O. F. CASSADAY.

TOLL TRUNK CIRCUIT.

APPLICATION FILED DEC. 6, 1915.

1,336,615.

Patented Apr. 13, 1920.

2 SHEETS—SHEET 1.

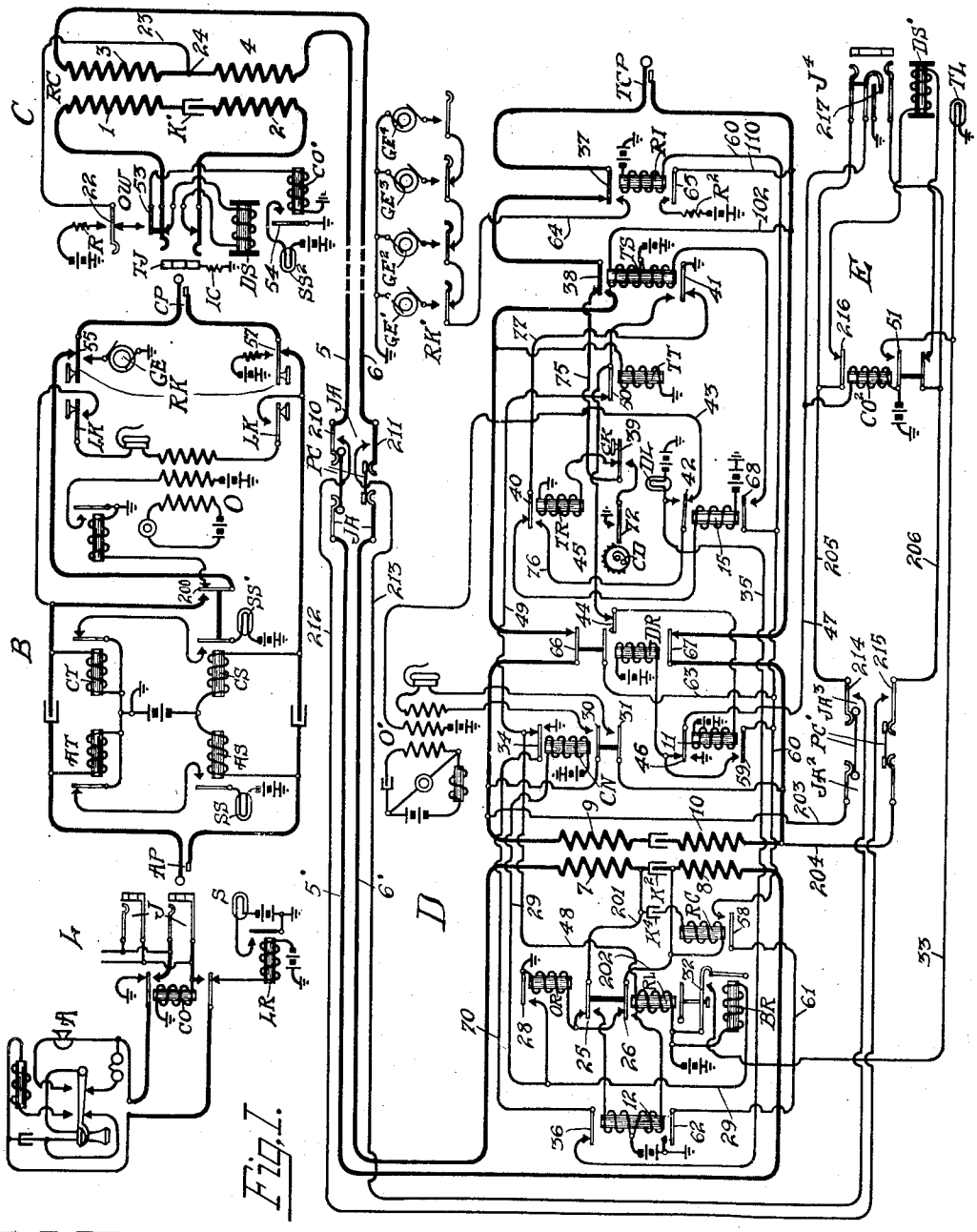

Fig. 1.

Witnesses:
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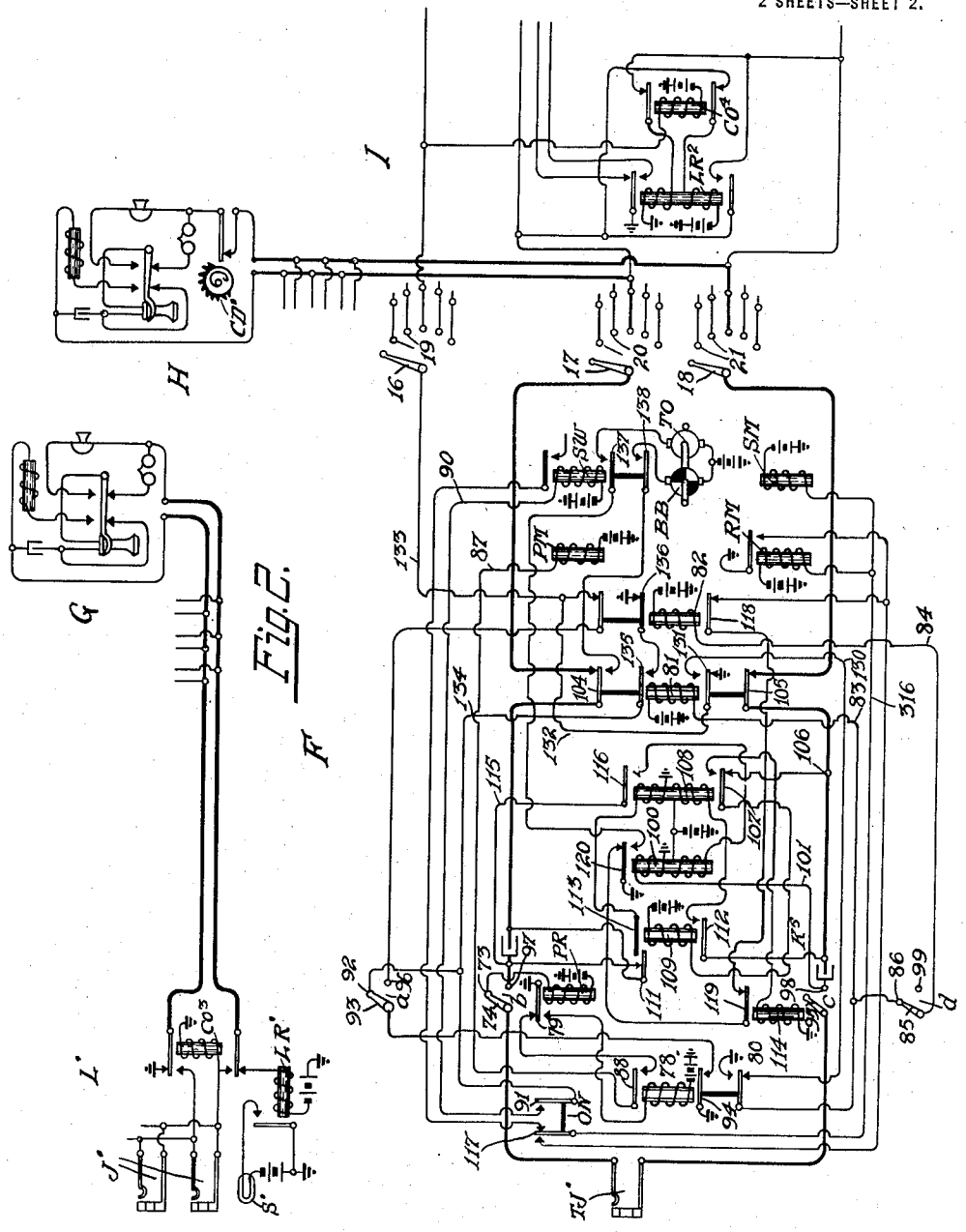

Fig. 2.

