G. DEAKIN.

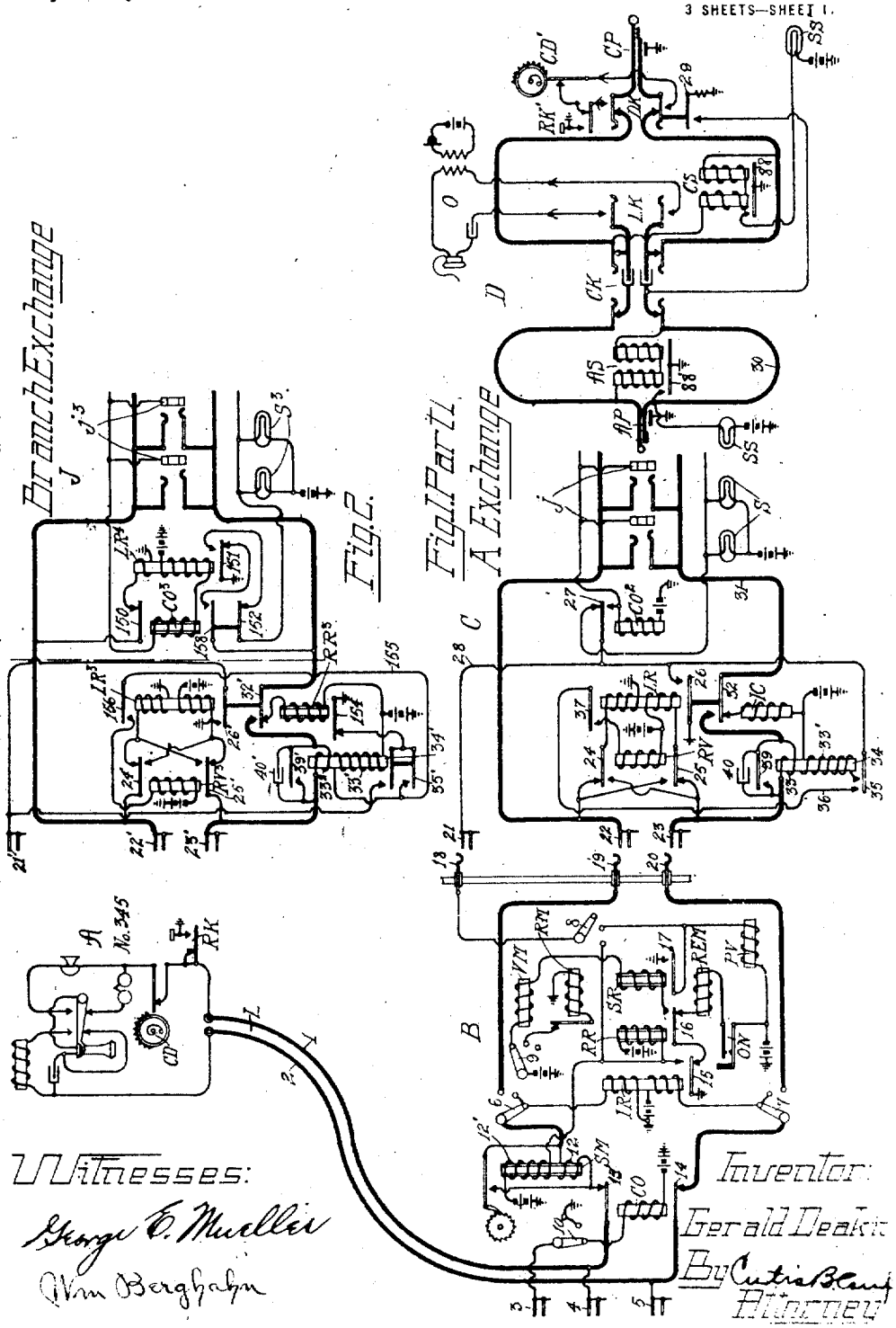
TELEPHONE SYSTEM.

APPLICATION FILED MAY 13, 1912.

1,251,350.

Patented Dec. 25, 1917.

3 SHEETS—SHEET 1.



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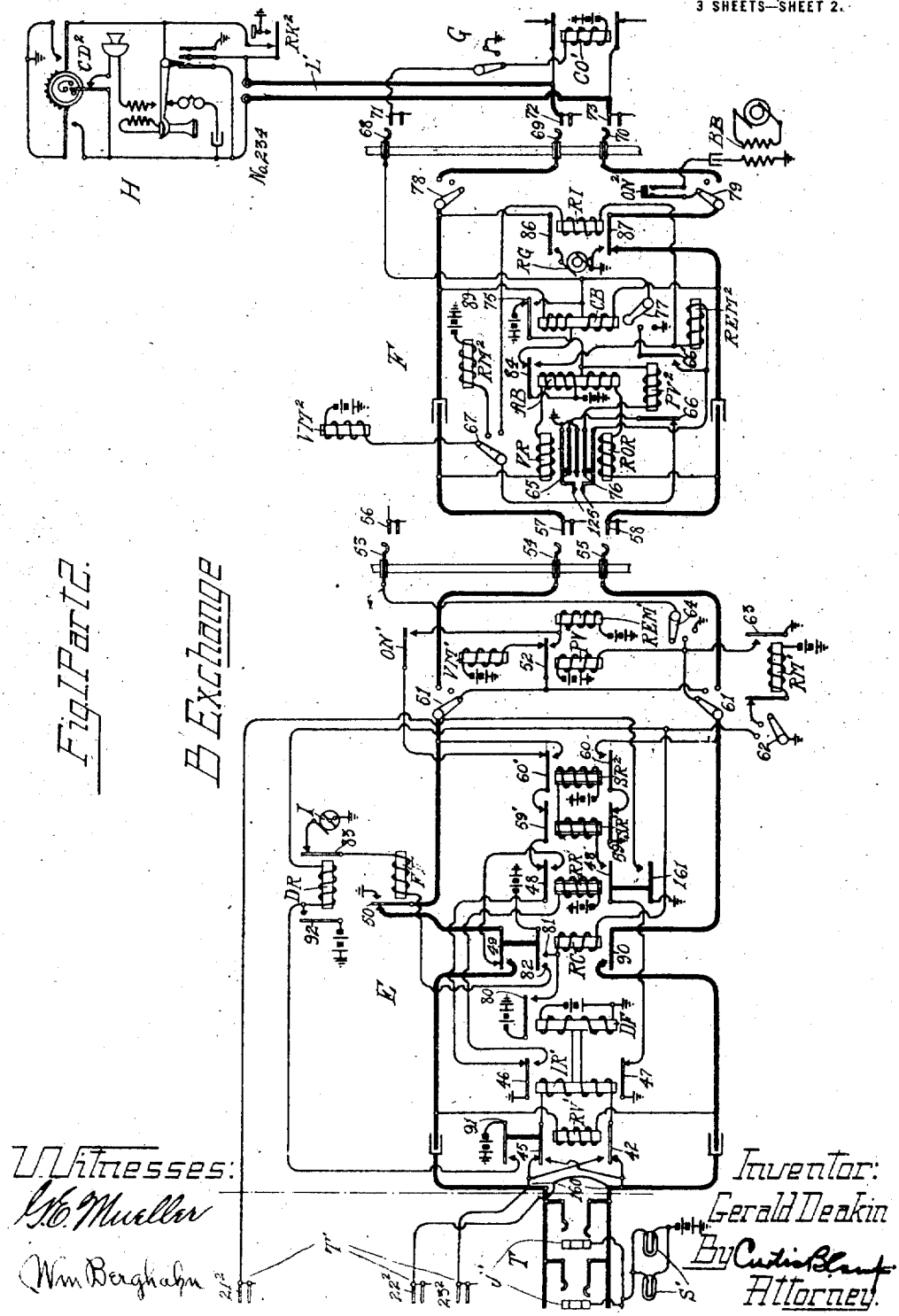

