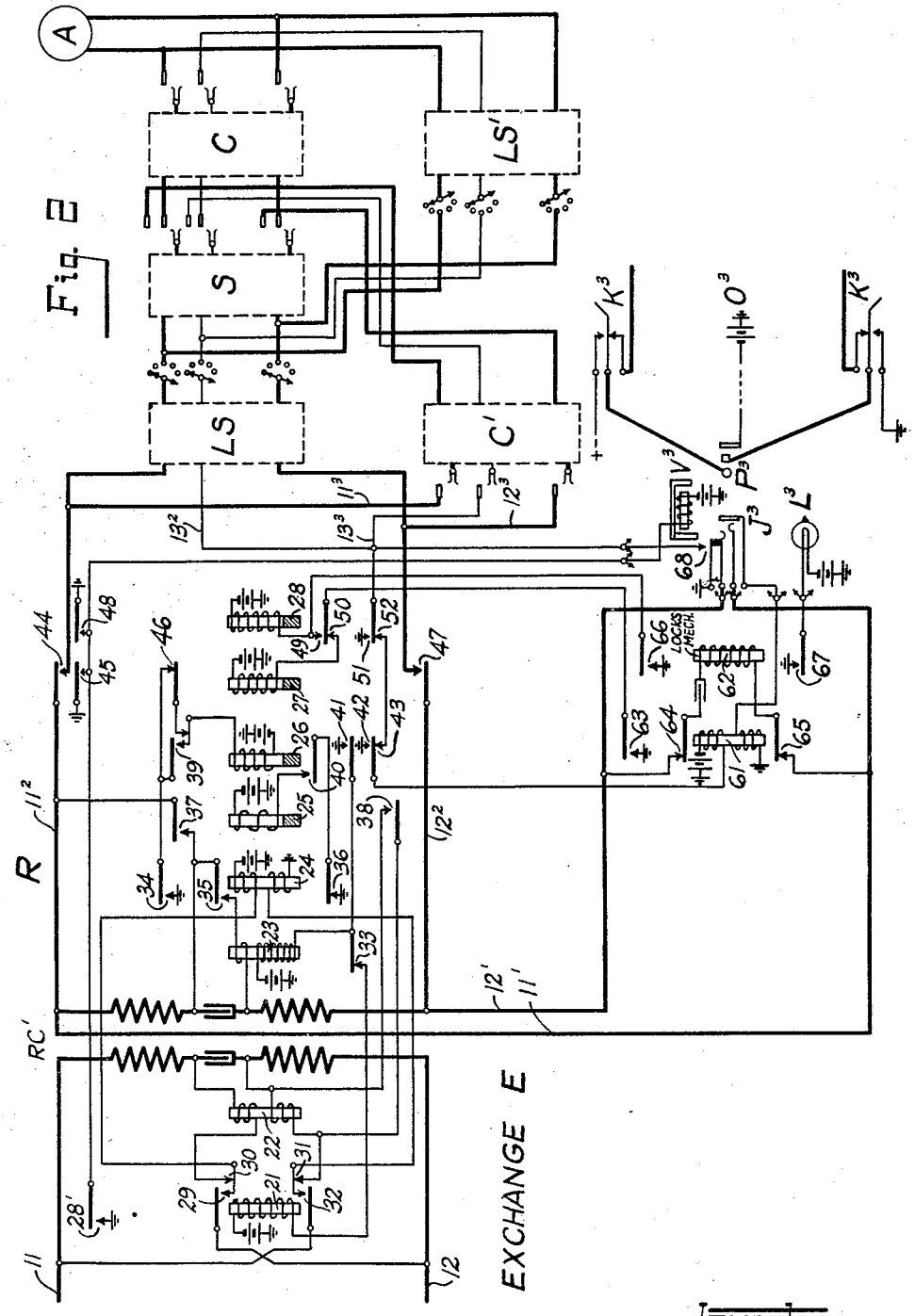


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Patented Sept. 9, 1930

1,775,146

# UNITED STATES PATENT OFFICE

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## TOLL SWITCHING SYSTEM

Application filed September 8, 1927, Serial No. 218,179. Renewed December 11, 1929.

This invention appertains to telephone systems in general, but more particularly to toll switching systems in which connections within a certain community may be completed either manually or automatically.

