Dec. 26, 1922. 1,440,110.

C. SPARKS.

TRUNK CIRCUITS.

FILED APR. 4, 1918. 2 SHEETS—SHEET 1.

Fig. 1.

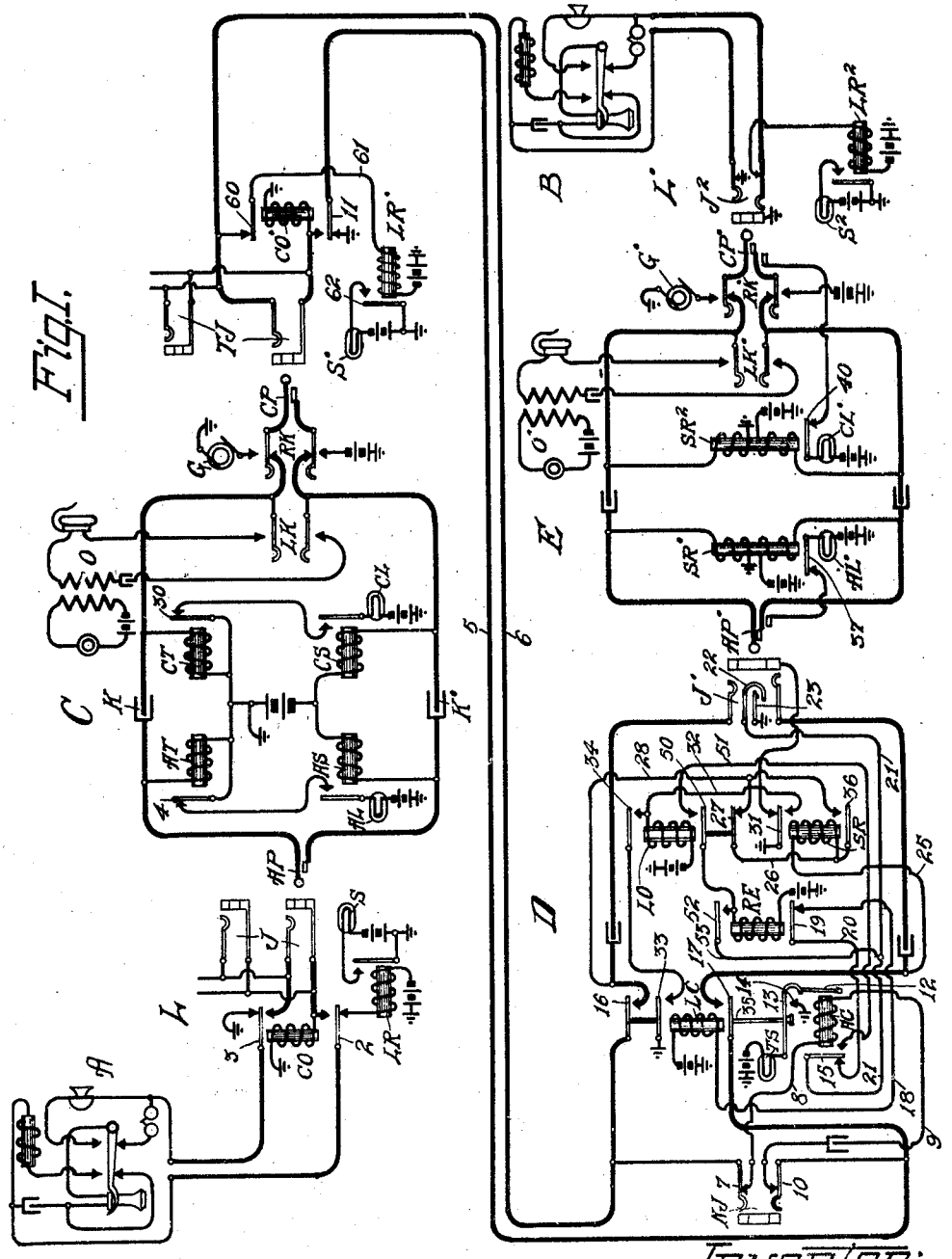

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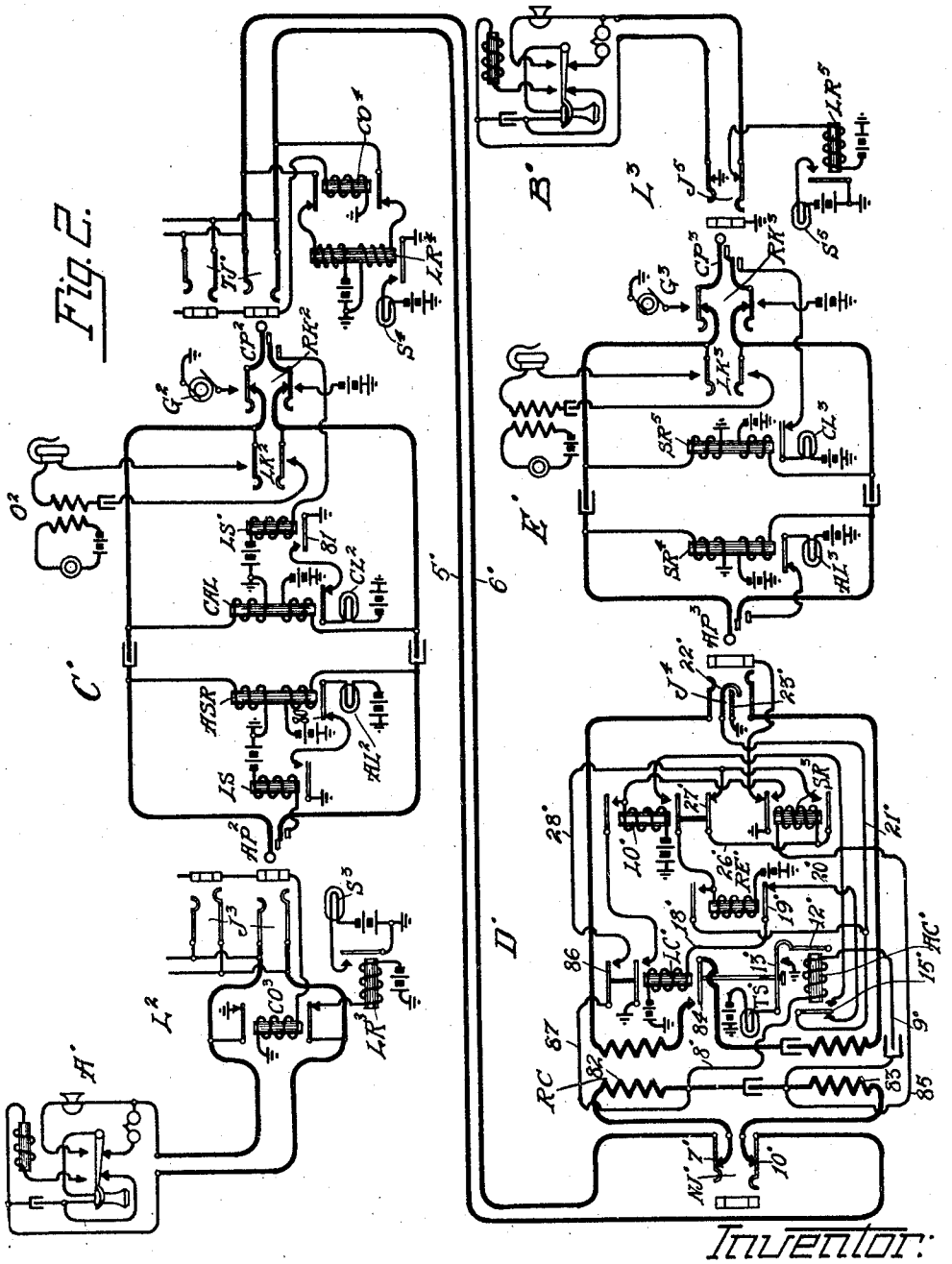
Fig. 2.