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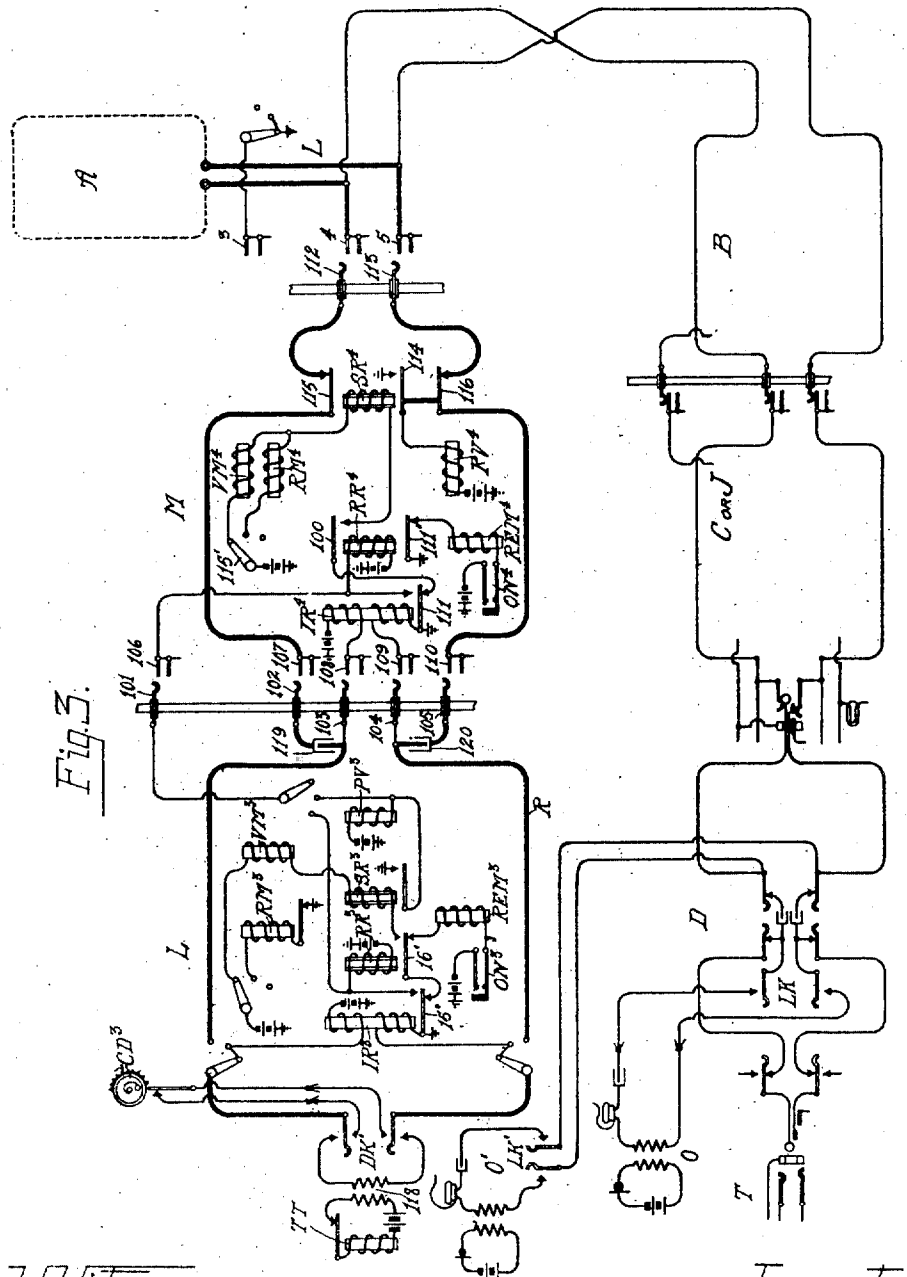

Fig. 3.

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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

1,251,350. Specification of Letters Patent. Patented Dec. 25, 1917.

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To all whom it may concern:

Be it known that I, GERALD DEAKIN, a citizen of the United States, residing at San Francisco, county of San Francisco, State of California, have invented certain new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to telephone systems and more particularly to automatic telephone systems or systems in which automatic switches are used for interchangeably connecting calling substations with trunk circuits, an object being to provide simplified and improved circuit arrangements new features of which will be pointed out more particularly in the following specification and claims.

One of the features of my invention is the provision of circuit arrangements whereby an operator may check the number of the calling substation, after being given by the subscriber thereat in making a call. For instance in automatic systems wherein certain connections such as toll connections are completed by an operator who desires to know the number of the calling substation unless the operator has means for checking up or proving that the number given is correct the subscriber might give the wrong number. Therefore, I provide means whereby the operator may complete the connection and also has means to connect directly to the terminals of the line of the telephone number given and then by means of a signal determine whether the line number given by the subscriber is or is not the correct number.

In illustrating my invention I have chosen to embody it in an automatic telephone system adapted for connection between several exchanges, and include toll circuits for interconnecting the telephone lines of the different exchanges and also a checking circuit controlled by an operator for the purpose already set forth.

In the accompanying drawings all parts are shown at normal and parts having like functions are designated by like reference characters except for the exponents.

Figure 1 of the drawings comprising parts 1 and 2 illustrates circuits for connecting a substation from a so-called two-wire exchange to a substation in a so-called three-wire exchange;

Fig. 2 illustrates a so-called two-wire trunk circuit for connecting branch exchange telephone lines with a main office toll board.

Fig. 3 illustrates an operator's checking circuit.

It is to be understood that the circuits are all shown diagrammatically and I have embodied my invention in circuits adapted for use in connection with the Strowger automatic switches although it is to be understood that my invention is not limited to systems using any particular type of switches. Referring now more particularly to Fig. 1 by placing part 2 thereof to the right of part 1, it may be readily followed from the ensuing description thereof. The circuits shown in Fig. 1 part 1 and to the left of the dotted line in part 2 are preferably associated with the A exchange while the circuits shown to the right of the dotted line of part 2 are preferably associated with the B exchange, although as will be pointed out, the switch circuits of Fig. 1 part 2 may be used in the A exchange.

Referring now more in detail to the apparatus of Fig. 1 a substation A is illustrated comprising the ordinary switch hook and receiver, transmitter, induction coil, call bell and condenser, two-wire calling device CD and ringing key RK, these all being well understood and no further description thereof being deemed necessary. A telephone line comprising a pair of line conductors 1—2 connects substation A with a first selector switch B at a central office, also terminating in terminals 3—4—5 before automatic connector switches in a well known manner.

Selector B is preferably of the well known Strowger type and comprises an impulse relay IR, a vertical magnet VM, rotary magnet RM, private relay PV, release magnet REM, side switches 6, 7, 8, 9, 10, wipers and coöperating bank contacts, and a cut-off relay CO. A slow acting secondary relay SR is provided for controlling the starting of the secondary selecting movement of the switch, and a slow acting release relay RR is adapted for controlling the release of the

switch. Both relays SR and RR are so adjusted with relation to the speed of calling device CD that they will not retract their armature responsive to impulses effected by said calling device. Off-normal switch ON is adapted to move to its alternate position upon the first primary or vertical step of the wipers, being restored upon restoration of said wipers. The service meter magnet SM is so adjusted that it will not respond to current through one of its windings only, or to current through both of its windings differentially, but will respond only to current acting cumulatively through its two windings.