It frequently happens that within a certain community there is a town served by an automatic telephone system, and a number of nearby towns served by manual systems, and the automatic telephone exchange serves as a switching center for the community in the establishment of toll and interexchange connections, each of the manual exchanges being connected to the automatic exchange by toll trunks. In a telephone system of this kind, it is often desirable to equip the trunk lines between the manual exchanges and the automatic exchange so that the manual operator at the manual exchange may set up connections to the automatic exchange over the trunk lines automatically to complete the interexchange connections, or may call the toll operator at the automatic exchange exclusive of any automatic switches when a toll connection to a distant point is desired. The more usual method of controlling automatic switches over a trunk line is by the intermittent interruptions of the circuit of a line relay bridged across the two trunk conductors; while the usual way to signal an operator over a trunk line is by applying ringing current to the trunk conductors to operate a ringing current responsive relay bridged across the trunk conductors. If a line relay were bridged directly across the trunk conductors, and ringing current were applied to the trunk conductors to signal an operator, part of the ringing current would be shunted through the line relay causing it to vibrate and falsely operate automatic switches under its control.

The patent to L. L. Ruggles, No. 1,693,962, Dec. 4, 1928, discloses and describes a system of the type being discussed in which the automatic switches at the automatic exchange are controlled from the manual exchange over a circuit including the two trunk conductors in parallel. Under certain conditions, however, it is preferable to control automatic switches over a loop circuit including the two trunk conductors in series.

The main object of this invention, therefore, is the provision of a system as described above wherein automatic switches at an automatic exchange may be controlled from a manual exchange over the two conductors of an interconnecting trunk line in series, and the operator at the manual exchange may signal the toll operator at the automatic exchange by applying ringing current to the two trunk conductors without causing false switch operations at the automatic exchange. According to the main feature of this invention, a line relay for controlling the automatic switches at the automatic exchange is bridged across the trunk conductors in series with an impedance coil which prevents all but a very small amount of ringing current from being shunted through the line relay windings when it is applied to the trunk conductors to signal the toll operator at the automatic exchange, and thus prevents any false operations of the line relay due to the ringing current.

Another feature of this invention is that means are provided for excluding the impedance from the circuit of the line relay during the time that the line relay is being operated to set up an automatic connection.

The features of the invention, those mentioned and others not specifically mentioned, will become apparent from the accompanying specification and the two figures of drawings forming a part thereof. The drawings illustrate one preferred embodiment of the invention. It is understood, of course, that the precise construction shown is for illustrative purposes only to which the inventor does not wish to be limited. The principles of the invention lend themselves very readily to many modifications and adaptations all of which come within the general scope of this invention.

The drawings, which should be placed with the Fig. 2 to the right of Fig. 1, show by means of the usual circuit diagrams a schematic layout of a telephone system embodying the principles of the invention.

The apparatus shown in Fig. 1 is located

in one of the manual exchanges in a certain community, designated exchange F. The operator's cord O, shown only in part, terminating in the plug P and equipped with a ringing key K is one of the cords provided for the manual operator at exchange F. The toll trunk comprising conductors 11 and 12 is one of the toll trunks extending from exchange F to the automatic exchange shown in Fig. 2 and designated exchange E. At exchange F the toll trunk comprising conductors 11 and 12 terminates in two jacks, jack J′, a dialing and answering jack for answering calls from the automatic exchange and for extending calls to subscribers in the automatic exchange, and jack $J^2$, a ringing jack for ringing the toll operator at the automatic exchange. A drop signal D and a visual busy signal V are also provided. A calling device CD, common to the operator's position, is provided which may be associated with the trunk comprising conductors 11 and 12 by operating the dialling key K′.

At the automatic exchange E, Fig. 2, the trunk comprising conductors 11 and 12 terminates via the repeater R in the rotary lineswitch LS. The lineswitch LS has access to selectors, such as selector S, which in turn have access to groups of local connectors such as connector C, in certain levels and to a group of rotary connectors such as rotary connector C′, in one particular level. In the banks of the local connectors access is had to subscribers' lines, such as the line of station A. The line of station A terminates in the individual lineswitch LS′ which also has access to the selectors. The trunks from the various manual exchanges are accessible via branches in the banks of the rotary connectors, the trunks from each exchange being accessible in a separate level. The trunk line comprising connectors 11 and 12 from exchange F is accessible to rotary connector C′ via the branch comprising conductors $11^3$, $12^3$, and $13^3$.