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Patented Dec. 26, 1922.

1,440,110

UNITED STATES PATENT OFFICE.

CHARLES SPARKS, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TRUNK CIRCUITS.

Application filed April 4, 1918. Serial No. 226,690.

To all whom it may concern:

Be it known that I, CHARLES SPARKS, a citizen of the United States of America, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Trunk Circuits, of which the following is a specification.

My invention relates to telephone systems and has to do more particularly with the systems employing two-way trunk circuits for use between two exchanges, as between a main exchange and a private branch exchange, and has for its object a novel and improved system of the above type.

A feature of my invention is the means employed to provide double supervision so that when the private branch exchange operator or the main exchange operator removes the plug from a trunk jack of the trunk circuit extending between the two exchanges, the supervisory lamp of the cord circuit connected to the other end of the trunk circuit will be lighted.

Another feature of my invention is the provision of means whereby the main exchange operator can ring over the private branch exchange trunk circuit at any time and light the supervisory lamp of the private branch exchange cord circuit and also relight the trunk line lamp at the private branch exchange.

Still another feature of my invention is the provision of means whereby when the main exchange operator re-rings or rings over a trunk extending to the private branch exchange on which the private branch exchange operator has left a cord circuit plug in a jack, the ringing current is disconnected from the private branch exchange cord circuit, thus preventing the private branch exchange operator from being rung in the ear and also prevents the ringing of the private branch exchange subscriber's bell connected to the private branch exchange cord circuit.

A still further feature is the provision of means for preventing the lighting of the line lamp associated with a trunk leading to the private branch exchange when the main exchange operator removes the calling plug of a cord circuit from the outgoing jack of the said trunk circuit before the private branch exchange operator has taken down the connection at the private branch exchange.

Other objects of my invention will be more particularly pointed out in the following specification and in the appended claims.

Referring now more in detail to my invention as illustrated, I show in Fig. 1 a circuit arrangement in which the trunk circuit of my invention is adapted to establish a connection between a calling subscriber of a main exchange and a private branch exchange subscriber. In Fig. 2, I show a modification of the trunk circuit of my invention, the said trunk being provided with a repeating coil.

For a more complete understanding of my invention, reference may be had to the accompanying drawings in which only sufficient apparatus is shown for connecting a calling subscriber at the main exchange with a called subscriber at a private branch exchange. A connection is completed through the medium of the subscriber's line equipment L, main exchange cord circuit C, trunk circuit D, private branch exchange cord circuit E, and the line equipment L′ of the called subscriber.

Referring now more in detail to the apparatus as illustrated in Fig. 1, I show a calling substation A of any well known or suitable type of common battery substation which terminates in a line circuit L, comprising the usual line relay LR, line lamp S, cut-off relay CO, and the multiple jacks J. The cord circuit C may be of any suitable or well known type, and as shown comprises an answering plug AP and a calling plug CP connected by the heavily marked conductors and having the condensers K and K′ interposed. Associated with the answering plug AP is the answering tip supervisory relay AT and an answering sleeve supervisory relay AS. The two supervisory relays AT and AS control the circuit of the answering supervisory lamp AL. Associated with the calling plug CP is the calling tip supervisory relay CT and the calling sleeve supervisory relays CS. The two relays CT and CS control the circuit of the calling supervisory lamp CL. At O is shown an operator's set adapted to be connected to the cord conductors through the medium of the operator's listening key LK. At RK a ringing key is shown which, when actuated, connects the ringing generator G

to the conductors of plug CP. The link circuit C is adapted to complete connections between local substations or for extending a call from a local substation over the trunk circuit D to a subscriber at a private branch exchange, or for completing a call initiated by a private branch exchange subscriber to a subscriber terminating at the main exchange.

The trunk circuit D terminates in a trunk jack TJ at the operators' position in the main exchange, and in a jack J′ at the operator's board at the private branch exchange. Associated with the trunk jack TJ is a line relay LR′, line signal S′, and a cut-off relay CO′. The line relay LR′ and the line signal S′ are used when connections are extended from the private branch exchange to the main exchange. Associated with the opposite end of the trunk circuit D is a link control relay LC and an alternating current relay AC. The relays LC and AC have their armatures mechanically related to each other and co-operate with each other. The said relay AC is provided with a locking latch which upon the energization of said relay AC locks its armature 12 in its operated position. The relay LC is provided with a connecting link, which link upon the energization of the relay LC engages the latch associated with the relay AC to restore the armature 12 of AC to its normal position. The armature 15 of relay AC is free to move back and forth. A trunk signal TS is also provided, and the lighting of the said lamp notifies the private branch exchange operator that a call has been extended to the said private branch exchange from the main exchange. A locking relay LO, a supervisory relay SR, and a recall relay RA are also provided for the said trunk circuit C.