Trunk circuit C includes a line relay LR which is adapted to be energized by current over the calling line upon connection made with said trunk circuit, whereby signals S are displayed to indicate that the trunk terminating in jacks *j* has been selected. These multiply connected jacks *j* and associated signals S are disposed before operators at a switchboard, in which case a jack and associated signal is placed, one for each operator's position. A reversing relay RV is adapted to reverse the current over the calling line for operating service meters and also controlling supervisory apparatus as will be more particularly described. Several other relays are included in this circuit, the functions of which will be more particularly pointed out in the description of operation.

Operator's cord circuits D are provided and include an answering supervisory relay AS and a calling supervisory relay CS these being of the polarized type. An answering plug AP and calling plug CP are connected by the heavily marked talking conductors having an interposed two-way cut-off key CK, a listening key LK, and a calling device key DK, key LK being adapted to connect the operator's set O in circuit with the link D while key DK is adapted to connect a calling device CD^1, in circuit with the calling end of the link. Two supervisory signals SS and SS^1 are provided being controlled from their respective associated ends of the link D. Relays AS and CS are of comparatively high resistance so as not to unduly shunt the voice currents.

Out-going trunk circuits T are provided for the toll operators, said circuits terminating in second selector switches E at the distant exchange, the apparatus to the left of the dotted line in part 2 being located at the A exchange while the apparatus to the right of the dotted line is preferably located at the B exchange. Trunk circuits T are multiply connected to jacks j^1 before the different operators' positions, there being a signal S^1 for each jack, these signals being preferably arranged to be operated while their associated trunk T is busy to indicate such busy condition, but so far as some of the features of my invention are concerned other means for indicating a busy trunk may be provided.

Switches E are preferably arranged as combined second selectors and repeater switches, that is the circuit arrangement E is adapted to repeat impulses transmitted from a calling station to another connected switch. Switch E comprises an impulse relay IR^1 adapted to be energized over a metallic circuit upon connection made with switch E over trunk T, a reversing relay RV^1 for reversing the battery flow over trunk circuit T, a differential relay DF for controlling the application of ringing current, an interrupter or flip-flop relay FF adapted to be initially controlled by a ringing control relay RC, a second control relay DR for stopping the application of ringing current upon response of the called substation, a slow acting release relay RR^1 and a pair of secondary relays SR^1, SR^2 which act conjointly to cause a secondary circuit change for the transmission of a secondary or rotary impulse. Relays SR^1 and SR^2 are both of the slow acting type, being so adjusted as not to retract their armatures when the circuit is interrupted by an impulse operation of relay IR^1, and relay SR^2 being adjusted slightly slower than SR^1 so that when their circuit is interrupted SR^1 retracts its armature first followed by the retraction of the armature of SR^2. A suitable number of side switches are also provided as is also the usual vertical magnet VM^1, rotary magnet RM^1, release magnet REM^1 and private magnet PV^1.

Connector switch F which is also of the Strowger type, includes a vertical relay VR, rotary relay ROR, vertical magnet VM^2, rotary magnet RM^2, release magnet REM^2, private magnet PV^2, a ringing relay RI, ringing generator RG, an answering bridging relay AB and a calling bridging relay CB together with the usual side switch arms, off-normal contacts and a busy back BB.

The subscribers' automatic switches in the B exchange are of the three-wire type and I have illustrated a so-called three-wire substation H connected by line L^1 to the first selector G at the central office, the switch being of the well known Strowger type and a further illustration thereof is deemed unnecessary although I have shown cut-off relay CO^1 and one of the side switch arms. Of course it is to be understood that so far as some of the features of my invention are concerned the subscribers' automatic apparatus in exchange B may be of other types than three-wire type.

Although I have referred to switches E and F being associated with the B exchange these switches may be used in the A exchange for use in interconnecting telephone lines

thereat and I have shown at second selector E three sets of terminals T^1 which may be terminals of first selectors B in which case trunk circuit T may be disconnected from switch E at contacts 160.

Checking system.

Fig. 3 illustrates a so-called checking circuit adapted to be controlled by an operator for checking up the telephone number given by the calling subscriber to the toll operator when making a call. For instance a subscriber desiring a toll or a long distance connection will extend connection from his line to the toll operator and then ask for a connection which we will assume is a toll connection, and the toll operator then asking for the number of the calling substation and the called substation completes the connection. It will be apparent that unless the toll operator has some means for ascertaining whether the number given is really the calling substation number or not, the calling subscriber could give the wrong number and therefore the charge would be made against the wrong substation. Therefore, I provide a checking circuit by which the toll operator who is completing the connection or some other operator, may extend a connection to the terminals of the telephone number given by the calling subscriber and connect a characteristic signal thereto which will be transmitted to the toll operator, or this other operator, if the number given is correct while if the wrong number has been given this signal will not be extended to the operator who will then know that something is wrong.

This checking system comprises preferably automatic switches of the Strowger type controlled by the checking operator or toll operator which are adapted to extend connection to the called terminals of the lines adapted to be checked in the present instance these switches being special first selectors L and connectors M. Of course other selectors may be included between switches L and M depending on the number of lines served.

First selector L comprises apparatus similar to first selector B and has an additional pair of wipers 102, 105, connected through condensers to the heavily marked conductors, while the connector switch M has the usual vertical magnet VM^4, rotary magnet RM^4, release magnet REM^4, private relay PV^4, impulse relay IR^4, secondary relay SR^4, release relay RR^4, together with side switch contacts and wipers and bank contacts. It will be noted that the connector switch has but two wipers, the conductors connected thereto extending to the extra pair of contacts in the second selector switches L whereby the connection when completed extends over the heavily marked conductor of the first selector to the checking test tone TT which may be a characteristic signal.

The circuits in Fig. 3 shown at A, B, C, D and T represent diagrammatically a connection extending from a calling substation A to trunk circuit T this being illustrated to show the manner in which the checking circuit and tone test TT are applied. In Fig. 3 I have shown an operator's telephone O^1 extending from cord circuit D, this being for the use of a checking operator when one is employed.

In general the checking system operates as follows: Assuming a subscriber at substation A has had a connection extended to the toll operator's cord circuit D and through to trunk circuit T, and assuming that the toll operator does her own checking, she operates switches L and M to connect to terminals of the telephone line whose number was given by the calling subscriber. If the calling subscriber has given the correct number, that is the number of his telephone line, upon the toll operator connecting the test tone TT by key DK^1, a characteristic test tone will be transmitted to the terminals of the line connected to and then over the connection through switches B, C, and D to the operator's telephone O whereby the operator knows that the number given is correct.

Assuming now that the calling subscriber gave an incorrect number, that is, not the number of his own telephone line, the operator will extend connection through switches L and M to the terminals of this telephone line and upon connecting the test tone TT to the terminals thereof, due to the fact that this line is not connected back to link circuit D, the operator will not receive this test tone and knows that the number given was the wrong one.

If it is desired that special checking operators be employed for performing this checking operation during busy hours or in fact at all times, a circuit may be extended from cord circuit D to such checking operator's telephone set O^1 so that this operator may do her own testing, the conversation between the operators being either over an order wire in the well known manner or they may be situated in close proximity to each other so that no order wire need be used.

Operation, Fig. 1.

Having described more in detail the apparatus of Fig. 1, an operation of the system in establishing a connection between a calling subscriber at A and a called subscriber at H will now be described.