At repeater R, a branch of the trunk line comprising conductors 11′ and 12′ terminates at the toll operator's switchboard in the jack $J^3$. Associated with this jack is the call lamp $L^3$ and the busy visual $V^3$. One of the toll operator's cords $O^3$ terminating in the plug $P^3$ and having the ringing key $K^3$ is shown in part.

The lineswitches LS and LS′ may be of the usual rotary type. The selector S, the local connector C, and the rotary connector C′ may be of the well known Strowger vertical and rotary type. The connector C′ is to be of the kind which releases when the calling party replaces his receiver. The repeater R forms a particular part of the invention and will be described in detail subsequently.

All the toll lines from distant points terminate at the toll operator's switchboard at exchange E, exchange E being a switching center for the whole community. Therefore all toll calls to and from distant points are completed by the toll operator at exchange E, over branches such as the one comprising conductors 11′ and 12′ of the trunks extending to the different manual exchanges, or via automatic toll switches (not shown) to the subscribers in the automatic exchange E.

To describe the operation of the invention in detail, it will first be assumed that the operator at exchange F has received a call for a subscriber in exchange E, the subscriber at station A, for example. The operator at exchange F thereupon inserts the plug of the cord used to answer the calling subscriber, the plug P, for example, into the jack of an idle trunk extending to exchange E, such as jack J′. Inserting the plug P into the jack J′ disconnects the drop D from the trunk conductors by separating contacts 4, and closes a bridge including polarized relay 3 across the trunk conductors 11 and 12 at contacts 5. The placement of the bridge across the trunk conductors 11 and 12 closes the circuit for line relay 24 of repeater R at the automatic exchange, this circuit including the left hand windings of the repeating coil RC′, the windings of impedance 22 and the normally closed contacts 30 and 31. Line relay 24 operates and closes a bridge including the upper winding of relay 23 across trunk conductors $11^2$ and $12^2$ and closes the energizing circuit of release relay 26 at contacts 34, this circuit including contacts 46. Relay 26 operates and closes a locking circuit for itself at contacts 39 independent of contacts 46, prepares a circuit for relay 25 at contacts 40, closes the circuit of the polarizing winding of relay 23 and also the circuit of reversing relay 21 at contacts 41, and closes the circuit for the upper winding of relay 61 at contacts 42. Reversing relay 21, in operating, closes the circuit for busy visual $V^3$ at the toll operator's switchboard at contact 28′ and reverses the connections of the windings of line relay 24 to the trunk conductors 11 and 12 independent of the impedance 22 and the left hand windings of the repeating coil RC′ by closing contacts 29 and 32 and separating contacts 30 and 31. The direction of the current flow over the trunk conductors 11 and 12 and through the polarized relay 3 at the exchange F is now in the proper direction to cause the operation of the polarized relay 3, this relay not having operated previous to this time. Polarized relay 3, in operating, removes the short circuit from the visual V so the visual V now operates in series with relay 3.

Relay 61 at exchange E operates when the circuit for its upper winding is established, and closes the circuit for relay 27 at contacts 63 and disconnects the ringing relay 62 from the conductors 11′ and 12′ at contacts 64 and 65. Relay 27 operates and closes another cir-

cuit for visual $V^3$ at contacts 45, opens a point in the energizing circuit of relay 26 at contacts 46, and at its contacts 44 and 47 closes normally open points in conductors $11^2$ and $12^2$ thereby initiating the operation of the lineswitch LS.

Lineswitch LS operates and extends the connection to an idle selector, such as the selector S, and also grounds the private normal conductor $13^2$ to which the test contacts of this trunk in the rotary connector banks are connected via conductor $13^3$.

All the operations thus far described after the operator at exchange F inserted the plug P into the jack J′ have taken place automatically responsive to that operation. After inserting the plug P into the jack J′ the operator at exchange F operates the dialling key K′ which disconnects the repeating coil RC and the polarized relay 3 and visual V from the trunk conductors 11 and 12 and bridges the calling device CD across the trunk conductors. Incidentally the polarized relay 3 and the visual V deenergize. The operator then dials the number of the called subscriber in the usual manner, after which she again restores the key K′.

The dialing of each digit interrupts the circuit of line relay 24 a corresponding number of times, which in turn interrupts the bridge across conductors $11^2$ and $12^2$ at contacts 35 a like number of times. Upon each deenergization of line relay 24 the circuit of relay 25 is closed at contacts 36. Relay 25 being slow-acting remains operated during the dialing of each digit and by short-circuiting the upper right hand winding of repeating coil RC′ improves the repeating of impulses to the automatic switches. The closure of contacts 38 has no utility at this time.