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UNITED STATES PATENT OFFICE.

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TOLL TRUNK-CIRCUIT.

1,336,615. Specification of Letters Patent. Patented Apr. 13, 1920.

Application filed December 6, 1915. Serial No. 65,216.

To all whom it may concern:

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

My invention relates to trunk circuits for telephone systems for use in extending connections from one exchange to another and has to do more particularly with so-called toll trunk circuits, an object of my invention being to provide an improved system of the above character.

The general practice in handling so-called toll calls is to have an operator commonly known as an A-operator answer the incoming calls by means of an operator's cord circuit and then to extend the calling subscriber's line to a so-called toll operator's board, upon which appears one end of all the toll trunks leading to the toll boards in the distant cities. The toll operator then extends the connection over the toll trunk to the toll operator's board at the distant city. The toll operator at the distant city then extends the toll call to a local operator who completes the connection with the desired called-for subscriber. It has been found necessary to extend all toll calls through a distant toll operator's board instead of direct to a local operator's board as a great many of the toll connections handled by the toll operator must be extended through the toll operator's board, over a second toll trunk, to another toll operator's board in a third city. Systems of the above described character have been found faulty owing to the length of time that is consumed by the toll operator at the incoming end of the toll trunk in connecting to an idle local operator and for the local operator to then extend the connection to the desired called subscriber. To overcome this objection, I provide a parallel branch circuit connecting the toll trunk to a local operator's board and provide means at the outgoing end of the trunk by which the toll operator may either signal the local operator at the opposite end of the trunk if a local connection in that city is desired, or she may signal the toll operator in the same place and she then extends the toll call over a second toll trunk to a third toll operator's board. By this method of trunking the incoming toll calls are handled by a local operator direct doing away with the time required for the toll operator to extend the connection from her position to a local operator. I also provide means by which the toll operator may control the connection of the local operator's telephone set with the toll trunk whereby she may immediately inform the local operator that a toll connection is desired. At the same time means is provided for designating to the local operator the trunk over which the toll connection is being extended and for causing a busy lamp to be lighted upon the toll operator's board to show that this trunk is being used and that it is not accessible to her for extending a connection back to the originating toll operator's board. There are other features of my invention and these will be more particularly referred to in the following specification and the appended claims.

Referring more in detail to my invention as illustrated in the accompanying drawings, in Figure 1, I show a calling substation A, an operator's link circuit B for connecting to the line of the calling subscriber for extending a connection either to a local subscriber or to the toll trunk circuit D. The outgoing end of the toll trunk circuit D terminates upon the local operator's board or upon a toll operator's board in a trunk jack TJ. In the case in which the trunk circuit D terminates upon a toll operator's board, an operator's trunk circuit (not shown) is used by the local operator for extending the connection from the calling line to the toll operator's board. The toll operator then extends the connection through the trunk jack TJ to the trunk circuit D. The opposite end of the trunk circuit D terminates upon a distant local operator's board in a trunk calling plug TCP and upon the toll operator's board in a jack J^4. The local operator connects either direct to the called subscriber's line through the medium of the multiple jack J^1 (Fig. 2) or connects through the medium of a trunk jack TJ^1 to an automatic switch F (Fig. 2), that is then operated to extend the call to the called subscriber's line.

The calling substation A is of a well-known common battery type terminating

at the exchange in a line circuit L comprising a line relay LR, a cut-off relay CO, multiple jacks J and a line signal S.

The local operator's cord circuit B comprises an answering plug AP and a calling plug CP connected by the heavily marked conductors. At the answering end of the cord circuit B, I provide answering tip and sleeve supervisory relays AT and AS, the two relays controlling a supervisory signal SS. At the calling end I provide calling tip and sleeve supervisory relays CT and CS, the two relays controlling a supervisory signal SS^1. A listening key LK is shown which when moved to its alternate position connects an operator's set O to the cord conductors and a ringing key RK is provided which when actuated connects a ringing generator GE to the strands of the calling plug CP. The calling plug CP may be inserted into the multiple jacks of a called line or if a call be for a subscriber at a distant exchange, the said plug CP may be used to connect to the outgoing end of a toll circuit C.

The outgoing end of the toll circuit C terminates in a trunk jack TJ and an orderwire key OW is provided which when moved to its alternate position brings about circuit changes in the trunk circuit D, as will be hereinafter more fully described. A drop signal DS is provided for denoting incoming calls and a relay CO^1 and a supervisory signal SS^2 for supervisory purposes. A repeating coil RC is shown comprising the windings 1, 2, 3, 4, a condenser K^1 being interposed between the windings 1 and 2. The trunk conductors 5, 6 lead to a test panel at the distant exchange and terminate in a jack JA. A patching cord PC is shown which connects the jack JA through the jack JA^1 to the conductors 5^1 and 6^1 which lead therefrom to the trunk circuit D and terminate in windings 7, 8, of a repeating coil RC^1.

The repeating coil RC^1 of the trunk circuit D comprises the windings 7, 8, 9 and 10, said trunk circuit D terminating in a trunk calling plug TCP upon a local operator's board. A trunk jack J^4, which terminates upon a toll operator's board, is connected through the medium of the jacks JA^3 and JA^2 and patching cord PC^1 to the trunk circuit D. An operating relay OR is provided which is operated upon the depression of the key OW, to close a circuit through the operator's connecting relay CN. The said relay CN upon energizing connects the operator's set O^1 to the conductors of the trunk circuit D. The relay CN also operates to close a circuit for the disconnect lamp DL. The glowing of this lamp identifies the particular trunk that is being used by the originating toll operator in extending the connection to the local operator at trunk circuit D. A busy relay BR is also provided which energizes upon the operation of the relay OR and operates to mechanically lock its armature in an attracted position. The relays OR, CN and BR restore when the orderwire key OW is released but the armature of relay BR remains in its alternate position due to it being mechanically locked, the armature remaining in its alternate position which keeps the trunk busy lamp TL of the toll circuit E glowing. A trunk sleeve relay TS is provided which is operated when the operator inserts the trunk plug TCP into the jack of a called line but when the said plug is inserted into a trunk jack leading to an idle connector switch the relay TS does not operate until the called line contacts have been seized and the side switch has assumed its second position. The relay TS, upon energizing, establishes a circuit for relay 11, which relay upon energizing closes a circuit for the cut-off relay CO^2 of the toll circuit E at the toll operator's board. A release magnet RL is provided which operates to restore the locked armature of relay BR and to close a circuit for the ringing control relay RC. The relay RC, upon energizing closes an energizing circuit for the relay 12 and the cut-off relay CO^1 of the trunk C lighting the supervisory signal SS^2 notifying the local operator at cord circuit B that the connection has been extended to the called subscriber. The local operator at B is provided with a ringing key RK which when actuated connects the ringing generator G to the trunk circuit D to operate the ringing control relay RC. The operation of relay RC closes a circuit for the disconnect magnet DR and ringing relay RI, the said relay RI connects ringing current from the proper frequency generator GE^1, GE^2, GE^3 or GE^4 due to the depression of the ringing key plunger of the ringing key RK^1 to the line of the called subscriber. A trunk tip relay TT is provided which is operated when the called subscriber answers and brings about certain circuit changes in the trunk circuit D, as will be more fully hereinafter described. A test relay TR and a normally energized relay 15 are provided for testing the idle or busy condition of a called line. I show a calling device CD which may be connected to the tip conductor of the trunk circuit D upon the operation of the connecting key CK and is used for controlling an automatic connector switch F as illustrated in Fig. 2 when connection is to be extended to an automatic exchange to call a subscriber whose telephone terminates at said automatic exchange. The calling device is illustrated diagrammatically but the dial used in the system illustrated is adapted to transmit a plurality of impulses, say from 1 to 50.