The subscriber at A upon initiation of a call removes his receiver from its switch hook whereby a circuit for impulse relay IR is established traced from ground through the

upper winding thereof, normal contact of side switch 6, winding 12 of service meter magnet SM, normal contact 13, line conductor 1, substation A, line conductor 2, normal contact 14, normal side switch contact 7, and the lower winding of IR to battery causing the operation thereof whereby its alternate contact 15 is closed establishing an energizing circuit for release relay RR.

The subscriber at A desiring a connection which is to be made through an operator, whom we will assume is a toll operator, will operate calling device CD say to cause five operations of the impulse springs, (assuming the fifth level of contacts is reserved for such service) this resulting in five interruptions of the metallic circuit including relay IR whereby said relay operates its armature five times. Responsive to the first retraction of the armature of IR, its normal contact 15 is closed and due to the fact that relay RR is a slow relay its armature is maintained attracted and its alternate contact 16 closed whereby a circuit is extended from ground at normal contact 15 through said alternate contact 16, the windings of relay SR and vertical magnet VM, and side switch 9 to battery resulting in the energization of SR which is maintained energized responsive to the following impulses from normal contact 15, thus closing its alternate contact 17 thereby energizing private magnet PV while the five said impulses cause five operations of vertical magnet VM whereby wipers 18, 19, 20 are stepped to the fifth level of contacts 21, 22, 23. After the last operation of IR, relay RR is of course maintained energized through alternate contact 15 while secondary relay SR retracts its armature interrupting alternate contacts 17 whereby private magnet PV deënergizes moving the side switch arms to their middle position. Upon side switch 9 assuming its middle position a vibratory circuit is closed through rotary magnet RM whereby the wipers are stepped into engagement with the first set of contacts of the selected level, the first operation of magnet RM due to a mechanical connection moving the armature of private magnet PV to its attracted position. Therefore if the first encountered set of contacts 21, 22, 23 lead to a busy trunk circuit C, the test contact 21 thereof is grounded so that magnet PV is energized and rotary magnet RM continues to advance the wipers until an idle set of contacts 21, 22, 23 is reached whereby the circuit for private magnet PV is interrupted causing its deënergization whereby the side switch arms are moved into their last position thus interrupting the circuit for rotary magnet RM.

As soon as side switch arms 6—7 move into their third position a circuit for line relay LR of the seized trunk C is energized over a circuit including the calling line, and although IR of first selector B deënergizes as soon as said side switch arms 6—7 move into said third position, relay RR being a sluggish relay, maintains its armature attracted until a substitute circuit is provided from relay LR at the seized trunk circuit C. The energizing circuit for LR is traced from ground through the upper winding thereof, normal contact 24, contact 22, wiper 19, side switch 6, winding 12, normal contact 13, line L and substation A, normal contact 14, side switch 7, wiper 20, contact 23, normal contact 25 and the lower winding of LR to battery causing its energization. Its alternate contact 26 is therefore closed connecting ground over the private or test conductor 28 and through release relay RR to battery maintaining it energized and its armature attracted. This ground connection of course also holds a circuit through winding 12^1 but magnet SM it will be remembered does not operate unless current is acting cumulatively upon both windings. Also responsive to the closing of alternate contact 26 of relay LR a circuit for signal lamps S is established through normal contact 27 and said lamps S to battery lighting said lamps and notifying the operators that a connection is desired with the selected trunk circuit C.

One of the idle operators in response to the signal received inserts the answering plug AP of a cord circuit D into a jack *j* of the selected trunk circuit C whereby a circuit for cut-off relay CO^2 is established traced from battery through the winding of CO^2 and the third contact of jack *j* and plug AP to ground causing its energization whereby the circuit for lamps S is interrupted at normal contact 27 and ground from the third conductor is connected through alternate contact 27 to the private conductor 28 thus maintaining the release relay RR of first selector B energized until the plug AP is again withdrawn.

The operator now closes her listening key LK thereby connecting her telephone set O in circuit with the calling substation to ascertain the wants of the calling subscriber and assuming that connection is desired with telephone No. 234 at the B exchange, the operator inserts calling plug CP into the jack j^1 of an idle trunk T leading to said exchange. Thereafter the operator throws her calling device key DK to connect calling device CD^1 in circuit with trunk circuit T. The operation of DK also closes alternate contact 29 thereof thereby connecting ground through the sleeve strand 30 of cord circuit D, sleeve strand 31 of link circuit C, alternate contact 32, winding 33 of series relay 34, normal contact 25 and the lower winding of LR to battery causing an energization of relay 34 whereby its alternate contacts 35 are closed establishing a locking circuit through its high resistance winding 33^1 and

conductor 28 to ground thus locking relay 34. The closing of alternate contacts 35 also connects ground from conductor 28 through conductor 36 and alternate contact 37, relay RV to battery causing its energization whereby its alternate contacts 24—25 are closed reversing the direction of current flow over the calling line and thus through the winding 12 of service meter magnet SM causing an operation of said magnet SM as its windings are now acting cumulatively. Also responsive to energization of relay 34 its alternate contact 39 is closed thereby shunting winding 33 and condenser 40 and excluding them from the talking circuit.

It will be noted that upon insertion of plug AP, a circuit is established from battery through relay LR and over the tip and sleeve strands of circuits C, D, and through the winding of AS, this flow being in a direction to operate relay AS to light lamp SS, but upon reversal of this flow due to operation of RV, relay AS is operated in an opposite direction to efface signal SS.

The operator having connected calling device CD^1 in circuit with trunk circuit T an energizing circuit for impulse relay IR^1 at second selector E is established traced from ground through the lower winding of differential relay DF, the lower winding of $1R^1$, normal contact 42, sleeve contacts of jack j^1 and plug CP, key DK and calling device CD^1, tip contacts of plug CP and jack j^1, normal contact 45, the upper winding of relay IR^1, and DF to battery causing an energization of IR^1, but relay DF being differential does not energize to attract its armature. Responsive to the closing of alternate contact 46 of relay IR^1 the slow acting relay RR^1 is energized and is now maintained energized until a release or disconnection is desired.

Upon the operator inserting plug CP in a jack j^1 a circuit is also established from ground through the third contact of said plug and jack and through lamps S^1 to battery lighting said lamps to indicate that the trunk connected to the associated jacks is busy. Of course, it is to be understood that any well known busy test device for determining the condition of trunk T may be provided in place of lamps S^1 if desired.

The operator now wishing to make connection with telephone No. 234 in the B exchange first operates calling device CD^1 to cause two interruptions of its impulse springs whereby two operations of impulse relay IR^1 are effected and upon the first operation thereof its normal contact 47 is closed causing energization of secondary relays SR^1, SR^2. These relays being of the slow acting type maintain their armatures attracted during any following operations of relay IR^1. Responsive to the two operations of relay IR^1 its normal contact 46 is closed twice, thereby transmitting two impulses of current through vertical magnet VM^1 traced from ground through said normal contact 46, alternate contact 48, normal contact 49, normal contact 50, normal side switch contact 51, normal contact 52 and the winding of VM^1 to battery causing two operations thereof and stepping wipers 53, 54, 55 to the second level of contacts 56, 57, 58 which are the contacts leading to connector switches F in the second hundred group of lines. After the said two operations of IR^1 its armature remains attracted and its normal contact 47 interrupted for a long enough period to allow deënergization of SR^1 followed by SR^2 whereby a rotary or secondary impulse is transmitted from ground at normal contact 59, alternate contact 60, normal side switch contact 61 and the winding of PV^1 to battery causing an operation thereof whereby the side switch arms are stepped into their middle position. Upon side switch arm 62 moving to its middle position a vibratory circuit for rotary magnet RM^1 is established; the first operation thereof stepping wipers 53, 54, 55 into engagement with the first set of contacts 56, 57, 58, and due to the closing of its alternate contact 63 an energizing circuit for private magnet PV^1 is established so that if the first encountered set of contacts lead to a busy connector switch F private magnet PV^1 is maintained energized over a circuit including test wiper 53 this maintaining circuit for PV^1 continuing until wiper 53 engages an idle or ungrounded contact 56 whereby magnet PV^1 restores moving the side switch arms into their third or last position and thereby interrupting the circuit for rotary magnet RM^1. Upon side switch arm 64 moving to its last position ground is connected through wiper 53 to multiple contacts 56 rendering connector switch F busy.