The first digit dialed operates the selector S which extends the connection to an idle connector in the proper group, such as the connector C. Responsive to the last two digits of the called number, connector C operates to extend the connection to the called subscriber's line and signal the called subscriber. When the called subscriber answers, the signalling is interrupted and the direction of current flow over the conductors $11^2$ and $12^2$ and through the upper winding of relay 23 is reversed by the operation of the back-bridge relay (not shown) of connector C in the regular manner. This reversal of current through its upper winding causes the operation of relay 23. Relay 23, in operating, opens the circuit of the reversing relay 21 by separating contacts 33. Relay 21 thereupon deenergizes and again causes the windings of the line relay 24 to be connected to the trunk conductors 11 and 12 via the windings of impedance 22 and the left hand windings of the repeating coil RC′, the direction of current over conductors 11 and 12 again being reversed back to normal.

The restoration of key K′ after dialling again bridged polarized relay 3 across trunk conductors 11 and 12 and after operating caused visual V to operate in series therewith. The reversal of current over conductors 11 and 12 resulting when the called subscriber answers causes polarized relay 3 to restore and again short-circuit the visual V. Visual V restores which indicates to the operator at exchange F that the called subscriber has answered.

The two subscribers may now hold conversation. At the termination of the conversation both subscribers will replace their receivers. The operator at exchange F is notified that the calling subscriber has replaced his receiver by the lighting of a lamp (not shown) associated with the cord O in the usual way. The replacement of the receiver at station A again causes the direction of the flow of current over the conductors $11^2$ and $12^2$ to be restored to normal. This causes the release of the relay 23. Relay 23, in releasing, again closes the circuit for the reversing relay 21. Relay 21, in operating, again reverses the direction of current over the trunk conductors 11 and 12 which causes the operation of polarized relay 3. Polarized relay 3, in operating, again removes the short circuit from the visual V permitting the visual V to operate in series with relay 3. The operation of the visual V at this time indicates to the operator in exchange F that the called subscriber has replaced his receiver.

The operator thereupon removes the plugs of the cord O from the calling jack and jack $J^1$. Removing the plug P from jack J′ opens the bridge across the trunk conductors 11 and 12 which causes the deenergization of line relay 24 at the automatic exchange E. Line relay 24, in deenergizing, opens the bridge across the trunk conductors $11^2$ and $12^2$ at contacts 35, thereby causing the release of the lineswitch LS, the selector S, and the connector C in the well known manner. Relay 24, in releasing, opens the circuit of relay 26 at contacts 34 and closes the circuit of relay 25 at contacts 36, for the interval that relay 26, being slow-acting, maintains its armature attracted after its circuit is opened. Relay 25 energizes and at contacts 38 short-circuits the lower winding of impedance 22. A short time after its circuit is opened, relay 26 deenergizes and opens a point in its locking circuit at contacts 39, opens the circuit of relay 25 at contacts 40, opens the circuit of relay 61 at contacts 42 and also the circuit of the polarizing winding of relay 23 at contacts 41. Relay 61 and reversing relay 21 restore to normal immediately and relay 25 being slow acting maintains the lower winding of impedance of 22 short-circuited at contacts 38 while relay 21 is restoring, which, as found by test, prevents any discharge of the

condensers in the circuit of line relay 24 from causing relay 24 to falsely operate.

Relay 61, in deenergizing, reconnects relay 62 across conductors 11′ and 12′ and opens the circuit of relay 27. Relay 27 thereupon restores to normal, opening of the circuit of the visual $V^3$ by separating contacts 45 which causes the visual $V^3$ to restore to normal.