The private branch exchange operator's link circuit E comprises an answering plug AP′ and a calling plug CP′, connected through the medium of the heavily marked conductors. An answering supervisory relay SR′ is associated with the answering plug AP′, the said relay controlling the answering supervisory lamp AL′. A calling supervisory relay SR^2 is associated with the calling plug CP′, the said relay controlling the calling supervisory lamp CL′. A listening key LK′ is also provided and connects the private branch exchange operator's set O′ to the cord conductors. A ringing key RK′ is provided which, when actuated, connects the ringing generator G′ to signal the called for private branch exchange subscriber. The private branch exchange substation is similar to that of the main subscriber's substation A and terminates in a line circuit L′ comprising a line relay LR^2, line signal S^2, and its associated jack J^2.

The circuit as illustrated in Fig. 2 shows a calling subscriber's substation A′ terminating in a line circuit L^2, comprising the usual cut-off relay CO^3, line relay LR^3, line signal S^3, and multiple jacks J^3. The main exchange operator's cord circuit C′ comprises the usual answering plug AP^2 and the calling plug CP^2 connected by the heavily marked conductors. The answering end of the cord circuit is provided with a local sleeve relay LS and an answering supervisory relay ASR. The answering supervisory signal AL^2 at the answering end of the cord circuit is controlled by the two relays LS and ASR. The calling end of the cord circuit is provided with a local sleeve relay LS′ and a calling supervisory relay CAL. A calling supervisory lamp CL^2 is provided and is controlled by the two relays CAL and LS′. A listening key LK^2 is also associated with the cord circuit C′, and when actuated connects the operator's set O^2 to the cord conductors. A ringing key RK^2, is also shown, which, when actuated, connects the ringing generator G^2 to the calling plug CP^2.

The trunk circuit D′ terminates in jacks TJ′ at the operators' positions in the main exchange, and in a jack J^4 in the operator's board at the private branch exchange. The usual line relay LR^4, cut-off relay CO^4, and the trunk signal S^4 are associated with the trunk jack TJ′. The opposite end of the trunk circuit D′ is provided with apparatus similar to that just described in connection with Fig. 1. The trunk circuit D′ as illustrated in Fig. 2 is provided with a repeating coil RC. Private branch exchange operator's circuit E′, private branch exchange substation B′, and line circuit L^3 are provided with apparatus similar to that described in connection with Fig. 1.

Having described in general the apparatus employed in the embodiment of my invention as herein illustrated, a connection from a calling to a called subscriber will now be described in detail. Referring to Fig. 1, assuming that the subscriber at the substation A desires to initiate a call, upon removing his receiver from the switchhook, a circuit is closed through the line relay LR. The said line relay LR upon energizing, closes a circuit through the line lamp S. The operator upon noting the lighted signal S inserts the answering plug AP of the cord circuit C into the jack J of the calling line, thus closing a series circuit through the answering sleeve supervisory relay AS of the cord circuit C and cut-off relay CO of line circuit L. The circuit extends from battery through the winding of the said answering sleeve supervisory relay AS, sleeve contacts of the connected plug AP and jack J, through the winding of the cut-off relay CO to ground. The cut-off relay CO upon energization disconnects the line relay LR

from the subscriber's line and completes the connection between the conductors of the jack J and the subscriber's line, thus closing the circuit through to the answering tip supervisory relay AT. The circuit through the answering tip supervisory relay AT extends from battery through the winding of the relay AS, sleeve contacts of the connected plug AP and jack J, alternate contact 2 of relay CO, through the substation A, alternate contact 3 of relay CO, tip contacts of the connected jack J and plug AP, and through the winding of the tip supervisory relay AT to ground. Relay AT, upon energizing, prevents the premature lighting of the answering supervisory lamp AL by the opening of its contact 4. The operator now operates her listening key LK to connect her operator's set O to the cord conductors and inquires the wants of the calling subscriber.

Upon learning that the calling subscriber desires connection with a subscriber at the private branch exchange, the operator now inserts the calling plug CP into an idle trunk jack TJ. Upon the insertion of the calling plug CP into the jack TJ, a series energizing circuit is established through the cut-off relay CO', associated with the jack TJ and the calling sleeve supervisory relay CS. The circuit extends from battery through the winding of the calling sleeve supervisory relay CS, sleeve contacts of the plug CP and jack TJ, and the winding of the cut-off relay CO' to ground. The cut-off relay CO', upon energizing, disconnects the line relay LR' from the conductors of the trunk circuit D, and connects the tip and sleeve conductors of the jack TJ to the heavily marked trunk conductors 5 and 6. The closing of alternate contact 39 of relay CS closes a circuit for the calling supervisory lamp CL from battery through the lamp CL and alternate contact 39 to ground at normal contact 30 of relay CT. The said lamp CL remains lighted until the private branch exchange operator answers the call. The operator at the main exchange now actuates the ringing key RK to connect ringing current from the generator G to the trunk circuit D. The path for ringing current extends from the ungrounded pole of the generator G through the alternate contact of ringing key RK, tip contacts of the plug CP and jack TJ, trunk conductor 6, normal contact 7 of the night jack NJ, conductor 8, through the winding of the alternating current relay AC, conductor 9, normal contact 10 of the night jack NJ, trunk conductor 5, alternate contact 11 of relay CO', sleeve contacts of the connected jack TJ and plug CP, through the alternate contacts of ringing key RK to battery, and back to the grounded pole of generator G. The alternating current relay AC, when energized by the said ringing current, attracts its armature 12, and the attraction of armature 12 allows the latch spring 13 to assume its alternate position. The spring 13 is provided with a hooked end which engages the armature 12 and locks the said armature 12 in an actuated position. The spring 13 moving to its alternate position, establishes an energizing circuit for the trunk signal TS, the said circuit being traced from battery through the said lamp TS and to ground at alternate latch spring contact 13. The closing of alternate contact 15 of the relay AC upon the energization of the said relay is only incidental at this time and does not bring about any circuit changes. The contact 15 is not associated with the latch spring 13 and is moved to its alternate position and restored again when the relay AC is energized and de-energized.