The operator now operates calling device CD^1 to effect three interruptions of the metallic circuit including impulse relay IR^1 whereby said relay is operated three times causing energization of the slow acting secondary relays SR^1, SR^2, and maintaining them energized until cessation of said operations as before, while three impulses of current are transmitted through the vertical relay VR of switch F traced from ground at normal contact 46 of relay IR^1, alternate contact 48, normal contacts 49, 50, third contact of side switch 51, wiper 54, contact 57, relay VR and the upper winding of relay AB to battery causing three operations of said relays VR, AB. Responsive to the three operations of relay VR, three impulses of current are transmitted through vertical magnet VM^2, traced from ground through alternate contact 65, normal contact 66, normal side switch contact 67 and the winding of VM^2 to battery causing three

operations thereof and effecting three vertical steps of wipers 68, 69, 70 to select the third level of contacts 71, 72, 73 which is the level including the terminals of the called line L^1 of substation H.

After the said three operations of IR^1, relays SR^1 and SR^2 deënergize in the same order as before whereby a secondary or rotary impulse is transmitted from ground through normal contact 59, alternate contact 60, third side switch contact 61, wiper 55, contact 58, rotary relay ROR, the lower winding of AB to battery at normal contact 75 causing a single operation of said relays ROR and AB. Responsive to the closing of alternate contact 76 of ROR, a circuit for private magnet PV^2 is established from ground at said alternate contact 76, winding PV^2, to battery at normal contact 75 whereby side switch arms of switch F are moved to their middle position.

The operator now actuates calling device CD^1 to effect four interruptions of the metallic circuit including impulse relay IR^1, whereby relays SR^1 and SR^2 are energized and maintained energized as before and four impulses of current are transmitted from ground at normal contact 46 of IR^1 over the previously described path causing four operations of vertical relay VR whereby its alternate contact 65 is closed four times thereby transmitting four impulses of current through rotary magnet RM^2 and stepping wipers 68, 69, 70 to the fourth set of contacts 71, 72, 73 in the selected level, which are the terminal contacts of the called line. Thereafter relays SR^1, SR^2 deënergize as before transmitting a rotary impulse through relays ROR and AB causing a single operation of said relays. Responsive to the closing of alternate contact 76 of ROR, private relay PV^2 is operated as before thereby stepping the side switch arms into their last position whereby assuming the called line is idle, ground is connected from the third contact of side switch arm 77 to wiper 68 and contacts 71 and to cut-off relay CO^1 to battery causing its energization and removing the substation control of first selector G. The closing of side switch arms 78 and 79 closes the heavily marked talking conductors of switch F whereby the called bridging relay CB is connected in bridge of the called line but due to the condenser at substation H, it is not operated until the called subscriber responds.

The operator now actuates ringing key RK^1 thus grounding the tip conductor of trunk circuit T and causing an increased flow of current through the upper winding of differential relay DF whereby its armature is attracted and thus alternate contact 80 is closed establishing a circuit for ringing control relay RC traced through the winding thereof to ground at the third contact of side switch 62. The relay RC is thus energized, its alternate contact 81 being closed whereby a locking circuit for itself is established and due to the closing of its alternate contact 82 a circuit for interrupter relay FF is established from battery through said alternate contact 82, the winding of FF, normal contact 83 and interrupter wheel I to ground, the interruptions of said circuit by interrupter I causing corresponding operations of FF whereby alternate contact 50 is periodically closed thus establishing periodical energizing circuits for relays VR and AB of F, traced from said ground at alternate contact 50, third side switch contact 51, wiper 54, contact 57, relay VR and the upper winding of AB to battery. Responsive to each operation of VR its alternate contact 65 is closed, establishing an energizing circuit for ringing relay RI traced through said contact 65, normal contact 66, third side switch contact 67, the winding RI and alternate contact 84 to battery resulting in corresponding energizations of RI whereby ringing current from ringing generator RG is connected through alternate contacts 86, 87 in bridge of the called line causing an operation of the call bell at substation H.

After the operator has depressed ringing key RK^1, she restores calling device key DK whereby polarized relay CS is connected in bridge of the trunk circuit T but said relay CS is so connected that current from battery through relays DF and IR^1 is in a direction not adapted to close its alternate contact 88, but upon response of the called subscriber as will be seen, the current flow through said magnet CS is reversed to cause effacement of signal SS^1.

The subscriber H in response to the operation of the call signal removes his receiver from its switch hook whereby a circuit through relay CB is established from ground at the third contact of side switch 77 of connector F, the lower winding of CB, normal contact 87, third contact 79, wiper 70, contact 73, line L^1 and substation H, contact 72, wiper 69, third contact 78, conductor 89 and the upper winding of relay CB to battery at normal contact 84. This circuit results in the energization of relay CB (to effect operation of RV^1 of E) whereby its alternate contact 75 is closed thereby connecting ground from third side switch contact 77 through said alternate contact 75, lower winding of AB, relay ROR, back over the lower heavily marked rotary conductor through alternate contact 90 which has been closed, reversing relay RV^1 along the upper heavily marked vertical conductor through vertical relay VR and the upper winding of AB to battery this current flow being sufficient to operate reverse relay RV^1 but not sufficient to operate relays VR, AB and ROR.

The operation of RV^1 effects the closing of its alternate contact 91 whereby an energizing circuit for disconnect relay DR is established to ground at the third side switch contact 62 causing the closure of locking contact 92 of relay DR and due to the interruption of its normal contact 83 further operation of interrupter relay FF is prevented thus preventing any further application of ringing current to the called line.

Also, responsive to the operation of RV^1 its alternate contacts 42, 45 are closed thereby effecting the said reverse of current through the polarized relay CS causing its restoration and interruption of its alternate contact 88 thereby effacing signal SS^1 and notifying the operator that the called subscriber has responded.

Thus it will be seen that the two substations A and H are connected for conversation the talking circuit being traced over the heavily marked conductors.

Checking circuit.

Having described the operation of the system in establishing a connection between a calling and a called substation, the method of checking the number of the called substation will now be described, reference being made to Fig. 3 of the drawing.

As previously stated the checking operation may be performed either by the toll operator who establishes the connection between the substations or by a checking operator, but for the present we will assume that the toll operator or the operator who is establishing the connection performs the checking operation.

When the toll operator answers the call to ascertain the wants of the calling subscriber she also requests the number of the calling substation, which in the case of toll service is used to make the toll charge, as is well understood. In Fig. 3 I have indicated by the diagrammatic circuits A, B, C, D, T, a connection established from calling substation A to called substation H but have indicated only enough of the circuit connection to show the method of operating the checking system.