The toll trunk circuit E terminates in a

jack J^4 as hereinbefore mentioned. Associated with the jack J^4 is a drop DS^1, a cut-off relay CO^2 and a supervisory lamp TL. Conductors 203 and 204 connect the trunk conductors of circuit D to the jack JA^2 located at the test panel and a patching cord PC^2 connects the jack JA^2 with a jack JA^3 and the conductors 205 and 206 connect the jack JA^3 to the trunk jack J^4. If the patching cord PC and PC^1 be withdrawn from the connected jacks JA, JA^1 and JA^2, JA^3, direct connection is established between one exchange and another by direct toll line without going through the auxiliary apparatus at the local operator's board.

In Fig. 2 I show a called common battery substation G terminating in a line circuit L^1 comprising the usual line relay LR^1, cut-off relay CO^3, multiple jacks J^1 and line signal S^1. The connector swing F is of the well-known type and terminates at one end in a trunk TJ^1 before a trunk operator and at its other end at the automatic exchange in wipers 16, 17 and 18. The subscriber's lines terminate in back contacts 19, 20 and 21 accessible to the wipers 16, 17 and 18 of connector switch F. The connector switch F as shown is preferably a one-motion switch, that is it has rotary motion only, the said switch being provided with the usual switch shaft, (not shown) which carries the wipers 16, 17, and 18. I also show the side switches *a*, *b*, *c*, and *d*, which assume their second position when contacts of the called line have been seized by the wipers of connector switch F. A primary relay PR and primary magnet PM supply motor power to step wipers 16, 17 and 18 over the bank contacts 19, 20, 21 into engagement with the contacts of the called line in response to the impulses which are transmitted from the calling device CD. A side switch relay SW is provided to control the said side switch wipers in a well-known manner. A release magnet RM and a side switch release magnet SM are also provided which control the release of the wipers 16, 17, 18 of connector switch and also the said side switches *a*, *b*, *c*, and *d*. A busy back tone BB is provided which operates when a busy line is encountered to notify the calling subscriber and also the trunk operator, of the busy condition of the called line. Off normal contacts ON are also associated with the connector switch F and assume their alternate position upon the first step of the wipers 16, 17 and 18 off normal. I show a called automatic substation H provided with the usual apparatus also including a calling device CD^1. Substation H terminates in automatic equipment I, which includes a line relay LR^3 and a cut-off relay CO^4.

Having described in general the apparatus embodying my invention, I will now describe in detail the operation of my system as illustrated.

Assuming that the subscriber at substation A wishes to initiate a call, the removal of the receiver thereat closes an energizing circuit for the line relay LR of line circuit L, the said relay operating brings about the lighting of the line signal S. The operator of the cord circuit B noting the lighted signal S inserts the answering plug AP into the jack J of the calling line and operates the listening key LK to connect her operator's set O to the cord conductors. The insertion of the answering plug AP into the jack J establishes a series energizing circuit for the answering sleeve supervisory relay AS and the cut-off relay CO. The energization of the said relay CO opens the circuit of relay LR bringing about the effacement of the signal S. The answering tip supervisory relay AT also operates from battery through relay AS through the now closed contacts of the relay CO, through the substation and back through the winding of said relay AT to ground. The operation of the two supervisory relays AT and AS prevents the premature lighting of the supervisory signal SS. The operator having connected her operator's set O to the cord conductors now inquires the wants of the calling subscriber, and assuming that it is the subscriber at the common battery substation G, which subscriber is located at a distant exchange, the operator now inserts the calling plug CP in an idle jack TJ of the toll circuit C and depresses the orderwire key OW to connect a local operator's set at the distant exchange to the conductors of the trunk circuit D, after which she operates ringing key RK to connect the ringing generator GE to bring about circuit changes in the trunk circuit D which will be more fully described in the ensuing specification. The operator at link circuit B instead of connecting direct to the trunk jack TJ, may connect to a trunk extending to a toll operator's board, the toll operator would then extend the connection to the trunk circuit D. For illustrative purposes, I have shown the connection extending direct from a local operator's circuit to the toll trunk circuit. The insertion of the plug into the trunk jack TJ closes a circuit for the relay CS from battery through the winding of relay CS, sleeve contacts of the plug and jack through the impedance coil IC to ground. The relay CS operating brings about the closing of alternate contact 200 to close the continuity of the tip conductor of link circuit B. The closing of the alternate contact 22 of the orderwire key OW establishes an energizing circuit for the relay OR of the trunk circuit D at the distant local operator's board, from battery through the resistance R, alternate contact

22 of the key OW, conductor 23 to the point 24 between windings 3 and 4 of the repeating coil RC, from this point through windings 3, 4 over both trunk conductors 5 and 6 in parallel through windings 7, 8 to the repeating coil RC^1, through normal contacts 25 and 26 of relay RL through the winding of relay OR to ground. Relay OR, upon energizing, closes its contact 28 closing an energizing circuit for the relay CN from battery through the winding of said relay CN, conductor 29 to ground at alternate contact 28 of relay OR. The closure of alternate contacts 30 and 31 of relay CN connects the trunk operator's set O^1 to the trunk conductors. The operator at the outgoing end of the trunk now informs the local operator at the trunk circuit D the connection desired. The closure of alternate contact 28 of relay OR also establishes an energizing circuit for relay BR from battery through the winding of relay BR, conductor 29, to ground at alternate contact 28 of the relay OR. The closure of alternate contact 32 of relay BR closes a circuit for the trunk busy lamp TL, traced from battery through the alternate contact 32 of relay BR, conductor 33, through the busy lamp TL to ground causing the said lamp to glow, thus notifying the toll operator associated with the toll circuit E that the trunk D is in use. The closure of alternate contact 34 of relay CN establishes a circuit for the disconnect lamp DL of the trunk D, traced from battery through the said lamp, conductor 35, normal contact 36 of relay 12 to ground at alternate contact 34 of relay CN, lighting the said lamp, identifying the particular trunk that is being used by the trunk operator for completing the connection. The local operator at the incoming end of the trunk now tests the wanted line as to its idle or busy condition in the usual manner, and if the wanted line is busy, the sleeve of the multiple jack of the wanted line will be of a potential above that of ground, bringing about the operation of relay TR over a circuit traced from battery at the sleeve of the busy jack through the tip of the plug TCP, normal contact 37 of relay RI, normal contact 38 of relay TS, normal contact 39 of the dial connecting key CK and through the winding of relay TR to ground. The closure of alternate contact 40 of relay TR places ground from the normal contact 41 of relay TS through the alternate contact 40 of relay TR, the alternate contact 42 of relay 15 (which is normally held energized through contacts 40 and 41 of relay TR and TS to ground) test conductor 43 to the tertiary winding of the operator's induction coil to battery, producing the usual click in the operator's head receiver. When testing an idle line the relay TR remains normal due to the jack associated with the idle line being at a ground potential and no click is received.