The manner in which a subscriber at exchange E may call the operator at exchange F automatically to obtain a connection with a subscriber at exchange F will now be described. The subscriber at station A, for example, to initiate a call of this kind, removes his receiver and dials the directory number assigned to exchange F. Responsive to the removal of the receiver, lineswitch LS′ operates to extend a connection to an idle selector such as selector S. Selector S operates responsive to the first digit dialed to extend the connection to an idle rotary connector, such as rotary connector C′. Responsive to the next two digits dialed rotary connector C′ operates to extend the connection to an idle trunk extending to exchange F, the one comprising conductors 11 and 12, for example, by way of the branch comprising conductors $11^3$, $12^3$ and $13^3$. Rotary connector C′, after connecting with this trunk, places ground potential on conductor $13^3$ in the usual way which marks the trunk busy and also closes the circuit for the upper winding of relay 61 via normally closed contacts 52 and 43. Relay 61 operates as previously described and disconnects relay 62 from the conductors 11′ and 12′ at contacts 64 and 65 and closes the circuit for relay 27 at contacts 63. Relay 27 operates and as previously described closes normally open points in conductors $11^2$ and $12^2$ at contacts 44 and 47, closes the circuit of visual $V^3$ at contacts 45. After extending the connection to this trunk, rotary connector C′ also projects a ringing current on conductors $11^3$ and $12^3$ which passes through the right hand windings of repeating coil RC′. As a result ringing current is induced in the left hand windings of the repeating coil RC′ passing over the trunk conductors 11 and 12 and through the right hand windings of repeating coil RC in exchange F, and is induced in the left hand windings of repeating coil RC passing through the winding of drop D, causing its operation. The operation of drop D notifies the operator at exchange F of the incoming call.

Due to the impedance 22, practically no ringing current passes through the line relay 24, and thus false operations of the line relay due to ringing current are prevented.

The operator at exchange F, noting the operated condition of the drop D, inserts the plug of an idle cord into the dialing and answering jack $J^1$. This operation bridges the polarized relay across the trunk conductors 11 and 12 as previously described, causing the operation of line relay 24 of repeater R at exchange E. Relay 24, in operating, again bridges the upper winding of relay 23 across the conductors $11^2$ and $12^2$. This trips the ring in the rotary connector C′ in the usual manner. Relay 21 is not operated in this connection at this time. Consequently the current flow over conductors 11 and 12 is in such a direction as not to cause the operation of polarized relay 3 at the exchange F.

The operator at exchange A may now converse with the subscriber at station A and complete the desired connection manually in the usual manner.

At the termination of the conversation the operator in exchange F is signalled in the usual way when the called subscriber replaces his receiver. When the subscriber at station A replaces his receiver, rotary connector C′, selector S, and the lineswitch LS′ restore to normal. Rotary connector C′, in restoring, removes ground potential from conductor $13^3$ and thereby opens the circuit of relay 61. Relay 61, in deenergizing reconnects relay 62 to conductors 11′ and 12′ and opens the circuit of relay 27. Relay 27 then deenergizes and in restoring to normal closes the energizing circuit of relay 26 at contacts 46. Relay 26 thereupon energizes, performing current changes as previously described, including the closure of the circuit of reversing relay 21. Relay 21 now operates reversing the current flow over conductors 11 and 12 to cause the operation of relay 3 at exchange F. Relay 3, in operating, removes the short-circuit from the visual V so that visual V will operate and give the operator the disconnect signal.

The operator at exchange F, upon receiving the disconnect signals, removes the plug P from the jack J′ thereby opening the circuit of line relay 24 of the repeater R at exchange E. Relay 24 deenergizes and in restoring causes the resoration of relay 26, which in turn causes the restoration of relays 21 and 61, as previously described.

The procedure in establishing a toll connection from the exchange F to some distant point will now be described. To establish a toll connection, the operator at exchange F inserts the plug of an idle cord, such as plug P, into the ringing jack of an idle trunk to exchange E, the jack $J^2$ for example, and then throws the ringing key K to the ringing position. As a result, ringing current is induced in the right hand windings of the repeating coil RC, passing over trunk conductors 11 and 12 and through the left hand windings of the repeating coil RC′, passing over conductors 11′ and 12′ and through the ringing relay 62 at the toll operator's switchboard. As in the previous case, practically no ringing current passes through

the line relay 24 due to the impedance 22 connected in series with the windings of line relay 24. Relay 62 at the toll operator's switchboard operates responsive to the induced ringing current and locks mechanically to the armature of relay 61 and closes a circuit for relay 28 of repeater R. Relay 28 operates and prepares a holding circuit for itself at contacts 49, places ground potential on the test contacts of this trunk in the rotary connector banks to mark this trunk busy and at the same time closes the circuit of visual $V^3$ at contacts 48. Relay 62, in operating, also closes the circuit of lamp $L^3$ at contacts 67. The lighting of lamp $L^3$ notifies the toll operator of the incoming call.

To answer the call, the toll operator inserts the plug of an idle cord (not shown) into the jack $J^3$. The closure of contacts 68 further grounds conductor $13^3$. The circuit is also closed for the lower winding of relay 61 (battery being present on the sleeve of the cord). Relay 61 operates and unlocks relay 62 allowing it to deenergize, disconnects this relay from the conductors 11′ and 12′ at contacts 64 and 65, and closes the holding circuit for relay 28 at contacts 63.