Having ascertained the number of the calling telephone line L, which we will assume is No. 345, the operator throws a calling device key DK^1 to connect a calling device CD^3 in circuit with a selector switch L, this connection resulting in the energization of impulse relay IR^3 over the metallic circuit including the contacts of said device CD^3 and responsive to energization of IR^3 its alternate contact 15^1 is closed causing the energization of release relay RR^3 which is now maintained energized until a release of the switch is desired. The operator then actuates calling device CD^3 to effect three interruptions of the metallic circuit including IR^3 whereby said relay is operated three times effecting three operations of vertical magnet VM^3 and three vertical steps of the wipers in a manner which will be well understood from the previous description of first selector B, secondary relay SR^3 also being energized responsive to these three operations to effect the energization of private magnet PV^3. After the said three operations of IR^3, relay SR^3 deënergizes allowing magnet PV^3 to retract its armature and step the side switch arms into their second position. A vibratory circuit for rotary magnet RM^3 is thereby established causing it to operate to step wipers 101 to 105 inclusive into engagement with the first set of contacts 106 to 110 inclusive in the selected level and due to a mechanical connection the first operation of RM^3 moves the armature of magnet PV^3 into its attracted position whereby if the first set of contacts engaged lead to a busy second selector M, relay PV^3 is maintained energized and the magnet RM^3 continues to step the wipers until an idle set of contacts is reached whereby the maintaining circuit for PV^3 is interrupted causing it to deënergize and move the side switch arms into their third position thus preventing any further operations of RM^3 and extending the metallic circuit including calling device CD^3 over the heavily marked conductors and through the impulse relay IR^4 to battery causing its energization.

Closing of alternate contact 111 of relay IR^4 connects ground to the multiple contacts 106 preventing any other switch L from connecting to switch M, this connection also being adapted to maintain relay RR^3 energized. Also upon closing of alternate contact 111, release relay RR^4 is energized.

The operator now actuates calling device CD^3 to effect four operations of relay IR^4 whereby four impulses are transmitted through SR^4, VM^4 and vertical magnet VM^4 is operated four times to cause four vertical steps of wipers 112, 113 while secondary relay SR^4 due to the closing of its alternate contact 114 causes private magnet PV^4 to step side switch arm 115^1 into its middle position after the said four operations. The operator again actuates calling device CD^3 this time effecting five operations of relay IR^4 resulting in five operations of rotary magnet RM^4 and stepping wipers 112, 113 into engagement with the fifth set of contacts 4, 5, which are the terminals of substation No. 345. During this rotary operation of the wipers, they are disconnected at normal contacts 115, 116 respectively so that no existing connections will be interfered with. After the last said five operations private magnet PV^4 steps the side switch arm into its third position due to the circuit through alternate contact 114.

Thus, it will be seen that if the calling

subscriber has given the correct number a circuit will be established from calling device key DK¹ over the heavily marked conductors to the terminals of the calling line and then over circuits D, C, D, to operator's circuit O so that upon the operator throwing her key DK¹ to connect test tone device TT in circuit, a signal will be transmitted over the said circuit including switches L, M, B and circuits C, D, to operator's telephone set O where she receives the signal and is thus informed that the subscriber has given the correct number.

This test tone is traced from induction coil 118 of apparatus TT along the upper heavily marked vertical conductor, condenser 119, wiper 102, contact 107, the upper heavily marked conductor of M including normal contact 115, wiper 112 and contact 4, vertical conductor of first selector B, tip conductor of trunk circuit C, the tip conductor of cord circuit D, and through listening key contacts LK and operator's set O returning over the sleeve conductor of cord circuit D and trunk circuit C, the rotary conductor of first selector B, contact 5 and wiper 113, normal contact 116, contact 110 and wiper 105, condenser 120, rotary conductor of L to induction coil 118.

It will be apparent that if the calling subscriber gave some other number than his own, that wipers 112, 113 would have been connected to terminals 4, 5 of some line which is not connected back through cord circuit D, so that when the operator connected the test tone TT to the checking circuit the signal would not be received and she would know that something was wrong.

If it is desired to have some other operator than the toll operator to do the checking such other operator may be informed either directly or through an order wire of a calling subscriber's number and she may then operate the checking circuit in a manner as before and then connect her telephone set O¹ by means of the listening key LK¹ and thus determine whether the number given was correct or not.

After the checking operation has been performed, by restoring key DK¹ to its normal position the circuit for relay IR⁴ is interrupted causing its restoration, and due to the interruption of its alternate contact 111 release relays RR³ and RR⁴ are restored, the restoration of relay RR³ closing its normal contact 16¹ whereby a circuit for release magnet REM³ is established from ground through normal contacts 15¹, 16¹, the winding of REM³ through off-normal switch ON³ to battery causing the energization of the release magnet whereby switch L is restored in a well known manner.

Upon restoration of RR⁴, its normal contact 111¹ is closed whereby an energizing circuit for release magnet REM⁴ is established through off-normal switch ON⁴ causing restoration of switch M in a well known manner, whereby switches L and M are now available for use in performing other checking operations.

Release of Fig. 1.

After the subscribers at A and H have finished conversation they will restore their receivers to their respective switch hooks, the restoration of the receiver at A causing an interruption of the circuit through relay LR which restores to normal and due to the interruption of its alternate contact 37 relay RV restores thereby reversing the current flow through polarized relay AS causing it to close its alternate contact 88¹ and operate supervisory signal SS, indicating to the operator that the calling subscriber has restored his receiver. Although relay LR has restored interrupting its alternate contact 32 battery for relay AS is provided through impedance coil IC and although alternate contact 26 of relay LR is interrupted relay RR of switch B, cut-off relay CO² and series relay 34 are still maintained energized by the ground through the third contact plug AP so that switch B is not restored until the plug is withdrawn from the jack as will be described.

The restoration of the receiver at substation H interrupts the circuit for bridging relay CB whereby it is restored and due to the interruption of its alternate contact 75, the circuit for reversing relay RV¹ of switch E is interrupted causing its restoration whereby the flow of current through calling supervisory relay CS is reversed causing it to close its alternate contact 88 and operate supervisory signal SS¹ indicating to the operator that the called subscriber has replaced his receiver. The release of switches E and F does not occur until the calling plug CP is withdrawn from the trunk jack j^1.

The operator in response to the operation of signals SS, SS¹, withdraws plugs AP and CP from their respective jacks, the withdrawal of plug AP causing the interruption of the circuit for cut-off relay CO², relay 34 and release relay RR of switch B, resulting in their restoration. The restoration of RR results in the closure of the circuit through release magnet REM traced from ground through normal contacts 15, 16, magnet REM and off-normal contact ON to battery resulting in the release of switch B in a well known manner. Thus switch B and trunk circuit C having been restored they are available for use in establishing other connections.

Upon withdrawal of calling plug CP from the trunk jack j^1 the circuit for relay IR¹ of switch E is interrupted causing its restoration whereby a circuit is momentarily closed through relays SR¹, SR² of switch E, traced

from ground at normal contact 47, alternate contact 48^1 and the winding of relays SR^1, SR^2 to battery, this circuit being interrupted upon the immediately following restoration of relay RR^1. Relay SR^1 being quicker to restore than SR^2, a ground is momentarily connected to the rotary conductor of switch E resulting in the energization of the rotary relay ROR of connector F over the previously described path while an impulse of current is also transmitted over the vertical conductor through the vertical relay VR of connector F traced from ground at normal contact 46 of relay IR^1, normal contacts 48, 59^1, alternate contact 60^1, vertical conductor to wiper 54, contact 57, relay VR and the upper winding of AB to battery resulting in the energization of VR and AB.

Responsive to the simultaneous energization of relays VR and ROR, their contacts 125 are closed establishing a circuit for release magnet REM^2 traced from ground through said contacts 125 the winding of REM^2 to battery at alternate contact 84 resulting in the energization of the release magnet and the restoration of switch F in a well known manner. It might be added that due to the closing of alternate contact 76 of ROR, private magnet PV^2 is energized and by its contact 66 interrupts the circuit for ringing relay RI preventing any false operation thereof. The restoration of side switch arm 77 interrupts the circuit for cut-off relay CO^1 restoring it and therefore the substation control of switch G.