Assuming that the line being called is idle, the operator now inserts the trunk calling plug TCP into the multiple jack J^1 of the called line and depresses one of the plungers of the ringing key RK to select the proper generator frequency to ring the call bell of the subscriber at the called substation G.

The local operator having released the orderwire key OW after repeating the wanted number to the trunk operator brings about the restoration of the relay OR by opening its circuit at connector 22 of the key OW. The relay OR restoring to normal brings about the deënergization of relays CN and BR, the relay CN restoring again opens its contacts 30 and 31 disconnecting the operator's set O^1, the relay BR although it has its energizing circuit interrupted does not assume its normal position due to the said contact 32 being mechanically locked in its alternate position. The said contact 32 remaining closed keeps the trunk busy lamp TL lighted indicating the busy condition of its associated trunk circuit. The insertion of the plug TCP into the jack J^1 of the wanted line establishes a series energizing circuit for the cut-off relay CO^3 of line circuit L^1 and the relay TS of trunk circuit D, traced from battery through the upper winding of relay TS, sleeve contacts of the connected plug and jack through the winding of the relay CO^3 to ground. The relay TS upon energizing closes alternate contact 41 thereby establishing an energizing circuit for relay 11, traced from battery through the windings of the relay 11, the make before break contact 44 and conductor 45 to ground at alternate contact 41. Relay 11, upon energizing closes its alternate contact 46 thereby establishing an energizing circuit for the cut-off relay CO^2 of the toll circuit E. The circuit for cut-off relay CO^2 extending from battery through the winding of the relay CO^2 and over conductor 47, to ground at alternate contact 46 of relay 11. Relay CO^2 upon energizing disconnects drop DS^1 and closes a second circuit for the lamp TL. The closure of the alternate contact 41 of the relay TS also establishes an energizing circuit for relay RL, traced from battery through the winding of the relay RL, conductors 48, 49 and normal contact 50 of relay TT to ground at alternate contact 41. The relay RL, upon energizing brings about the restoration of the spring 32 of the relay BR due to its mechanical relation with the armature of relay BR, opening the initial circuit of the lamp TL, but a substitute circuit for the said lamp TL was previously closed at alternate contact 51 of relay CO^3. The relay RL, upon energizing, removes the

short circuit about the ringing control relay RC due to the normal contacts 25 and 26 assuming their alternate position while the closing of alternate contacts 25 and 26 establishes a series circuit for the relay 12 of the trunk D and cut-off relay CO^1 of the toll circuit C, traced from battery through both windings of the relay 12 in parallel, alternate contacts 25, 26, windings 7 and 8 of repeating coil RC^1, trunk conductors 5 and 6, to point 24, then over conductor 23, through normal contact 22 of the key OW, alternate contact 53 of the trunk jack TJ and through the winding of the relay CO^1 to ground. The closing of alternate contact 54 of relay CO^1 closes a circuit for the lamp SS^2, traced from battery through the lamp SS^2 to the alternate contact 54 of relay CO^1 to ground. The lighting of the said lamp SS^2 notifies the operator at the outgoing end of the trunk circuit D that the call has been extended to the called subscriber and that the subscriber may now be rung. The operator at the cord circuit B now throws the ringing key RK to connect the generator GE across the trunk conductors thereby causing the operation of the relay RC over a circuit traced from the ungrounded pole of the generator GE, alternate contact 55 of the key RK, the tip contacts of the connected plug and jack, winding 1 of relay RC, condenser K^1, winding 2 of the repeating coil RC, sleeve contacts of the connected plug and jack to battery and ground through alternate contact 57 of the key RK. The ringing current is repeated into the windings 3, 4 of repeating coil RC, thence over conductors 5 and 6 and windings 7 and 8 of the repeating coil RC^1, causing relay RC to be energized. Relay RC, upon energizing, closes its alternate contact 58 bringing about the energization of the relays DR and RI. The circuit for relay DR extends from battery through the winding of relay DR, alternate contact 59 of the relay 11, conductor 60, alternate contact 58 of relay RC and over conductor 61 to ground at alternate contact 62 of the relay 12. The relay 11 is held energized due to the make before break contact 44 of relay DR over a circuit traced from battery through the winding of the relay 11, the make-before-break contacts 44 of relay DR, conductor 63, conductor 60, alternate contact 58 of relay RC and conductor 61 to ground at alternate contact 62 of relay 12. Relay RI is also energized at the same time over a circuit traced from battery through the winding of the relay RI, conductor 60, alternate contact 58 of relay RC and conductor 61 to ground at alternate contact 62 of relay 12. Upon the closure of alternate contact 37 of relay RI, ringing lead 64 is connected to the tip side of the trunk circuit D which connects the proper generator frequency to the called line according to the button operated upon the party line ringing key RK^1. The ringing circuit of the called line extends from the connected generator GE^1, which we will assume is the generator selected over ringing conductor 64, alternate contact 37, tip contacts of the connected plug and jack, through condenser and call bell of the called substation back through the sleeve contacts of the jack and plug, through alternate contact 65 of relay RI to battery and ground. The operator at the cord circuit B controls the ringing of the called subscriber and each time the key RK is thrown circuit changes are brought about as above described to ring the call bell of the called subscriber. Relay DR operating opens its normal contacts 66 and 67 interrupting the trunk conductors to prevent interference from the repeated ring. Ground from alternate contact 62 over conductor 61, through alternate contact 58, over conductor 60 through the now closed contact 68 of relay 15 through the lower winding of relay TS to battery, prevents the relay TS from being deënergized during the ringing period.

Upon the removal of the receiver at the called substation G, the circuit for relay TT is established, traced from battery through the upper winding of the relay TS, sleeve contacts of the connected plug and jack, closed contacts of the switch-hook, back through the tip contacts of the connected plug and jack, normal contact 37 of relay RI, alternate contact 38 of relay TS and through the winding of relay TT to ground. The opening of normal contact 50 of relay TT upon its energization, opens the circuit for the relay RL and also opens the circuit of lamp DL at a second point. The relay RL upon deënergizing, opens the energizing circuit of the relay 12 at normal contacts 25 and 26. The restoration of the relay RL also allows the cut-off relay CO^1 of the toll circuit C to restore opening its alternate contact 54 effacing the signal SS^2, thus notifying the operator at cord circuit B that the called subscriber has answered. The calling subscriber at the substation A and called subscriber at substation G may now carry on conversation over the heavily marked conductors.