The operator at the private branch exchange upon noting the lighted trunk signal TS inserts the answering plug AP' of the private branch exchange link circuit E into the jack J'. However, if ringing current is being applied to the trunk conductors of the trunk circuit D, the alternating current relay AC will remain energized as long as current is being applied to the trunk circuit over the herein-before described circuit. Should the operator insert the answering plug AP' into the jack J' while ringing current is thus being applied, the alternating current relay causes its spring 15 to move to its alternate position, opening the normal contact 15, thus preventing the link control relay LC from energizing, and due to the link control relay remaining at normal, the trunk conductors are interrupted at contacts 16 and 17, thus preventing the ringing current from being transmitted to the operator's set O'. As soon, however, as the relay AC de-energizes, it allows its normal contact 15 to restore to close an energizing circuit for the link control relay LC which may be traced from battery through the winding of the said relay, conductor 18, normal contact 19 of relay RE, conductor 20, normal contact 15 of relay AC, conductor 21, to ground at the now closed jack contacts 22 and 23, the said contacts being closed upon the insertion of the plug AP' into the jack J'.

The closing of the alternate contacts 16 and 17 of the relay LC establishes an energizing circuit for the supervisory relay SR, the said circuit being traced from battery through the winding of the relay CS of the main exchange, link circuit C, normal contact of the ringing key RK, sleeve contacts of the connected plug CP and jack TJ, alternate contact 11 of the cut-off relay CO', trunk conductor 5, alternate contact 17 of relay LC, conductor 25, winding of the relay SR, conductor 26, normal contact 27 of relay LC, conductor 28, alternate contact

16 of relay LC, trunk conductor 6, tip contacts of the connected plug CP and trunk jack TJ, normal contact of the ringing key RK, through the winding of the relay CT, to ground. The relay CT, upon energizing, opens its normal contact 30 to efface the calling supervisory signal CL of the cord circuit C, thus notifying the operator at the main exchange that the private branch exchange operator has answered the call. The closing of alternate contact 31 of relay SR establishes an energizing circuit for the relay LO, traced from battery through the winding of the said relay LO, and conductor 32, to ground at alternate contact 31. The relay LC being energized as described, its alternate contact 33 is closed, and upon the energization of the relay LO, its alternate contact 34 is closed, thus establishing a locking circuit for relay LO traced from battery through the winding of the relay LO and its alternate contact 34, to ground at alternate contact 33 of the relay LC. The relay LC, upon energizing, causes the link 35 associated with the latch spring 13 to engage the same and raise the said spring 13 so that its hooked end disengages the said armature 12, allowing the said relay armature 12 to restore to normal. At the same time contact 13 is removed from its alternate contact, effacing the trunk signal TS. The opening of normal contact 27 of relay LO opens the initial energizing path for the relay SR, but, due to the fact that the relay SR energizes before relay LO does, its alternate contact 36 is closed before the normal contact 27 of relay LO is opened. The substitute energizing path through the relay SR may be traced from battery through the relay CS over the before-traced circuit, through the winding of the said relay SR, through the now closed contact 36 of said relay SR, and conductor 28, to ground over the previously traced path.

Upon the insertion of the plug AP′ into the jack J′, an energizing circuit for the answering supervisory lamp AL′ is momentarily established, traced from battery through the said lamp AL′, normal contact 37 of relay SR′, and the sleeve contacts of the connected plug and jack, to ground at normal contact 31. Upon the energization of the relay SR, its normal contact 31 is opened, preventing the premature lighting of the said supervisory signal AL′. The operator at the link circuit E now actuates the listening key LK′ to connect her operator's set O′ to the trunk conductors, through the medium of the answering plug AP′ and jack J′, and inquires the wants of the calling subscriber A. The private branch exchange subscriber B being wanted, the private branch exchange operator inserts the calling plug CP′ into the jack J^2 of the called line, closing the circuit of the supervisory signal CL′, over a circuit traced from battery through the lamp CL′, normal contact 40 of relay SR^2, and sleeve contacts of the plug CP′ and jack J^2, to ground at the sleeve of the jack. The said lamp CL′ remains lighted until the called subscriber answers. Upon the insertion of the plug CP′ into the jack J^2, the normal contacts of the jack J^2 are opened to disconnect the substation control of the line relay LR^2. The operator now actuates the ringing key RK′ to connect ringing current to the call bell at the called substation B.

Upon the response of the subscriber at the called substation B, an energizing circuit for the supervisory relay SR^2 is established, traced from battery through the lower winding of the relay SR^2, the ring contacts of the plug CP′ and jack J^2, through the now closed contacts of the substation switch hook, back through the tip contacts of the jack J^2 and the plug CP′, and through the upper winding of the relay SR^2 to ground. The relay SR^2, upon energizing, opens its normal contact 40, effacing the calling supervisory signal CL′. The calling substation A and the called substation B are now in conversational circuit, over the heavily marked conductors.

Assuming that the conversation has now terminated, the calling subscriber upon replacing his receiver opens the circuit of the answering tip supervisory relay AT of the link circuit C, and thereby allows the same to restore to normal. The answering tip supervisory relay AT, upon de-energizing, closes a circuit for the answering supervisory lamp AL at its contact 4. The called subscriber at the private branch enchange, upon replacing his receiver, opens the circuit of the supervisory relay SR^2 of the link circuit E, thereby allowing the said relay SR^2 to de-energize. The calling supervisory relay SR^2 upon de-energizing, closes a circuit through the calling supervisory lamp CL′ at its contact 40, thus indicating to the operator of the private branch exchange that the called subscriber has replaced his receiver.

Assuming that the operator at the main exchange in response to the disconnect signal AL first removes the plug CP from the trunk jack TJ, the removal of the said plug from the jack brings about the de-energization of the relays CT, CS and CO′. The apparatus of the cord circuit C and line circuit L are now at normal and available for use in establishing other local connections.

The removal of the plug CP from the jack TJ also allows the relay SR of the trunk circuit D to de-energize and close its contact 31. The closing of normal contact 31 of the relay SR again closes a circuit for the answering supervisory lamp AL′ of the

link circuit E. The operator at the private branch exchange noting the two lighted signals AL′ and CL′ withdraws the plugs AP′ and CP′ from their respective jacks J′ and J². The withdrawal of the plug AP′ from the jack J′ allows the jack springs 22 and 23 to open, bringing about the de-energization of the link control relay LC. The link control relay LC upon de-energizing, opens its alternate contact 33, opening the locking circuit of the relay LO, permitting the said relay LO to restore to normal. The supervisory lamps AL′ and CL′ are effaced due to the disconnection of the answering plug AP′ and the calling plug CP′, and the apparatus at the trunk circuit D is restored to normal as is also that of the link circuit E, and the link circuit E is now available for establishing other connections at the private branch exchange.