The operator at exchange F now converses with the operator at exchange E, the latter completing the desired connection in the well known manner.

At the termination of the call the operators are given the disconnect signals in the usual manner whereupon the operator at exchange F removes the plug from the jack $J^2$ and the toll operator at exchange E removes the plug from the jack $J^3$. Removing the plug from the jack $J^3$ opens the circuit of relay 61 which restores and opens the circuit of relay 28 which likewise restores.

Toll connections from distant points may also be completed to any subscriber in the community by the toll operator at exchange E. To complete a toll connection to the exchange F, the toll operator at exchange E inserts the plug of the cord used to answer the incoming toll calls, the plug P, for instance, into the jack of an idle trunk extending to exchange F, the jack $J^3$, for example, and then applies ringing current to the trunk conductors 11′ and 12′ by operating key $K^3$. Inserting plug $P^3$ into jack $J^3$ causes the operation of relay 61 which performs circuit changes as previously described. Ringing current applied to the trunk conductors causes the operation of the drop D at exchange F in the manner previously described. The operator at exchange F then answers the call by inserting the plug of a cord into the answering and dialing jack J′ and after learning the name of the wanted subscriber completes the connection in the regular manner.

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

What is claimed is:

1. In a telephone system, an operator's switchboard, an automatic switch, a trunk line comprising two conductors individual thereto and terminating in said switchboard and also in said automatic switch at one end, means responsive to the application of alternating current to the other end of said trunk line for signalling the operator at said switchboard, means for preventing said switch from responding to said alternating current, and means whereby said switch may be controlled from said other end over two conductors of said trunk line in series.

2. In a telephone system, a manual exchange, an automatic exchange, an interconnecting trunk line terminating at each exchange in an operator's switchboard, a branch at the automatic exchange connecting said trunk to an automatic switch in that exchange, means at each switchboard whereby the operator thereat may call the other over said trunk line, means whereby said automatic switch may be controlled over two conductors of said trunk line in series from the switchboard at the manual exchange.

3. In a telephone system, an automatic exchange, a trunk line terminating at said exchange, a signal at said exchange operative responsive to the application of alternating current to said trunk line, automatic switches at said exchange, a line relay bridged across the conductors of said trunk line and responsive to direct current impulses sent over said trunk line for controlling the operation of said automatic switches, and means for substantially preventing the passage of any alternating current through said line relay when such current is applied to said trunk line to operate said signal.

4. In a telephone system, an automatic exchange, a trunk line terminating at said exchange, a signal at said exchange operative responsive to the application of alternating current to said trunk line, automatic switches at said exchange, a line relay bridged across the conductors of said trunk line and responsive to direct current impulses sent over said trunk line for controlling the operation of said switches, an impedance normally included in the circuit of said line relay for substantially preventing the passage of any alternating current through said line relay when such current is applied to said trunk line to operate said signal, and means for excluding said impedance from the circuit of said line relay when direct current impulses are sent over said trunk line.

5. In a telephone system, an automatic exchange, a trunk line terminating at said exchange, a signal at said exchange operative responsive to the application of alternating

current to said trunk line, automatic switches at said exchange, a line relay bridged across the conductors of said trunk line and responsive to direct current impulses sent over said trunk line for controlling the operation of said switches to extend a call, an impedance normally included in the circuit of said line relay for substantially preventing the passage of any alternating current through said line relay when such current is applied to said trunk line to operate said signal, means for excluding said impedance from the circuit of said line relay when direct current impulses are sent over said trunk line, and means responsive to the answering of the call for disabling said last means.

6. In a telephone system, a manual exchange, an automatic exchange, a trunk line interconnecting said exchanges, a signal at each exchange, means at each exchange for applying alternating current to said trunk to operate the signal at the other exchange, automatic switches at the automatic exchange, a line relay bridged across said trunk line at the automatic exchange and responsive to direct current impulses sent over said trunk line for controlling the operation of said automatic switches, and means for substantially preventing the passage of any alternating current through said line relay when such current is applied to said trunk line at either exchange.

7. In a telephone system, a trunk line extending from a first exchange to a second exchange, a signal at the first exchange, means for establishing a current flow over the conductors of said trunk line when the trunk line is seized, and means at the second exchange responsive to said current flow for reversing the direction of current flow to cause the operation of said signal.