Assuming now that the subscribers have finished conversation, the replacement of the receiver at called substation G brings about the restoration of relay TT. The said relay TT, upon deënergizing, closes its normal contact 50 closing the circuit of relay RL, which again energizes to close a series energizing circuit for relay 12 and the cut-off relay CO^1. The said relay CO^1, again energizing, closes its alternate contact 54 to light the signal SS^2. The lighted signal SS^2 notifies the operator that the called subscriber

has replaced his receiver and she now withdraws the plug CP from the trunk jack TJ. The calling subscriber having replaced his receiver opens the energizing circuit for relay AT, which relay restores to normal and brings about the lighting of supervisory signal SS. The operator noting the lighted signal withdraws plug AP from jack J. The withdrawal of the plug CP from the jack TJ opens the circuit for the relay 12, which relay, upon its restoration closes a circuit for the disconnect lamp DL. The circuit for the lamp DL extends from battery through the said lamp, conductor 35, normal contact 36 of relay 12, conductor 70, normal contact 34 of relay CN, conductor 49, and normal contact 50 of relay TT to ground at alternate contact 42 of relay TS. The lighting of the lamp DL notifies the operator of the trunk circuit D that the subscribers have finished conversation and that the local operator has withdrawn the plug from the trunk jack TJ. She now removes the trunk plug TCP from the jack J^1 opening the circuit of the relay TS, which relay, upon its restoration opens the circuit of relay RL. The opening of the alternate contact 41 of relay TS also effaces the disconnect signal DL. The apparatus of the cord circuit B and trunk circuit D are now at normal and are available for establishing other connections.

Assuming now that the subscriber at the calling substation A, wishes to converse with the subscriber H whose telephone terminates at an automatic exchange, the operation of this connection is the same up to the time that the operator of the trunk circuit D inserts the plug TCP into the trunk jack TJ^1 connected to an idle connector switch as F at the automatic exchange. The operator first tests the trunk circuit which leads to a connector as F, in the manner as above described, and assuming that the trunk tested, leads to an idle connector, the operator then inserts the plug TCP into the trunk jack TJ^1 and depresses one of the key plungers of the ringing key to select the proper generator frequency to ring the call bell at the called substation. The insertion of the plug into the trunk jack closes a series energizing circuit for the relay TR of the trunk D and primary relay PR of the connector switch F, traced from battery through the winding of the said relay PR, contact 73, wiper 74 of the side switch *b*, tip contacts of the connected plug and jack, normal contact 37, normal contact 38, conductor 75, normal contact 39 of the dial connecting key CK through the winding of the relay TR to ground. Relay TR, upon energizing opens its contact 40, thereby opening the circuit of the normally energized relay 15 allowing the said relay to deënergize. The said relay 15, upon deënergizing, closes its normal contact 42 thereby establishing a circuit for the disconnect lamp DL, traced from battery through the said lamp, normal contact 42, conductor 76, alternate contact 40 of relay TR, and conductor 77 to ground at normal contact 41. Assuming that the called subscriber's number is 38, the operator now presses the dial connecting key DK to connect the calling device CD to the tip conductor of the line and then operates the calling device in a well-known manner to transmit 38 impulses to operate the connector switch F to select the contacts of the called line and the impulses transmitted due to the closing and opening of contact 72 of the calling device CD are transmitted from battery through the winding of the primary relay PR of conductor switch F, contact 73, wiper 74 of side switch *b*, tip contacts of the connected plug and jack, normal contact 37, normal contact 38, alternate contact 39 of key DK, to ground at alternate contact 72.

Upon the first energization of the relay PR, an energizing circuit for the slow acting relay 78 is established extending from battery through the winding of relay 78 to ground at alternate contact 79 of relay PR. The closing of alternate contact 80 of relay 78 establishes an energizing circuit for the relays 81, 82, the circuit for relay 81 being traced from battery through the winding of relay 81, conductor 83 to ground at alternate contact 80, the circuit for relay 82 being traced from battery through the winding of the said relay conductor 84, side switch wiper 85, contact 86 to ground at alternate contact 80 of relay 78. Upon the first deënergization of relay PR, an energizing circuit for primary magnet PM is established from battery through the winding of magnet PM, conductor 87, alternate contact 88 of relay 78 to ground at normal contact 79 of relay PR. Relay 78 being slow to release its armature, its contact 81 is held in its alternate position during the transmission of impulses to the primary magnet PM. The impulses from the calling device CD as before described, cause the primary relay PR to energize and deënergize due to the closing and opening of contact 72 of the dial CD. The said magnet PM is likewise energized and deënergized due to the opening and closing of contact 79 of relay PR, the said magnet PM stepping wipers 16, 17 and 18 of the connector switch F into engagement with contacts 19, 20 and 21 of the called line. The relay 78 as before described, being slow acting, is not affected by the rapid interruptions of the relay PR and therefore the relays 81 and 82 remain energized during the transmission of impulses. Upon the first step of the wipers off normal, the off-normal contacts ON assume their alternate position. The impulses having ceased the relay PR remains de-

nergized thereby opening the energizing circuit for the relay 78, said relay restoring and opening the circuits for relays 81 and 82 at contact 80. The relay 78, upon de-energizing closes a circuit for side switch magnet SW from battery through the winding of said relay SW, conductor 90, alternate contact 91 of the off-normal contacts ON, contact 92 and wiper 93 of the side switch *a* to ground at normal contact 94 of relay 78. Upon the energization of the magnet SW, the side switch wipers 74, 85, 93 and 95 are stepped into their second position into engagement with contacts 97, 99, 96 and 98. When the side switch wiper 93 leaves its contact 92 and engages contact 96, the circuit for the magnet SW is opened, the said magnet deënergizing permits side switches *a*, *b*, *c*, and *d* to remain in their second position. As soon as the side switches have assumed their second position a series circuit for the relay 100 and the relay TS of the trunk circuit D is established, said series circuit being traced from ground through upper winding of relay 100, conductor 101, contact 98, wiper 95 of side switch *c*, sleeve contacts of the connected plug and jack, conductor 102, through the upper winding or relay TS to battery. The closing of alternate contact 41 of relay TS brings about the operation of the relay RL, which relay upon energizing opens contacts 25 and 26 removing the short circuit about relay RC. The closing of alternate contacts 25 and 26 closes the series energizing circuit for relay 12 and cut-off relay CO^1 at the toll circuit C. The energization of the said cut-off relay CO^1 brings about the lighting of the signal SS^2, said signal notifying the operator at the cord circuit B that the call has been extended to the called substation. The local operator now throws her ringing key RK and brings about the energization of the relay RC which relay, upon energizing closes a circuit for the relays DI and RI as already described. The energization of the relay RI connects ringing lead 64 to the tip of the trunk circuit D. The path for the ringing current extends from the ungrounded pole of the generator GE^1 through closed contacts of the plunger of the ringing key RK^1, ringing lead 64, alternate contact 37 of relay RI, tip contacts of the connected plug and jack, wiper 74, contact 97, normal contact 104 of relay 81, wiper 17, contact 20, condenser and call bell at the substation G, contact 21, wiper 18, normal contact 105, to contact point 105 where the current divides, part of it going through normal contact 107 of relay 108, through winding of the relay 109 to battery, part extending through the condenser K^5, contact 98, through the upper winding of the relay 100 to ground and part extending through the wiper 95 of the side switch *c*, sleeve contacts of the connected plug and jack, conductor 110 and through the alternate contact 65 to battery and ground. Each time the operator at the local cord circuit B operates the ringing key RK, the relay RC is energized bringing about circuit changes as above described, to energize relay RI to connect ringing current to ring the call bell of the called subscriber.