Assuming that the private branch exchange operator is the first to withdraw the plug AP′ from the jack J′, this withdrawal opens the closed contacts 22 and 23 to bring about the de-energization of the link control relay LC. The opening of alternate contacts 16 and 17 of the said relay LC brings about the de-energization of the relay SR, and the opening of alternate contact 33 opens the locking circuit of the relay LO, allowing the said relay to restore to normal. The circuit of the calling tip supervisory relay CT of the link circuit C at the main exchange de-energizes upon the restoration of the link control relay LC of the trunk B, to close a circuit for the calling supervisory lamp CL at its normal contact 30 to light the said lamp. The operator at the link circuit C now withdraws the answering plug AP and the calling plug CP from their respective jacks J and TJ, and the relay CO of the line circuit L and the relay CO′ associated with the trunk circuit D restore to normal. The answering supervisory relay AS and the calling supervisory relay CS also restore, effacing said signals AL and CL. The apparatus is now at normal and available for other connections. The removal of the plug CP′ from the jack J² at the private branch exchange brings about the restoration of the apparatus at the link circuit A, as before described. It is thus seen that should the main exchange operator be the first to remove her plug CP from the trunk jack TJ, the restoration of relay SR of the trunk circuit D brings about the lighting of the supervisory lamp AL′ of the private branch exchange cord E. Should the private branch exchange operator be the first to withdraw her plug AP′ from the jack J′, the restoration of the relay LC as already described brings about the lighting of the supervisory lamp CL of the main exchange link circuit C, this lighting of the supervisory lamps in the cords at the opposite ends of the trunk D depending on which operator was first to disconnect, thereby providing double supervision.

Assuming now that the calling subscriber A and the called subscriber B have replaced their receivers upon their respective switch hooks and the operator at the main exchange in response to the disconnect signal removes the plug CP from the trunk jack TJ, the relay SR of the trunk circuit D restores to normal, as previously described. Now, should the private branch exchange operator neglect to remove the answering plug AP′ from the jack J′ of the trunk circuit D, the plug AP′ remaining in said jack J′ does not tie up the trunk circuit D. When a condition of this kind arises, the relays LC and LO remain energized due to the closed contacts 22 and 23 of the jack J′, which closed contacts hold LC energized and the said relay LC in turn keeps the relay LO in its locked energized position. The relay SR has its energizing circuit opened at contact 27 of relay LO and, therefore, relay LR′ of jack TJ remains at normal, no busy indication being given at trunk jack TJ. The main exchange operator may again insert the calling plug CP into the jack TJ and actuate her ringing key RK to connect ringing current from the ringing generator G to the trunk conductors. The ringing current will pass through the alternating current relay AC as previously described, and effect the closure of its alternate contact 13 to again light the trunk signal TS. Upon the actuation of the relay AC, due to ringing current passing through its energizing winding, its alternate contact 15 is closed, opening the energizing circuit of the relay LC. The relay LC upon de-energizing, restores and opens its alternate contact 33, thereby opening the locking circuit of the relay LO. The relay LO being a slow-acting relay, that is, being slow to release its armature, holds its contact 50 momentarily closed after the de-energization of the said relay LC, and this act closes an energizing circuit for the recall relay RE, traced from battery through the winding of the said relay, closed contact 50 of the relay LO, conductor 51, alternate contact 15 of the relay AC and conductor 21, to ground at the contact 23 of the jack J′. The relay RE thereupon closes a locking circuit for itself traced from battery through the winding of said relay RE, its alternate contact 52, conductor 53, and conductor 21 to ground at contact 23. The relighting of the trunk signal TS notifies the operator at the private branch exchange of the recall. The private branch exchange operator to place herself in communication with the calling subscriber withdraws the plug AP′ from the jack J′, opening the locking circuit for the relay RE at contact 23 of the jack J′, allowing the

said relay to restore to normal. Then upon the re-insertion of the plug AP′ into the jack J′, an energizing circuit for the relay LC is established, which energizes relay LC and causes the energization of the relay SR over the trunk conductors. The relay LO is again energized to close a locking circuit for itself, and the energization of relay LC restores the spring 13 of relay AC to efface the trunk signal TS, all of which has been previously described in connection with the call from the calling subscriber A to the called subscriber B. The operator at the private branch exchange cord E now actuates her listening key LK′ to connect her operator's set O′ to the trunk conductors through the medium of the plug AP′ and jack J′ to inquire the wants of the calling subscriber A.

It will thus be seen that when the main exchange operator re-rings over a trunk on which the private branch exchange operator has left the plug in the jack, ringing current is cut off from the private branch exchange board due to the relay LC de-energizing upon the actuation of the alternating current relay AC, which relay AC opens its normal contact 15 to bring about the de-energization of the said relay LC. The relay LC restoring opens its alternate contacts 16 and 17, opening the trunk conductors of the trunk circuit D, preventing the ringing current from passing to the private branch exchange cord E and ringing the operator in the ear, should her listening key LK′ be actuated, and preventing the ringing of the private branch exchange subscriber's call bell should the plug CP′ remain in the jack J².

Assuming now that a subscriber at a private branch exchange wishes to communicate with a subscriber at the main exchange, the subscriber at the private branch exchange upon removing his receiver brings about the energization of the line relay LR² from battery through the said relay, normal contact of jack J², through the substation to ground at the jack spring of the jack J². Upon the energization of the relay LR², the line signal S² is lighted. The private branch exchange operator now inserts the answering plug AP′ into the jack J² of the calling subscriber, and this insertion of plug AP′ opens the normal spring jack contacts of the jack J² to bring about the de-energization of the line relay LR² and the effacement of the line signal S². The relay SR′ of the link E is also energized over the line, preventing the lighting of the supervisory signal AL′ in a well known manner. The operator now actuates the listening key LK′ to inquire the wants of the calling subscriber, and upon learning that the wanted subscriber's line terminates at the main exchange, she inserts the calling plug CP′ into the jack J′ of the trunk circuit D, bringing about the lighting of the calling supervisory lamp CL′, over a circuit traced from battery through the said lamp, normal contact 40 of relay SR², sleeve contacts of the connected plug CP′ and jack J′, to ground at normal contact 31 of relay SR of the trunk D, the said lamp CL′ remaining lighted until the main exchange operator answers the call. The insertion of the plug AP′ into the jack J′ closes an energizing circuit for the link control relay LC traced from battery through the winding of the said relay LC, conductor 18, normal contact 19, conductor 20, normal contact 15, and conductor 21, to ground at closed contacts 22 and 23.