Referring now to the restoration of selector E, after all of the relays IR^1, RR^1, SR^1 and SR^2 are restored an energizing circuit for release magnet REM^1 is established traced from ground at normal contact 46 of for release magnet REM^1 is established contact ON^1 and the winding of REM^1 to battery causing its energization and the restoration of switch E. Upon restoration of side switch arm 62 the circuit for ringing control relay RC is interrupted causing its restoration while the restoration of arm 62 also interrupts the locking circuit for disconnect relay DR allowing it to restore. Switch E and trunk circuit T having been rendered idle are again available for further use in establishing other connections.

Called line busy.

In the foregoing description it will be remembered that it was assumed that the called line was idle but we will now assume that the line L^1 of substation H was busy upon connection made therewith by connector switch F, in which case switch F is automatically restored and a busy signal transmitted.

Responsive to the last rotary impulse whereby relays ROR, AB and PV^2 were energized, an energizing circuit for release magnet REM^2 is established traced from the grounded private or test terminal 71, wiper 68, middle contact of side switch arm 77, alternate contact 66^1 and the winding of release magnet REM^2 to battery at alternate contact 84. The resulting energization of magnet REM^2 is effective to restore switch F in a well known manner, but the operator at D not aware as yet that the called for line is busy, operates her ringing key RK^1 in the usual manner thereby operating vertical relay VR and relay AB as before whereby connector switch F is stepped off-normal by the resulting operation of magnet VM^2. Off-normal contact ON^2 is thereby closed connecting busy back BB to the rotary talking conductor and thus a characteristic busy signal is transmitted from BB along the lower heavily marked conductor out over the calling line and substation A returning over the upper heavily marked conductor and through the upper winding of line relay LR of trunk circuit C through battery to ground. The calling subscriber in response to this signal replaces her receiver upon its switch hook thereby operating supervisory signal SS in a manner as before described, while supervisory signal SS^1 having remained operated, the operator at D withdraws plugs AP and CP from their respective jacks effecting the restoration of switch B and trunk circuit C as before while switches E and F are also restored in a manner as before described.

Branch exchange trunk J.

Fig. 2 illustrates a trunk circuit adapted for interconnecting branch exchange lines with a toll board preferably located at the A exchange and therefore I have preferably arranged the trunk circuit J as a two-wire circuit the apparatus to the left of the dotted line being associated with the branch exchange while the apparatus to the right of the dotted line is located at the A exchange. Substations and first selectors similar to those of the A exchange may be used at the branch exchange and therefore trunk circuit J is adapted for use with such apparatus. Relays of trunk circuit J and relays of trunk circuit C having similar functions have similar reference characters and comprise a line relay LR^3 adapted to be energized by current over the calling line responsive to connection made with terminals 21^1, 22^1, 23^1 whereby a circuit is closed through line relay LR^4 to operate line signals S^3 whereupon the operator inserting a plug in a jack j^3, cut-off relay CO^3 is energized effacing said signals S^3. Upon the operator throwing her calling device key DK relay 34^1 is energized as in trunk circuit C resulting in the energization of reversing relay RV^3. A release relay RR^3 is also added to trunk circuit J to control the release of a first selector B

upon withdrawal of a connecting plug from jacks j^3.

In establishing a connection from the calling substation in a branch exchange to an operator's position in the A exchange and assuming that the calling substation is similar to A while its first selector is like B, the connection to terminals 21^1, 22^1, 23^1 of an idle trunk J is established in a manner as before described. Upon connection made with said terminals, relay LR^3 is energized by current flowing through its winding and over the calling line whereby its alternate contact 26^1 is energized to hold release relay RR at first selector B energized. An energizing circuit for relay LR^4 is also established upon such connection, being traced from battery through the lower winding of LR^3 out over the calling line returning over the tip strand of trunk circuit J, normal contact 150 and the upper winding of LR^4 to ground causing its energization whereby its alternate contact 151 is closed establishing a circuit through normal contact 152 and signal lamps S^3 to battery effecting their illumination.

An idle one of the operators before whom jacks j^3 are located answers the call in the usual manner, that is by inserting a plug AP in a jack j^3. A series circuit for relays LR^4, CO^3 is established from ground through the third contact of plug AP and jack j^3 and then through the windings of relays CO^3 and LR^4 to battery energizing CO^3 and maintaining relay LR^4 energized until withdrawal of the plug. Due to the interruption of contact 152 of CO^3, signals S^3 are effaced. After ascertaining the number of the wanted line in the usual manner the operator presses her calling device key DK thereby establishing an energizing circuit for relay 34^1 through its upper winding 33^2, similar to that of circuit C, whereby said relay 34^1 is energized closing a locking circuit for itself through its alternate contact 35^1 to ground at normal contact 154. Due to the grounding of conductor 155 a circuit is established through alternate contact 156 and the winding of RV^3 to battery causing the energization of RV^3 and reversing the current flow over the calling line to operate its service meter magnet as before described.

The operation of extending the connection of the calling substation to that of a called substation in a distant exchange is similar to that before described. After the subscribers have finished conversation they replace their receivers upon their respective switch hooks, the act of the called subscriber operating the polarized relay CS and lighting signal SS^1 as before described while the act of the calling subscriber at A restores relay LR^3 thereby reversing the current flow through polarized relay AS thus lighting signal SS as before, while the replacing of the receiver at the called station effects the illumination of signal SS^1.

It will be noted that at trunk circuit J a release relay RR^3 is connected to normal contact 32^1 of line relay LR^3 while in trunk circuit C an impedance coil IC was used but it is to be understood that relay RR^3 is adjusted not to respond to this current flow through relay AS, relay AS being of a comparatively high resistance. The operator in response to the disconnect signals withdraws the connecting plugs from their respective jacks whereby switches E and F are restored as before described.

The release caused by the withdrawal of plug AP in this case is different than in connection with trunk circuit C. Upon withdrawal of said plug AP the circuit for relays CO^3 and LR^4 is interrupted at the third contact of the jack, and relay LR^4 being a quick acting relay restores its armature before the restoration of the armature of the slow acting relay CO^3 so that a grounded impulse is transmitted over the sleeve conductor traced from normal contact 151 of LR^4, alternate contact 158 over the sleeve conductor and normal contact 32^1 and then through the winding of RR^3 to battery causing the energization thereof and the interruption of its normal contact 154. Therefore, the holding circuit for relays 34^1, and RR of switch B is interrupted allowing these relays to restore whereby switch B is restored in a manner as before described and trunk circuit J and switch B having been restored are available for use in establishing other connections.

As to checking the number of calling lines in the branch exchange, I preferably use the circuits of Fig. 3 for this purpose, preferably placing the switches as L and M in the branch exchange, while the calling device CD^3, key DK^1 and test apparatus TT are associated with the exchange where the operator is located. The operation of the checking system with this arrangement is of course the same as before described.

Local automatic connections.

In the previous description I have referred to connections between substations located in different exchanges but for local work in interconnecting telephones in the A exchange and branch exchanges by subscriber's automatic apparatus, any of the well known systems adapted for use with substations as A may be used but I have provided second selector E with additional terminals T^1 so that said switch E may be used as a second selector and switch F as a connector in said A exchange and branch exchanges. Should second selector E be used for such local work, the automatic terminals 21^2, 22^2, 23^2 are used and the trunk

circuit T may be disconnected at connections 160.