8. In a telephone system, a trunk line extending from a first exchange to a second exchange, a signal at said first exchange, means for establishing an initial current flow over the conductors of said trunk line when the trunk line is seized at said first exchange to extend a call to said second exchange, current reversing means at said second exchange operating responsive to said initial current flow for controlling said signal, and means operative when the call is answered for disabling said current reversing means.

9. In a telephone system, a trunk line extending from a first exchange to a second exchange, a signal at said first exchange, current reversing means at said second exchange for controlling said signal operative when said trunk line is connected with in the extension of a call to said second exchange, and means for preventing the operation of said current reversing means when said trunk line is connected with to answer a call from said second exchange.

10. In a telephone system, a trunk line extending from a first exchange to a second exchange, a signal at said first exchange, current reversing means at said second exchange for controlling said signal operative when said trunk line is connected with in the extension of a call to said second exchange, means for preventing the operation of said current reversing means when said trunk line is connected with to answer a call from said second exchange, and means for disabling said current reversing means when a call to said second exchange is answered and when a call from said second exchange is abandoned.

11. In a telephone system, a two conductor trunk line having two branches at one end, a relay bridged across one of said branches in series with a condenser, a second relay bridged across the other of said branches in series with a source of current, means including the two conductors of the trunk line in series for operating either one of said relays to the exclusion of the other, and means responsive to the operation of the second relay for disconnecting said first relay.

12. In a telephone system, a two conductor trunk line having two branches at one end, an impulse repeater terminating one of said branches, an operator's position terminating the other of said branches, a signal at said position operated responsive to alternating current transmitted over the two conductors of the trunk line in series, and an impulse relay for said repeater operated responsive to the connection of a direct current bridge across the conductors of said trunk line.

13. In a telephone system, a trunk line terminating in an impulse repeater, a branch of the trunk line extending to an operator's position, a signal at said position, means for establishing a flow of alternating current over the talking conductors of the trunk line in series to operate said signal, a relay in the repeater bridged across the talking conductors of the trunk line, means for establishing a flow of direct current over the trunk line to operate said relay, and means responsive to the operation of said relay for reversing the direction of current flow over the trunk line.

14. In a telephone system, a trunk line terminating in an impulse repeater, a branch of the trunk line extending to an operator's position, a signal at said position, means for establishing a flow of alternating current over the talking conductors of the trunk line in series to operate said signal, a relay in the repeater bridged across the talking conductors of the trunk line, an impedance in the circuit of said relay to render the same non-responsive to alternating current flow over the trunk line, means for establishing a flow of direct current over the talking conductors of the trunk line in series to operate said relay, and means responsive to the operation

of said relay for reversing the direction of current flow over the trunk line and for removing said impedance from the circuit of said relay.

15. In a telephone system, a trunk line terminating in an automatic switch, a branch of the trunk line extending to an operator's position, a call signal and a busy signal for the trunk line at said position, means for establishing a flow of alternating current over the talking conductors of the trunk line in series to operate both of said signals, and means for establishing a flow of direct current over the talking conductors of the trunk line in series to operate said switch and the busy signal only at said position.

16. In a telephone system, a trunk line, a double wound relay bridged across the conductors of said trunk line, an impedance normally connected in series with each winding of the relay, a condenser connected in parallel with said relay, means for establishing a flow of current over the trunk line to operate said relay, means responsive to the operation of said relay for disconnecting said impedances and for reversing the direction of current flow over the trunk line whereby said condenser becomes charged, means for interrupting the current flow to deenergize said relay and to re-connect said impedances, and means controlled by said relay for momentarily short circuiting one of said impedances to provide a discharge path for said condenser.

17. In a telephone system, a trunk line comprising two conductors extending, respectively, to windings of a repeating coil, a condenser connecting said windings, a relay bridged across the trunk conductors by way of make-before-break contacts of a reversing relay and energized responsive to current flow over the trunk conductors, said current flow also serving to charge said condenser, means including said contacts for reversing the connection of said relay to the trunk conductors and for inserting an impedance in the circuit of the relay responsive to its deenergization when current flow over the trunk ceases, and means controlled by said relay for short circuiting said impedance to provide a discharge path for said condenser during the momentary closure of said contacts.