The closing of alternate contacts 16 and 17 of the relay LC extends the trunk conductors to the trunk jacks TJ at the main exchange. The line relay LR′ at the main exchange is energized over a circuit traced from battery through the winding of the said relay, conductor 61, normal contact 60 of relay CO′, trunk conductor 6, alternate contact 16 of relay LC, conductor 28, contact 27 of relay LO, conductor 26, through the winding of the relay SR, conductor 25, alternate contact 17 of relay LC, trunk conductor 5, to ground at normal contact 11 of relay CO′. The relay SR of the trunk circuit D is not energized through the line relay LR′, due to the high resistance of the relay LR′, and remains at normal. The closing of alternate contact 62 of relay LR′ brings about the lighting of the line signal S′.

The operator at the main exchange now noting the lighted signal S inserts the answering plug AP into the trunk jack TJ, establishing a series energizing circuit for the relay AS and cut-off relay CO′ over a circuit traced from battery through the winding of the relay AS, sleeve contacts of the connected plug and jack, and through the winding of the relay CO′ to ground. The opening of alternate contact 11, upon the energization of the relay CO′, brings about the restoration of the line relay LR′ to efface the line signal S′. A circuit for the relay AT of the main exchange link circuit C and the relay SR of the trunk circuit D is now established, traced from battery through the winding of the relay AS, sleeve contacts of the connected plug and jack, alternate contact 11 of relay CO′, trunk conductor 5, alternate contact 17, conductor 25, winding of the relay SR, conductor 26, normal contact 27, conductor 28, alternate contact 16, trunk conductor 6, contacts of the connected plug and jack, through the winding of the relay AT′ to ground. Normal contact 4 of relay AT is opened, preventing the supervisory lamp AL from lighting. Upon the energization of the relay SR, its normal contact 31 is opened, interrupting the

circuit of the supervisory lamp CL′ of the private branch exchange link E, notifying the operator at the said branch exchange that the main exchange operator has answered the call. The closing of alternate contact 31 of the relay SR establishes an energizing circuit for the relay LO, and the closing of alternate contact 34 of relay LO establishes a locking circuit for itself, as previously described.

The operator at the main exchange now actuates her listening key LK to connect her operator's set O, and inquires the wants of the calling subscriber. Assuming that it is the main exchange subscriber A that is wanted, she inserts the plug CP into the jack J and actuates her ringing key RK to ring the call bell of the called subscriber A. Upon the insertion of the plug CP into the jack J, relay CS of the link C and the cut-off relay CO are energized in series, and upon the response of the called subscriber, the relay CT energizes, opening its normal contact 30, effacing the signal CL, notifying the operator at the main exchange that the called subscriber has answered. The subscribers may now carry on conversation over the heavily marked conductors. The disconnection of the apparatus in establishing a connection from the private branch exchange subscriber B to a main exchange subscriber A is similar to that previously described.

In Fig. 2, I illustrate a trunk circuit D having the same operation as that described in connection with Fig. 1, but in addition I show a repeating coil RC associated with the trunk circuit D′. Now assuming that the subscriber at the substation A′ initiates a call, upon removing his receiver from the switch hook a circuit is closed through the line relay LR^3, which relay upon energizing closes a circuit through the line signal S^3. The main exchange operator noting the lighted signal S^3 inserts the answering plug AP^2 into the jack J^3 of the calling line. The series circuit is established for the cut-off relay CO^3 and the local sleeve relay LS of the cord circuit C′ from battery through the winding of the relay LS, sleeve contacts of the connected plug and jack, through the winding of the relay CO^3 to ground. The supervisory relay AL is also operated over the line conductors upon the energization of relay CO^3, and the energization of the said relay AL brings about the opening of its normal contact 80, preventing the premature lighting of the answering supervisory relay AL^2. The operator now actuates her listening key LK^2 to connect her operator's set O^2 to the cord conductors, and inquires the wants of the calling subscriber. Upon learning that the calling subscriber desires connection with a subscriber at the private branch exchange, the operator now inserts the calling plug CP^2 into the trunk jack TJ′, establishing a series energizing circuit for the local sleeve relay LS′, and cut-off relay CO^4, traced from battery through the relay LS′, sleeve contacts of the plug and jack, and through the winding of the cut-off relay CO^4 to ground. The cut-off relay CO^4 upon energizing disconnects the line relay LR^4 from the conductors of the trunk circuit D′ and connects the tip and sleeve conductors of the jack TJ′ to the heavily marked trunk conductors 5′ and 6′. The closing of alternate contact 81 of relay LS′ of the cord circuit C′ closes the circuit through the calling supervisory lamp CL^2, the said lamp remaining lighted until a private branch exchange operator answers the call.

The main exchange operator now actuates her ringing key RK^2 to connect ringing current from the generator G^2 to the trunk circuit D′. The path for ringing current extends from the ungrounded pole of the generator G^2, through tip contacts of the connected plug and jack, trunk conductor 6′, normal contact 7′ of the night jack NJ′, the winding 82 of the repeating coil RC, conductor 8′, through the winding of the alternating current relay AC′, conductor 9′, the winding 83 of the repeating coil RC, contact 10′ of the night jack NJ′, trunk conductor 5′, contacts of the connected plug and jack, through the alternate contact of the ringing key RK^2 to battery, and back to the grounded pole of the generator G^2. The relay AC′ is also provided for the latch spring 13′, armature 12′ and spring 15′, as described in detail in the description of Fig. 1. The closing of alternate contact 13′ brings about the lighting of the trunk lamp TS′.