When the subscriber at called substation H answers in response to his call bell, the tip trunk relay TT of the trunk circuit D, and relay 109 of connector switch F are energized in series, the said energizing circuit being traced from ground through the winding of said relay TT, of trunk circuit D, alternate contact 38 of relay TS, normal contact 37 of relay RI, tip contact of the connected plug and jack, wiper 74, contact 97, contact 111 of relay 109, normal contact 104 of relay 81, wiper 17, contact 20 through the now closed contacts of the switch hook through the substation H contact 31, contact 18, normal contact 85 of relay 81, normal contact 107 through winding of relay 109 to battery. Upon the energization of the relay TT of the trunk circuit D, the energizing circuit for the relay RL is interrupted at the normal contact 50 of the said relay TT. The relay RL restoring opens the series energizing circuit for the relay 12 and the relay CO^1, which latter relay, upon restoring, opens the circuit of the supervisory signal SS^2 at contact 54 effacing the said signal and notifying the operator at cord circuit B that the called subscriber has answered. Upon the energization of the relay 109, a circuit for relay 108 is closed, traced from battery through the lower winding of relay 108, alternate contact 112 of relay 109, normal contact 105 of relay 81, wiper 18 of contact 21 through the closed contacts of switch-hook H, contact 20, wiper 17, normal contact 104 of relay 81, the alternate contact 113 of relay 109 through the upper winding of the relay 108, to ground. The relay 108 furnishes battery for talking purposes to the called subscriber's telephone. The relay 108, upon energizing, closes a substitute circuit for the relay 109, said substitute circuit being traced from battery through the winding of said relay 89, alternate contact 107 and through the winding of relay 114 to ground. The relay 114 upon energizing, opens the release circuit for the connector switch F at a second point and prevents the connector switch from releasing until the called subscriber has replaced his receiver upon the switch-hook and the operator has removed the plug from the trunk jack which leads to the connector switch F. The energization of the relay 108 also closes a substitute circuit for the relay TT of the trunk circuit D extending from ground through the winding

of relay TT, alternate contact 38, normal contact 37, tip contacts of the connected plug and jack, wiper 74, contact 97, conductor 115, normal contact 116 of relay 108 and through the lower winding of relay 100 to battery. The subscribers are now in conversational circuit. The said talking circuit may be traced over the heavily marked conductors.

Assuming now that the subscribers have finished conversation, they replace their receivers upon their respective switchhooks. The replacing of the receiver at the called substation H opens the energizing circuit for relay 108, which relay restores and opens the energizing circuit for relays 114 and 109 at contacts 107 of relay 108. The tip relay TT of the trunk circuit D is also deënergized due to the replacing of the receiver at the called substation H. The normal contact 50 of relay TT is again closed establishing a circuit for the relay RL which again closes its alternate contacts 25 and 26 to establish the series energizing circuit for relay 12 and cut-off relay CO^1. The relay CO^1, upon energizing, again lights supervisory signal SS^2 to notify the operator at cord circuit B that the subscriber at the called substation has replaced his receiver. The circuit for the release magnet RM and the said switch release magnet SM is not as yet closed due to the fact that the relay 100 is still held energized from battery through the trunk sleeve relay TS at the trunk circuit D. The operator at the cord circuit B noting the lighted signal SS^2 removes plug CP from trunk jack TJ opening the series circuit of the cut-off relay CO^1 and relay 12 of trunk circuit D. Relay 12 upon deënergizing, closes a circuit for the disconnect lamp DL said circuit being traced from battery through the said lamp, conductor 35, normal contact 36, conductor 70, normal contact 34, normal contact 50 through alternate contact 41 to ground. The operator at trunk circuit D noting the lighted lamp DL removes the trunk calling plug TCP from the trunk jack TJ^1. The removal of the plug from the said trunk jack opens the circuit of relay 100, which relay deënergizes and closes the circuits of the release magnet RM and side switch release magnet SM. The circuit of release magnet RM extends from battery through the winding of said magnet RM, conductor 316, alternate contact 117 of off-normal contacts ON, normal contact 118 of relay 82, normal contact 119 of relay 114 to ground at normal contact 120 of relay 100. The circuit for magnet SM extends from battery through the winding of the said magnet, conductor 116 following the same path as that of magnet RM. The magnet RM, upon energizing, releases the wipers 16, 17, and 18 allowing them to restore to normal and the magnet SM, upon energizing, releases the side switch to normal or first position. The off-normal contacts ON are also restored to normal thus opening the circuit of magnet RM and side switch magnet SM. The two magnets operate to restore to normal the apparatus of connector F. Upon the removal of the jack TCP from the trunk jack TJ^1, the circuit for the relay TS of trunk circuit D is opened bringing about the deënergization of the relays RL and 11. The apparatus of the trunk circuit D is now at normal and is available for establishing other connections. The operator at the cord circuit B receives the disconnect signal from the calling subscriber A in a well-known manner, whereupon she removes the answering plug AP from jack J thereby restoring the apparatus of the cord circuit B to normal.

Now, assuming that the called automatic subscriber's line is busy, the operation of the circuit is the same as previously described up to and including the time that the side switch is stepped to second position to engage the contacts 96, 97, 98 and 99. The called subscriber's line being busy, a ground will be encountered by the private wiper 16 when it engages the private contact 19, the said ground being furnished by another switch already in connection therewith. The relay PR deënergizes as before after the group of impulses have been transmitted and opens the contact 79 bringing about the restoration of the relay 78. The side switch relay SW is energized as before through the normal contact 94 of relay 78 to ground, the relay SW stepping the side switches *a*, *b*, *c* and *d* into their second or final position. The side switch wiper 85 having stepped to its second or final position opens the energizing circuit for the slow acting relay 82. The relay 81 has its circuit interrupted due to the opening of the contact 80 of relay 78. The relay 81 also being slow acting, a substitute circuit for the said relay is established before it restores. The said circuit extends from battery through the winding of the relay 81, conductor 83, normal contact 80 of relay 78, conductor 130, alternate contact 131 of said relay 81, conductor 132, conductor 133 to the ground encountered by the private wiper 16. The side switch relay SW is therefore held energized, the circuit being traced from battery through the winding of the said relay, conductor 90, alternate contact 91, and alternate contact 135 to ground at normal contact 136 of relay 82. The relay 100 is energized as soon as the side switch has moved to its second position, the circuit extending from ground through the upper winding of the relay 100, contact 98, wiper 95 of side switch, sleeve contacts of the connected plug and jack through the