Should the subscriber at A for instance desire a connection with a local telephone line, calling device CD is operated to cause switch B to pick out a second selector E of the proper group and upon connection being made with terminals 21^2, 22^2, 23^2 of the switch E, impulse relay IR^1 will be energized by current over the calling line in this instance where before it will be remembered that this relay IR^1 was energized by current flowing through polarized relay CS of cord circuit D. Responsive to IR^1, RR^1 is energized as before closing its alternate contact 161 and connecting ground to private or test contacts 21^2 thus maintaining switch E busy and relay RR of first selector B energized.

Thereafter the subscriber operates his dial according to the following digits of the called substation number whereby relay IR^1 is interrupted as where it was interrupted by the operator's calling device CD^1 thus effecting an operation of switch E and thereafter a switch F to connect to the called line as before. The subscriber then operates his ringing key RK unbalancing differential relay DF of switch E and causing the application of ringing current to the called line. Upon response of the called subscriber reversing relay RV^1 of switch E is operated reversing the current flow over the calling line and thus actuating service meter SM in a manner as previously described.

After the subscribers have finished conversation they will replace their receivers upon their respective switch hooks whereby the replacing of receiver at H restores relay CB as before thereby restoring reversing relay RV^1. Responsive to the replacing of the receiver at substation A, relay IR^1 of second selector E is restored effecting restoration of switches E and F in a manner as previously described. Due to the restoration of release relay RR^1 of switch E ground is removed from test contacts 21^2 thus causing restoration of relay RR and service meter magnet SM causing the restoration of switch B as before described. All of the switches and lines having been restored they are available for use in establishing other connections.

Although I have illustrated substation H as a well known form of three-wire automatic substation and referred to the subscriber's automatic apparatus in the B exchange as being of the three-wire type, I do not desire to be limited to the use of such a system but have chosen this particular system to illustrate an embodiment of my invention

While I have shown a number of batteries it is to be understood that those batteries associated with the apparatus in any one exchange may be all one and the same.

It will be apparent that many changes and modifications of the system in my application may be readily made and therefore I do not desire to be limited to the exact structure as shown and described but aim 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 comprising telephone lines, operator controlled link circuits, automatic switches for interchangeably connecting said lines and link circuits responsive to calls over said lines, connection terminals for said lines, and operator controlled automatic switches for operatively connecting to the terminals of a calling one of said lines while connection exists between said calling line and one of said link circuits, and while the receiver is removed at the calling substation.

2. A telephone system comprising telephone lines, operator controlled link circuits, automatic switches for interchangeably connecting said lines and link circuits responsive to calls over said lines, connection terminals for said lines, operator controlled automatic switches for connecting to said terminals of a calling line, and means for transmitting a characteristic signal over said automatic switches and terminals to a connected operator's link circuit.

3. A telephone system including a telephone line, operator controlled link circuits, an automatic switch for connecting said line with one of said link circuits responsive to a call over said line, connection terminals for said line, operator controlled automatic switches for connecting to said terminals of a calling line, and means for transmitting a characteristic signal over the established circuit including said automatic switches and the operator's link circuit.

4. A telephone system including a telephone line, operator controlled link circuits, an automatic switch for connecting said line with one of said link circuits responsive to a call over said line, means for establishing a conversational circuit over said line and link circuit whereby the operator may learn the number of the calling telephone line from the calling subscriber, and means controlled by the operator for ascertaining whether the telephone number given by a calling subscriber is the number of the calling line.

5. A telephone system including telephone lines, operator controlled link circuits, automatic switches for interchangeably connecting said lines and link circuits responsive to calls over said lines, means controlled

by the operator for establishing a conversational circuit over such a connection whereby she may learn the number of the calling telephone line from the calling subscriber, and means controlled by the operator for ascertaining whether the telephone number given by the calling subscriber is the number of the calling line.

6. A telephone system including a telephone line, operator controlled link circuits, an automatic switch for connecting said line with an idle one of said link circuits responsive to a call over said line, means for establishing a conversational circuit between said calling line and link circuit whereby the operator may learn the number of the calling line from the calling subscriber, operator controlled automatic switches for connecting to the telephone line corresponding to the number given by the calling subscriber, and means for determining whether the telephone line connected with is the calling telephone line.

7. A telephone system including a telephone line, operator controlled link circuits, an automatic switch for connecting said line with an idle one of said link circuits responsive to a call over said line, means for establishing a conversational circuit between said calling line and link circuit whereby the operator may learn the number of the calling line from the calling subscriber, means, controlled by the operator for connecting to the telephone line corresponding to the number given by the calling subscriber, and means for determining whether the telephone line connected with is the calling telephone line.

8. A telephone system comprising telephone lines and means controlled by an operator including operator controlled automatic switches for determining the number of the calling line.

9. A telephone system comprising telephone lines, operator controlled link circuits, switches for interchangeably connecting said lines and link circuits responsive to calls over said lines, connection terminals for said lines, and operator controlled electromagnetic switches for operatively connecting to the terminals of a line that is calling and is connected to one of said link circuits.

10. A telephone system comprising telephone lines, link circuits for extending said telephone lines, switches for interchangeably connecting said lines and link circuits controlled over said lines when calling, connection terminals for said lines, and operator controlled automatic switches for operatively connecting to the terminals of a line which is calling and is connected to an idle one of said link circuits.

11. A telephone system comprising telephone lines, operator controlled link circuits, switches controlled over said lines when calling for extending a calling line to an idle link circuit, operator controlled automatic switches for connecting to the terminals of a line which is calling, and means for transmitting a characteristic signal over said automatic switches and terminals to a connected operator's link circuit.

12. A telephone system comprising telephone lines, a central office operator's switchboard, operator controlled link circuits thereat, switches responsive to calls over said lines for interchangeably connecting said lines and link circuits, called line connection terminals for said lines, and electromagnetic switches controlled by an operator at the central office switchboard for connecting to the called line terminals of a line that is calling and is operatively connected in telephonic circuit with one of said link circuits.

13. A telephone system comprising telephone lines, called line connection terminals for said lines, a central office operator's switchboard, operator controlled link circuits thereat, switches responsive to calls over said lines for interchangeably connecting said lines and link circuits, electromagnectic switches controlled by an operator at the central office switchboard for extending a link circuit to the called line terminals of a wanted line, and electromagnetic switches controlled by an operator at the central office switchboard for connecting to the called line terminals of the calling line that is connected to the said link circuit.

14. A telephone system comprising telephone lines, called line connection terminals for said lines, a central office operator's switchboard, operator controlled link circuits thereat, switches responsive to calls over said lines for interchangeably connecting said lines and link circuits, electromagnetic switches controlled by an operator at the central office switchboard for extending a link circuit to the called line terminals of a wanted line, electromagnetic switches controlled by an operator at the central office switchboard for connecting to the called line terminals of the calling line, and means for transmitting a characteristic signal through the last said switches to said called line terminals and through the first said switches to an operator's link circuit.

15. A telephone system including a telephone line, a central office operator's switchboard, an operator's link circuit, means for connecting said telephone line to said link circuit, an operator controlled electromagnetic switch for connecting to said link circuit through terminals of said line, and means for transmitting an audible tone over said switch to the operator's set associated with said link circuit.

16. A telephone system including a telephone line, a central office switchboard, a link circuit at said switchboard, electromag-

netically controlled means for connecting said line to said link circuit, a tone device, and operator controlled electromagnetic means for connection to said line whereby an audible tone from said device may be connected to said link circuit at the will of the operator.

Signed by me at San Francisco, county of San Francisco and State of California, in the presence of two witnesses.

GERALD DEAKIN.

Witnesses:

PAULINE J. GLAUCH,

E. A. MCCANN.