The private branch exchange operator noting the lighted signal TS′ inserts the answering plug AP′ of the private branch exchange link circuit D′ into the jack J^4. However, if ringing current is being applied to the trunk conductors of the trunk circuit D′, the alternating current relay AC′ will remain energized as long as current is being applied, and should the operator insert the answering plug AP^3 into the jack J^4 while ringing current is thus being applied, the normal contact 15′ of the alternating current relay AC′ is in its alternate position, preventing the energization of the link control relay LC′, thus preventing the said ringing current from being transmitted to the operator's set O^3. As soon as relay AC′ is de-energized after ringing current has been discontinued, contact 15′ assumes its normal position and the plug AP^3 is in the jack J^4, a circuit is closed for the said relay LC′ traced from battery through the winding of the relay LC′, conductor 18′, normal contact 19′, conductor

20′, normal contact 15′, conductor 21′, to ground at spring jack contacts 23′ and 22′. The closing of alternate contact 84 of relay LC′ establishes an energizing circuit for the supervisory relay SR^3 of the trunk circuit D′, traced from battery through the lower winding of the supervisory relay CAL of the main exchange link circuit C′, through the contacts of the connected plug CP^2 and trunk jack TJ′, conductor 5′, normal contact 10′, winding 83 of the repeating coil RC, conductor 85, winding of the relay SR^3, conductor 26′, normal contact 27′, conductor 28′, alternate contact 86 of relay LC′, conductor 87, winding 82 of repeating coil RC, normal contact 7′, trunk conductor 6′, tip contacts of the connected plug CP^2 and the trunk jack TJ^2, through the upper winding of the relay CAL to ground. The operation of the apparatus of the trunk circuit D as to the effacement of the trunk signal TS′, due to the energization of the relay LC′, and the energizing of the locking relay LO′ and its locking circuit is the same as has been previously described in connection with Fig. 1, and a further description is not necessary. The connection which is extended to the called private branch exchange B′ is practically the same as described in detail in Fig. 1, and the features of double supervision and the provision of means for allowing the main exchange operator to re-ring over a trunk upon which the private branch exchange cord circuit is still connected is the same as that described in connection with Fig. 1. Disconnection of the apparatus used in establishing a connection, and the calling of a main exchange subscriber by a private branch exchange is the same as previously described in connection with Fig. 1.

While I have illustrated the preferred embodiment of my invention in certain specific circuit arrangements, yet it is to be understood that I do not wish to be limited to the arrangements as shown as many changes and modifications will readily suggest themselves to one skilled in the art, and I, therefore, desire to cover all such changes and modifications as come within the spirit and scope of the appended claims.

What I claim as new and desire to secure by United States Letters Patent is:

1. A telephone system including a calling and a called subscriber's line, a cord circuit, a trunk circuit provided with a pair of terminals, and a second cord circuit connecting said lines in conversational circuit, means for preventing the connection of one of said terminals to said trunk circuit while signalling current is being applied to said trunk circuit, a supervisory signal for each of said cord circuits, means whereby when either of said cord circuits is disconnected from said trunk circuit the supervisory signal of the other of said cord circuits will be effected, and recall means for said trunk circuit operable to denote a recall prior to the disconnection of said second cord circuit from said trunk circuit.

2. A telephone system including a calling subscriber's line, a cord circuit for connection thereto, a supervisory signal for said cord circuit, a called subscriber's line, a cord circuit for connection thereto, a supervisory signal for said latter cord circuit, a trunk circuit for use in extending connection from said first cord circuit to said second cord circuit, means for preventing the effective connection of said second cord circuit to said first cord circuit while signalling current is connected to said trunk circuit, means whereby the disconnection of either of said cord circuits from said trunk circuits will operate the supervisory signal at the other of said cord circuits, and a supervisory signal for said trunk circuit operable to indicate a call prior to the connection of said second link circuit to the said trunk circuit and also operable to indicate a recall prior to the disconnection of said second link circuit from said trunk circuit.

3. A telephone system including a calling and a called subscriber's line, a link circuit associated with each of said subscriber's lines, a supervisory signal for each of said link circuits, a trunk circuit for use in extending a call through one of said link circuits to the other of said link circuits, means for preventing the connection of one of said link circuits with the other as long as signalling current is connected to said trunk circuit, means whereby the disconnection of either of said link circuits from the said trunk circuit will operate the supervisory signal of the other of said link circuits, and a supervisory signal for said trunk circuit operable to indicate a call prior to the connection of said second link circuit to said trunk circuit and also operable to indicate a recall prior to the disconnection of said second link circuit from said trunk circuit.

4. A telephone system including a calling subscriber's telephone line and a called subscriber's telephone line, a link circuit, a trunk circuit and a second link circuit, all used for extending a connection from said calling subscriber's line to said called subscriber's line, a supervisory signal for said second link circuit, means responsive to the disconnection of said first link circuit from said trunk circuit for actuating said supervisory signal, and recall means for said trunk circuit operative to effect a trunk signal to cause the same to burn continuously until the recall is answered when said second link circuit remains connected to said trunk circuit, and no matter in what condition said link circuit signal may be.

5. A telephone system including an A op-

erator's link circuit, a two-conductor trunk circuit provided with terminals, a B operator's link circuit, means to prevent the operative connection of one of said terminals with the other of the terminals as long as a signal is being transmitted over said trunk circuit, a supervisory signal for said B operator's link circuit, means controlled by the A operator over the conductors of the outgoing end of said trunk circuit in series for operating said supervisory signal, and means for restoring said supervisory signal.

6. A telephone system including an "A" operator's cord circuit, a "B" operator's cord circuit, a trunk circuit for connecting said cord circuits, a supervisory signal for said "B" operator's cord circuit, means controlled by said "A" operator for causing the operation of said supervisory signal, a calling signal for said trunk circuit, and means controlled by the "A" operator for causing said calling signal to glow continuously until the "B" operator's cord circuit is disconnected from the said trunk circuit.

7. A telephone system including an "A" operator's cord circuit, a "B" operator's cord circuit, a trunk circuit connected to said cord circuits, a supervisory signal for said "B" operator's cord circuit, means responsive to the disconnection of the "A" operator's cord circuit from the trunk circuit for causing the glowing of said "B" operator's supervisory signal, a signal for said trunk circuit, and means controlled by the "A" operator for causing a continuous operation of said trunk circuit signal to denote a recall until the "B" operator disconnects the "B" operator's cord circuit from the trunk circuit.

8. A telephone system including an "A" operator's cord circuit, a "B" operator's cord circuit, a trunk circuit for connecting said cord circuits, a supervisory signal for said "B" operator's cord circuit, means controlled by the "A" operator for causing said supervisory signal to glow to denote disconnection, a supervisory signal for said trunk circuit controllable by the "A" operator when she signals for a recall, said signal being operative even though the "B" operator's cord circuit remains in connection with the trunk circuit, and means controlled by the disconnection of the "B" operator's cord circuit from the trunk circuit for effacing the signal of said "B" operator's cord circuit and for effacing said trunk circuit signal when the "B" operator's cord circuit is again connected to said trunk circuit.