18. In a telephone system, a trunk line comprising two conductors terminating, respectively, in windings of a repeating coil, a condenser connecting said windings, a double wound line relay connected across the trunk conductors and energized responsive to current flow thereover, impedances adapted to be connected in series with the windings of said relay, means for reversing the connection of said relay to the trunk conductors and for connecting up said impedances responsive to the deenergization of said relay when current flow over the trunk ceases, and means controlled by said relay for short circuiting one of said impedances to provide a momentary discharge path for said condenser while said reversal is taking place.

19. In a telephone system, a manual exchange, an automatic exchange, a trunk line terminating in an operator's switchboard at each exchange, a branch at the automatic exchange connecting said trunk line with an automatic switch, other switches accessible to said first switch, means at either switchboard for signalling the operator at the other switchboard over two conductors of the trunk line in series, and means controlled over the two conductors of the trunk line in series from the switchboard at the manual exchange for directively operating said switches to extend a connection to a called line.

20. In a telephone system, a trunk line comprising two inductively connected sections, two branches for the second section, one branch terminating in an automatic switch, the other branch extending to an operator's position, means for transmitting either direct current impulses or alternating current over said first section, an impulse relay bridged across the conductors of said first section for repeating said direct current impulses over said first branch, and a signal relay bridged across the conductors of said second branch operated responsive to alternating current transmitted over said first section.

21. In a telephone system, a trunk line comprising two inductively connected sections, two branches for the second section, one branch terminating in an automatic switch, the other branch extending to an operator's position, means for transmitting direct current impulses or alternating current over the first section, a signal associated with said second branch operated responsive to said alternating current, a relay bridged across the conductors of said first section for repeating said direct current impulses over said first branch, and means for substantially preventing the passage of said alternating current through said relay when such current is transmitted over the trunk line to operate said signal.

22. In a telephone system, a trunk line comprising two inductively connected sections, two branches for the second section, one branch terminating in an automatic switch, the other branch extending to an operator's position, means for applying alternating current to the first section of the trunk line or for transmitting direct current impulses thereover, a signal for the trunk line at said position operated responsive to the application of alternating current to said trunk line, a relay bridged across the conductors of said first section for repeating said direct current impulses over said first branch,

an impedance in the circuit of said relay for substantially preventing the passage of alternating current thereto when such current is applied to the trunk line to operate said signal, and means for disabling said impedance during the transmission of said direct current impulses.

23. In an impulse repeater, two incoming talking conductors, a double wound line relay, circuit connections each including an impedance for connecting the two windings of said relay, respectively, to the two talking conductors, other circuit connections excluding said impedances for connecting the two windings of said relay, respectively, to the two talking conductors in reverse order, an initial energizing circuit for said relay including said first connections, and a control circuit for said relay including said second connections effective responsive to the energization of the relay.

24. In a telephone system, a trunk line comprising two conductors extending to a line relay via windings of a repeating coil, means for operating said relay responsive to the extension of a call over the trunk and means responsive to the operation of the relay for connecting the trunk conductors to said relay independent of said repeating coil windings.

25. In a telephone system, a trunk line comprising two conductors extending to a line relay via windings of a repeating coil, means for operating said relay responsive to a call over the trunk, and means responsive to the operation of said relay for reversing the connection of the trunk conductors to the relay and for excluding said repeating coil from the circuit.

26. In a telephone system, a trunk line comprising two conductors extending to a line relay via windings of a repeating coil and an impedance, means for operating said relay responsive to a call over the trunk, and means responsive to the operation of said relay for reversing the connection of the trunk conductors to the relay and for excluding the impedance and the windings of the repeating coil from the circuit.

27. In a telephone system, a trunk line comprising two conductors normally extending to a line relay via windings of a repeating coil and an impedance, means for operating the relay responsive to a call over the trunk, means responsive to the operation of said relay for reversing the connection of the trunk conductors to the relay and for disconnecting the repeating coil and impedance from the circuit, and means responsive to the call being answered for restoring the normal connection of the trunk conductors to said relay.

28. The combination with an electrical circuit connecting two points, of means for establishing a current flow over the circuit when the circuit is taken into use, means at the distant end of the circuit responsive to the establishment of said current flow for reversing the direction thereof, and a signal at the near end of the circuit controlled by said reversal.

29. The combination with an electrical device adapted to be controlled from a distant point, of a circuit connecting the device and said point, means for establishing a flow of current over said circuit when the device is taken into use, means in the device responsive to said current flow for reversing the direction thereof, and a signal at said distant point. controlled by said reversal.

In witness whereof, I hereunto subscribe my name this sixth day of September, A. D. 1927.

VICTOR S. THARP.