upper winding of the relay TS of the trunk circuit D to battery. Upon energization of the relay 100 the tone generator TO is started, its circuit being traced from battery through the tone generator TO, alternate contact 137 to ground at alternate contact 120 of relay 100. The busy back machine is now connected to the trunk circuit D over a circuit traced from battery through the busy back BB, alternate contact 138, of relay SW, alternate contact 104 of relay 81, make-before-break contact 111 of relay 109, contact 97, wiper 74, tip contacts of the connected plug and jack, normal contact 37 of relay RI, alternate contact 38 of relay TS through the winding of relay TT to ground. The busy signal is also transmitted to the calling subscriber notifying him that the called line is busy. The relay TT of the trunk circuit D is thus intermittenly operated due to the busy back machine. The intermittent operation of the relay TT causes the relay RL to energize and deënergize which in turn opens and closes the series circuit for relay 12 and cut-off relay CO^1 of the trunk circuit D and toll circuit C which brings about the flashing of the supervisory signal SS^2. The operator noting the flashing of supervisory signal SS^2 knows that the called line is busy and removes plug CP from jack TJ. This removal of the plug CP from jack TJ causes signal DL to be operated. The operator at D noting the glowing of the disconnect signal DL removes the plug TCP from the jack TJ^1 which opens the energizing circuit of relay 100 which relay upon deënergizing closes release circuit for magnet RM and side switch relay SM as above described. The two relays upon energizing, bring about the restoration of wipers 16, 17 and 18 of connector switch F and side switches *a*, *b*, *c* and *d*. The restoration of the other connected apparatus is the same as above described.

It will now be assumed that the calling subscriber at substation A desires a toll connection which necessitates the use of the toll circuit E at the toll board in the distant exchange. The operator at cord circuit B after receiving the calling subscriber's instructions in the same manner as hereinbefore described, inserts the calling plug CP into the trunk jack TJ of the toll trunk circuit B and operates the ringing key RK to bridge generator G across the tip and sleeve conductors of the cord circuit B. The bridging of the generator GE across the windings 1, 2 of the repeating coil RC causes current to be induced in the coils 3 and 4 of the repeating coil RC, which is transmitted over the trunk conductors 5 and 6 and through the coils 7 and 8 of the repeating coil RC^1, at the distant end of the trunk circuit D. The windings 7 and 8 of repeating coil RC^1 operate to induce current in the windings 9 and 10 of said repeating coil thus current is transmitted over the conductors 205 and 206 through the drop signal DS^1 located on the toll operator's board. The toll operator noting the operation of the drop DS^1 inserts the answering plug of a link circuit (not shown) into the jack J^4 connected to the toll circuit E. The insertion of the answering plug into the jack J^4 causes contacts 217 to be closed thereby closing a circuit through the cut-off relay CO^2 of toll circuit E and through the disconnect relay DR of the trunk circuit D at the local operator's board. The disconnect relay DR upon energizing, disconnects the tip and sleeve conductors of the tip calling plug TCP from the windings 9 and 10 of the repeating coil RC^1. Cut-off relay CO^2, upon energizing, disconnects the drop DS^1 from across the conductors 205 and 206 of the toll circuit E and closes a circuit through the supervisory lamp TL. The toll operator now inquires of the operator at the outgoing end of the trunk circuit D the connection desired and after receiving this information extends the connection in the direction of the called subscriber's line.

Now assuming that the toll operator at circuit E wishes to extend a connection back to a subscriber located in the first exchange, she inserts the calling end of a link circuit (not shown) into the jack J^4 and operates the ringing key of said link circuit to connect ringing current across the conductors 205 and 206 of the circuit E. The insertion of the plug into jack J^4 brings about the operation of the cut-off relay CO^2 of circuit E and the disconnect relay DR of trunk circuit D at the local operator's board in the same manner as hereinbefore described. The bridging of the ringing current generator across the conductors 205 and 206 causes the operation of the drop signal DS associated with the trunk jack TJ at the toll operator's board at the distant end of the trunk circuit. The distant toll operator inserts the answering plug of the link circuit into the trunk jack TJ and receives instructions from the toll operator of toll circuit E. She then extends the connection in the direction of the called subscriber's line.

From the foregoing it is seen that I have provided a two-way circuit extending between two toll operators' boards which has a branch extending to a local operator's board, thus forming a Y-shaped trunking circuit over which a connection may be extended in either direction from one toll board to the other and over which a connection may be extended from the one toll operator's board to a local operator's board, thus making possible rapid fire service in one direction over the trunk circuit without going through the toll operator's board at

the incoming end of the trunk circuit. When it is desired to use the toll circuit as a direct toll circuit between the toll operators' boards, the patching cords PC and PC¹ may be removed thus disconnecting the local operator's equipment and making a through toll trunk over which connection may be extended in either direction.

While I have described my invention in connection with a certain circuit arrangement, I do not wish to be limited to the same as my invention is applicable to other circuit arrangements and many changes and modifications will readily suggest themselves to those skilled in the art, therefore I do not wish to be limited to the exact arrangement as shown, but aim to cover all such changes and modifications as come within the spirit and scope of the appended claims.

Having described my invention, what I claim as new and desire to secure by United States Letters Patent, is:

1. In a telephone system, subscribers' telephone lines, a trunk circuit for extending connections from one exchange to another exchange, a link circuit for connecting one of said subscriber's lines to said trunk circuit, a trunk operator's telephone, and means controlled over the two sides of the trunk circuit in parallel for automatically connecting said operator's telephone with said trunk circuit.

2. In a telephone system the combination of a link circuit connected to a trunk circuit, a trunk operator's telephone, automatic means for connecting the trunk operator's telephone with the trunk circuit, and means controllable by the link circuit operator for operating the said automatic means, said last means comprising a circuit including the two sides of the trunk circuit in parallel.

3. In a telephone system, a trunk circuit for extending connections from one exchange to another exchange, a trunk operator's telephone, and means controlled over the two sides of the trunk circuit in parallel for automatically connecting said operator's telephone with said trunk circuit, and a supervisory signal for said trunk circuit controlled over the two sides of said trunk circuit in parallel.

4. In a telephone system, a trunk circuit for extending connections from one exchange to another exchange, a supervisory signal for said trunk circuit located at one of said exchanges and controllable over the two sides of the trunk limbs in parallel, and automatic means for operating said signal continuously or intermittently.

5. In a telephone system, a trunk circuit having its opposite ends terminating at different operator's boards, a supervisory device associated with one end of said trunk circuit, means associated with the opposite end of said trunk circuit for operating said supervisory device over the two sides of said trunk circuit in parallel, and automatic means for intermittently operating said last means to cause said supervisory device to be intermittently operated.

6. In a telephone system, an operator's link circuit, a trunk circuit adapted to be connected to said link circuit, a trunk operator's telephone for connection to said trunk circuit, means for connecting said operator's telephone to said trunk circuit, and means controllable by the link operator for operating said connecting means over the two sides of the trunk circuit in parallel.

7. In a telephone system, an operator's link circuit, a trunk circuit adapted to be connected to said link circuit, a trunk operator's telephone for connection to said trunk circuit, means for connecting said operator's telephone to said trunk circuit, and means controllable by the link operator for operating said connecting means over the two sides of the trunk circuit in parallel whereby said trunk operator's telephone is operatively connected to the link operator's telephone.