9. A telephone system including an A operator's cord circuit and a B operator's cord circuit, a trunk circuit provided with a pair of terminals for connecting said cord circuits, means for preventing connection to one of the terminals to the trunk circuit while a signal is being transmitted over the trunk circuit, a supervisory signal for said trunk circuit and a supervisory signal for said B operator's cord circuit, and means controlled by the A operator for effecting both of said supervisory signals, said means adapted to cause said trunk supervisory signal to glow continuously to denote a recall until answered when said second link circuit remains connected to said trunk circuit.

10. A telephone system including an A operator's cord circuit and a B operator's cord circuit, a trunk circuit for connecting said cord circuits, a supervisory signal for said trunk circuit, means for preventing operative connection of one of said cord circuits with said trunk circuit while signalling current is being connected to said trunk circuit, and a supervisory signal for said B operator's cord circuit, means controlled by the A operator for actuating the supervisory signal of said B operator's cord circuit to denote disconnection, means controlled by the A operator for operating said trunk supervisory signal to denote a recall, and "B"-operator-controlled means for effacing said trunk circuit signal.

11. A telephone system including an A operator's cord circuit and a B operator's cord circuit, a trunk circuit for connecting said cord circuits, a supervisory signal for said trunk circuit, a supervisory signal for said B operator's cord circuit, and means controlled by the A operator for actuating both of said signals to denote a recall prior to a disconnection of said B operator's cord circuit from said trunk circuit.

12. A telephone system including an A operator's cord circuit and a B operator's cord circuit, a trunk circuit for connecting said cord circuits, a supervisory signal associated with each end of said trunk circuit, said signals being individual to said trunk circuit, means whereby the A operator may disconnect the A operator's cord circuit from said trunk circuit without effecting the supervisory signal at the outgoing end of said trunk circuit, means whereby the "A" operator may effect a signal at the incoming end of the trunk circuit to denote a recall prior to the disconnection of said "B" operator's cord circuit from said trunk circuit, said recall signal continuing effective to denote a recall until answered even after the "A" operator has ceased working said means.

13. A telephone system including an A operator's cord circuit and a B operator's cord circuit, a trunk circuit for connecting said cord circuits, a supervisory signal associated with each end of said trunk circuit and individual thereto, and means whereby the A operator may disconnect the A operator's cord circuit from said trunk circuit without effecting the supervisory signal at the outgoing end of said trunk circuit prior

to a disconnection of said B operator's cord circuit from said trunk circuit and means whereby the "A" operator may effect the supervisory signal at the incoming end of the trunk circuit to denote a recall prior to a disconnection of said "B" operator's cord circuit from said trunk circuit, said recall signal continuing effective to denote a recall until answered even after the "A" operator has ceased working said means.

14. A telephone system including an A operator's cord circuit and a B operator's cord circuit, a trunk circuit for connecting said cord circuits, a supervisory signal associated with each end of said trunk circuit, said signals being individual to the trunk circuit, means whereby the A operator may disconnect the A operator's cord circuit from said trunk circuit without effecting the supervisory signal at the outgoing end of said trunk circuit prior to a disconnection of said B operator's cord circuit from said trunk circuit, means whereby the "A" operator may effect the supervisory signal at the incoming end of said trunk circuit prior to disconnection of said "B" operator's cord circuit from said trunk circuit to cause the said incoming end supervisory signal to glow continuously until said "B" operator's cord is disconnected from said trunk circuit, means for disconnecting said B operator's cord circuit from said trunk circuit, and means responsive to a re-connection of said B operator's cord circuit to said trunk circuit to operate the supervisory signal at the A end of the trunk circuit.

15. A telephone system including a calling subscriber's line, a link circuit provided with a supervisory signal associated with said calling subscriber's line, a called subscriber's line, a link circuit provided with a supervisory signal associated with said called subscriber's line, a trunk circuit for extending a call from said first link circuit to said second link circuit, and means responsive to the disconnection of said first link circuit from said trunk circuit for operating the supervisory signal at said second link circuit, means responsive to the disconnection of said second link circuit from said trunk circuit for operating the supervisory signal of the said first link circuit, and a signal for said trunk circuit controllable by the A operator for denoting a recall prior to a disconnection of the B operator's cord circuit from the trunk circuit.

16. A telephone system including a trunk circuit provided with terminals, one terminal of said trunk circuit being normally disconnected from the other terminal of said trunk circuit, means for connecting said terminals together, means for applying signaling current to one end of said trunk circuit, and means associated with said trunk circuit for preventing the operation of said connecting means as long as signaling current is being applied to the said trunk circuit.

17. A telephone system including a trunk circuit, terminals in which said trunk circuit terminates, one of said terminals being normally disconnected from said trunk circuit, connecting means for connecting said terminal to said trunk circuit, a source of signaling current, means for connecting said source of current to one end of said trunk circuit, and means for preventing the operation of said connecting means as long as the said source of current is connected to said trunk circuit.

18. A telephone system including a trunk circuit provided with terminals, one of said terminals being normally disconnected from the other of said terminals, means responsive to a connection to one of said terminals for connecting said terminals together, and means for preventing the connection of said terminals together when said connection is made to one of said terminals.

19. A telephone system including a trunk circuit provided with a pair of terminals, one of said terminals being normally disconnected from said trunk circuit, a link circuit, means responsive to the connection of said link circuit to said trunk circuit to connect said normally disconnected terminal to said trunk circuit, and means for preventing the connection of said normally disconnected terminal to said trunk circuit when said link circuit is connected to said trunk circuit.

20. A telephone system including a pair of cord circuits and a trunk circuit connecting a pair of subscribers' lines, a supervisory signal for said trunk circuit, a source of signaling current for one of said cord circuits adapted to be connected to said trunk circuit to cause the operation of said trunk circuit signal, means responsive to the connection of said other cord circuit to said trunk circuit to efface said supervisory signal, means responsive to a second application of said current to said trunk circuit to reoperate said trunk circuit signal, and means responsive to the disconnection and reconnection of said second cord circuit to said trunk circuit for again effacing said trunk circuit signal.

Signed by me at Chicago, in the county of Cook and State of Illinois, this 2nd day of April, 1918.

CHARLES SPARKS.