8. In a telephone system, a calling and a called subscriber's line, a trunk circuit, means for connecting said calling line to said trunk circuit, means for connecting the said trunk circuit to the called subscriber's line, a supervisory device associated with one end of said trunk circuit, and means associated with the opposite end of said trunk circuit and controllable by said called subscriber for closing an operating circuit for said supervisory device including the two sides of said trunk circuit in parallel.

9. A telephone system comprising subscribers' telephone lines, a trunk circuit for interconnecting said lines, one end of said trunk circuit appearing upon a trunking operator's board and the opposite end of said trunk circuit having parallel branches appearing upon different operators' boards, a signal for each parallel branch of said trunk circuit, and means controllable by the trunking operator for operating either of said signals independently of the other.

10. A telephone system comprising subscribers' lines, a trunk circuit for interconnecting said lines, one end of said trunk circuit terminating upon a trunking operator's board and the opposite end of said trunk circuit being divided into two parallel branches which appear upon a trunking operator's board and a local operator's board, a signal for each parallel branch of said trunk circuit, and means controlled by the said first trunking operator for operating either of said signals.

11. A telephone system comprising sub-

scribers' lines, a trunk circuit for use in interconnecting said lines, one end of said trunk circuit terminating upon a trunking operator's board and the opposite end of said trunk circuit being divided into parallel branches which appear upon different operators' boards, a signal for each of said parallel branches, means controlled by the trunking operator over the two sides of the trunk circuit in parallel for operating one of said signals, and means controlled over the two sides of the trunk circuit in series for operating the other of said signals.

12. In a telephone system, a trunk circuit terminating at one end upon a trunking operator's board and at its opposite end upon a local and upon a second trunking operator's board, a calling signal at the local operator's board, a supervisory signal at the second trunking operator's board, means controllable over the two sides of the trunk circuit in series for operating said calling signal, and means for operating said supervisory signal when said trunk circuit is taken for use.

13. In a telephone system, a calling and a called subscribers' line, a trunk circuit, means for connecting the calling subscriber's line to the trunk circuit, parallel branch circuits for the opposite end of said trunk circuit, calling signals for said parallel branches, means controlled over said trunk circuit for operating either of said calling signals independently of the other, and means for completing the connection to the called subscriber's line.

14. In a telephone system, a calling subscriber's line, a called manual and a called automatic subscriber's line, a trunk circuit, means for connecting the calling subscriber's line to said trunk circuit, and means for connecting the opposite end of said trunk circuit to either said called manual or automatic subscriber's line, a supervisory signal at one end of said trunk circuit, and means controlled over the two sides of said trunk circuit in parallel when the connection is extended to either of said called lines for operating said supervisory signal.

15. In a telephone system, the combination of a calling subscriber's line connected to a trunk circuit, a supervisory signal associated with one end of said trunk circuit, means for connecting the opposite end of said trunk circuit directly to a called manual subscriber's line or to a called automatic subscriber's line, and means for operating said supervisory signal over the two limbs of said trunk circuit in parallel.

16. In a telephone system, a trunk circuit having its one end terminating upon a trunking operator's board and its opposite end terminating upon a local operator's board, means controlled by the trunking operator over the two sides of the trunk circuit in parallel for operatively connecting the local operator's telephone to the trunk circuit, and means controlled by the local operator for extending a connection to either a manual or an automatic subscriber's line.

17. In a telephone system, a trunk circuit terminating at one end upon a trunking operator's board and having its opposite end divided into parallel branch circuits terminating upon different operators' boards, a calling signal for said trunk located upon one of said last boards, a supervisory signal for said trunk located upon another of said last boards, and means for operating said calling signal to denote a call and for operating said supervisory signal to show that said trunk is in use.

18. In a telephone system, a trunk circuit terminating at one end upon a trunk operator's board and at its opposite end upon a second trunking operator's board and upon a local operator's board, cut-off relays for said trunk, and means controlled by the operator at said first trunking board for signaling for connection over one of said branches and for operating the cut-off relay of the other of said branches.

19. A telephone system including an operator's link circuit provided with a manual connection terminal, a telephone set, and means controlled over the two sides of the circuit in parallel for connecting said telephone set to said link circuit.

20. A telephone system including subscribers' telephone lines, a link circuit for connecting said lines, a supervisory lamp for said link circuit, and automatic means controlled over the two sides of said link circuit in parallel for intermittently flashing said supervisory lamp.

21. A telephone system including a link circuit, a signal for said link circuit controllable over the two sides of said link circuit in parallel, and automatic means responsive to the connection of said link circuit to a busy called line for intermittently operating said signal.

22. A telephone system including a link circuit, a trunk circuit adapted to be connected to said link circuit, an operator's telephone for connection to said trunk circuit, and means controllable by the link circuit operator over the two sides of the trunk circuit in parallel for connecting said operator's telephone to said trunk circuit.

23. A telephone system including a calling subscriber's line and a called subscriber's line, a link circuit, means for connecting said link circuit to the calling subscriber's line, a supervisory device for said link circuit, and means associated with one end of said link circuit to operate said device over the two sides of the link circuit in parallel

when said called subscriber responds or for intermittently operating said supervisory device when said link circuit is connected to a busy called subscriber's line.

24. A telephone system including a calling subscriber's line, a link circuit for connection to said calling subscriber's line, a supervisory device for said link circuit, means for connecting the opposite end of said link circuit directly to a called manual subscriber's line or to a called automatic subscriber's line, and means controlled over either of said latter lines for operating said supervisory device over the two limbs of said link circuit in parallel.

25. A telephone system including a connecting circuit, a pair of signals individual to and associated with one end of said circuit, and means for operating one of said signals over two sides of said circuit in series and for operating the other of said signals over the two sides of said circuit in multiple.

26. A telephone system including subscribers' telephone lines, a link circuit, means for connecting said link circuit to a subscriber's telephone line, a signal, an operator's telephone, and means controlled over the two sides of said link circuit in multiple for controlling said signal or said operator's telephone.

27. A telephone system including a connecting circuit, a signal for said connecting circuit, an operator's telephone, means controlled over the two sides of the link circuit in parallel for connecting said operator's telephone thereto, and means controlled over the two sides of said circuit in parallel for operating said signal.

28. A telephone system including subscribers' telephone lines, a link circuit for use in connecting said lines terminating at its one end in an A operator's board and at its opposite end in two different B operators' boards, a signal for each of said latter branches of said circuit, and means for operating either of said signals independently of the other.

29. A telephone system including subscribers' telephone lines, a connecting circuit for interconnecting said lines, said connecting circuit terminating at its one end in an A operator's board and at its opposite end in a pair of B operators' boards, cut-off relays for said circuits at each of said latter boards, and means for operating either of said cut-off relays independently of the other.

30. A telephone system including subscribers' telephone lines, a connecting circuit for interconnecting said lines, said connecting circuit terminating at its one end in two branch circuits, signals for said branch circuits, and means controlled over the said connecting circuit for operating either of said lamp signals independently of the other.

Signed by me at Chicago in the county of Cook and State of Illinois, in the presence of two witnesses.

ORMOND F. CASSADAY.

Witnesses:
G. A. YANOCKOWSKI,
B. O'BRIEN.