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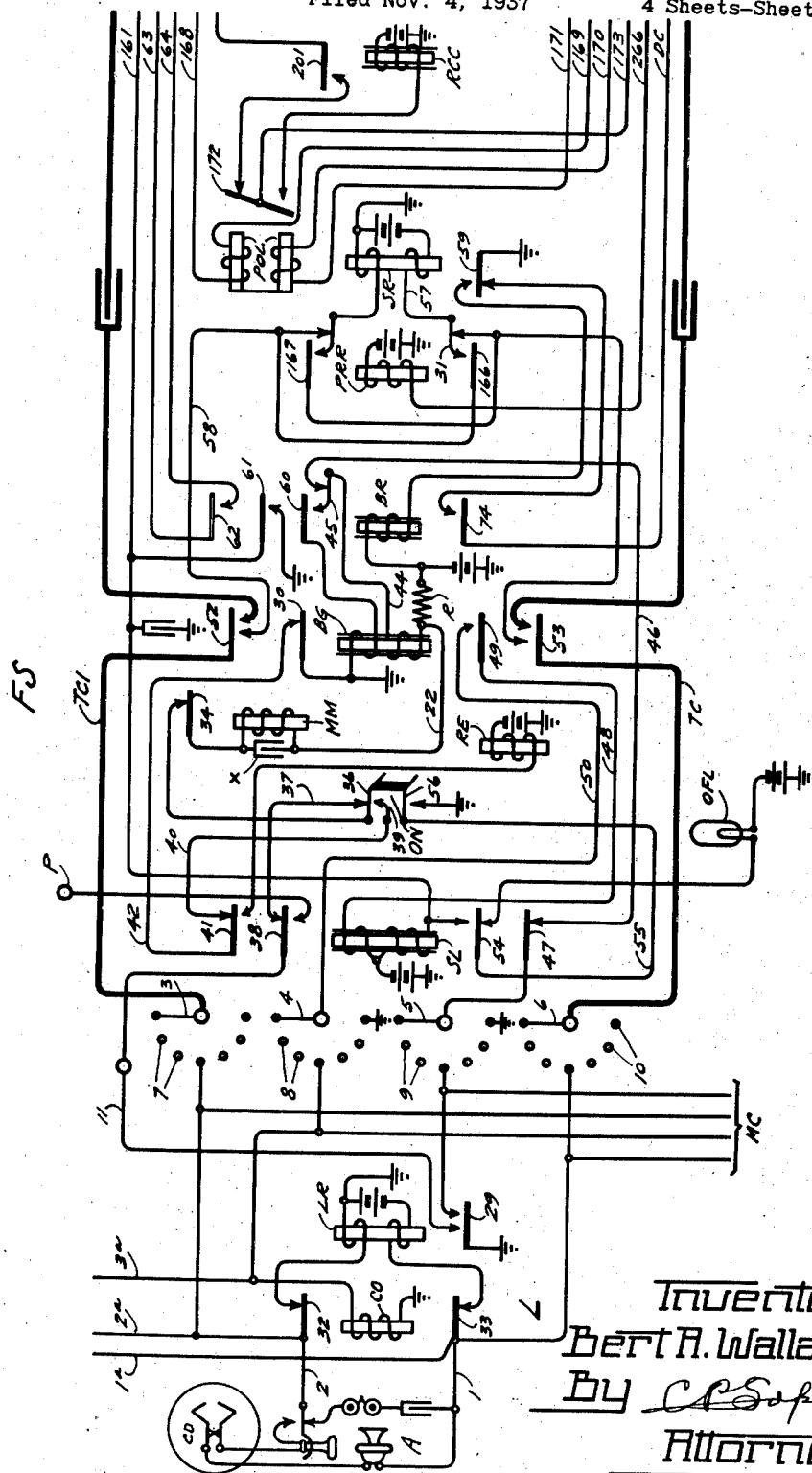
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2,187,186

TELEPHONE SYSTEM

Filed Nov. 4, 1937

4 Sheets-Sheet 1



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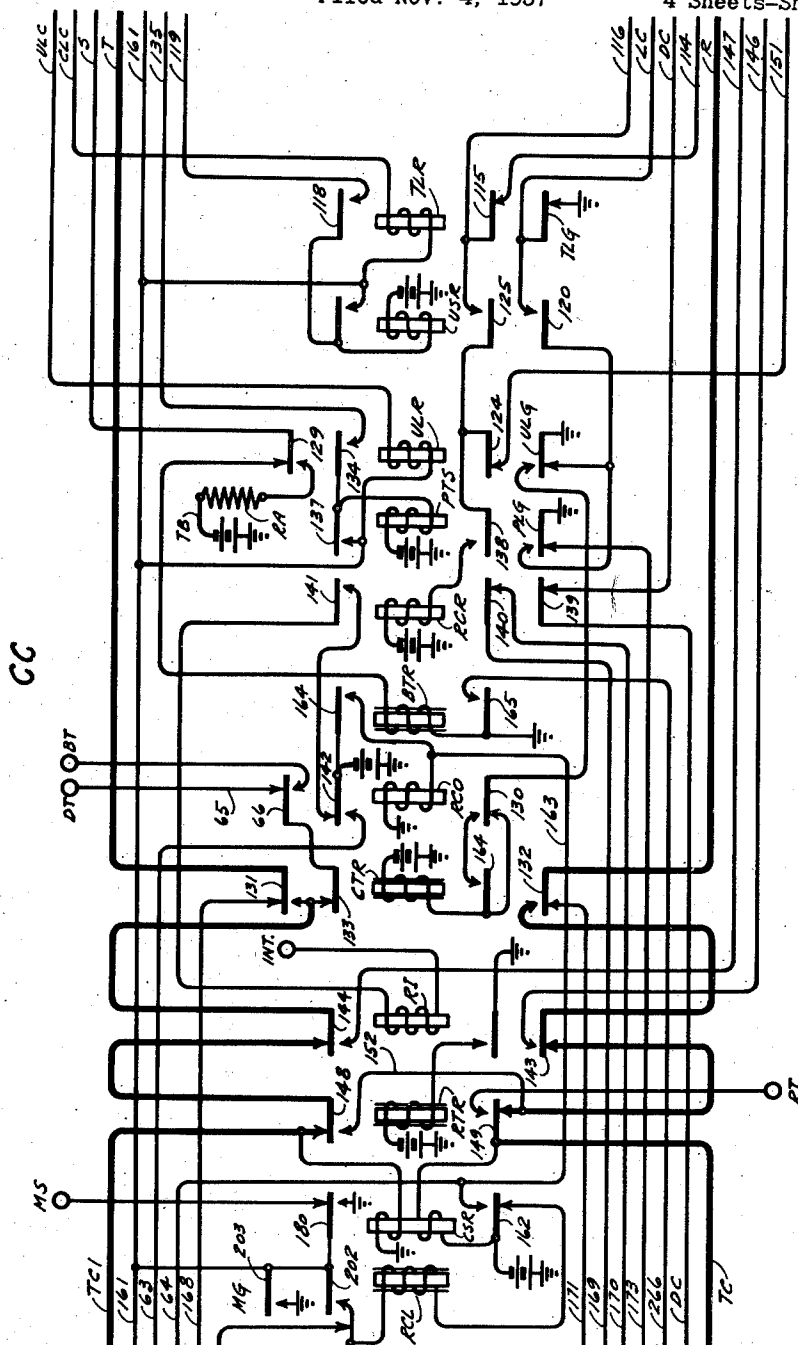
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TELEPHONE SYSTEM

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4 Sheets-Sheet 2



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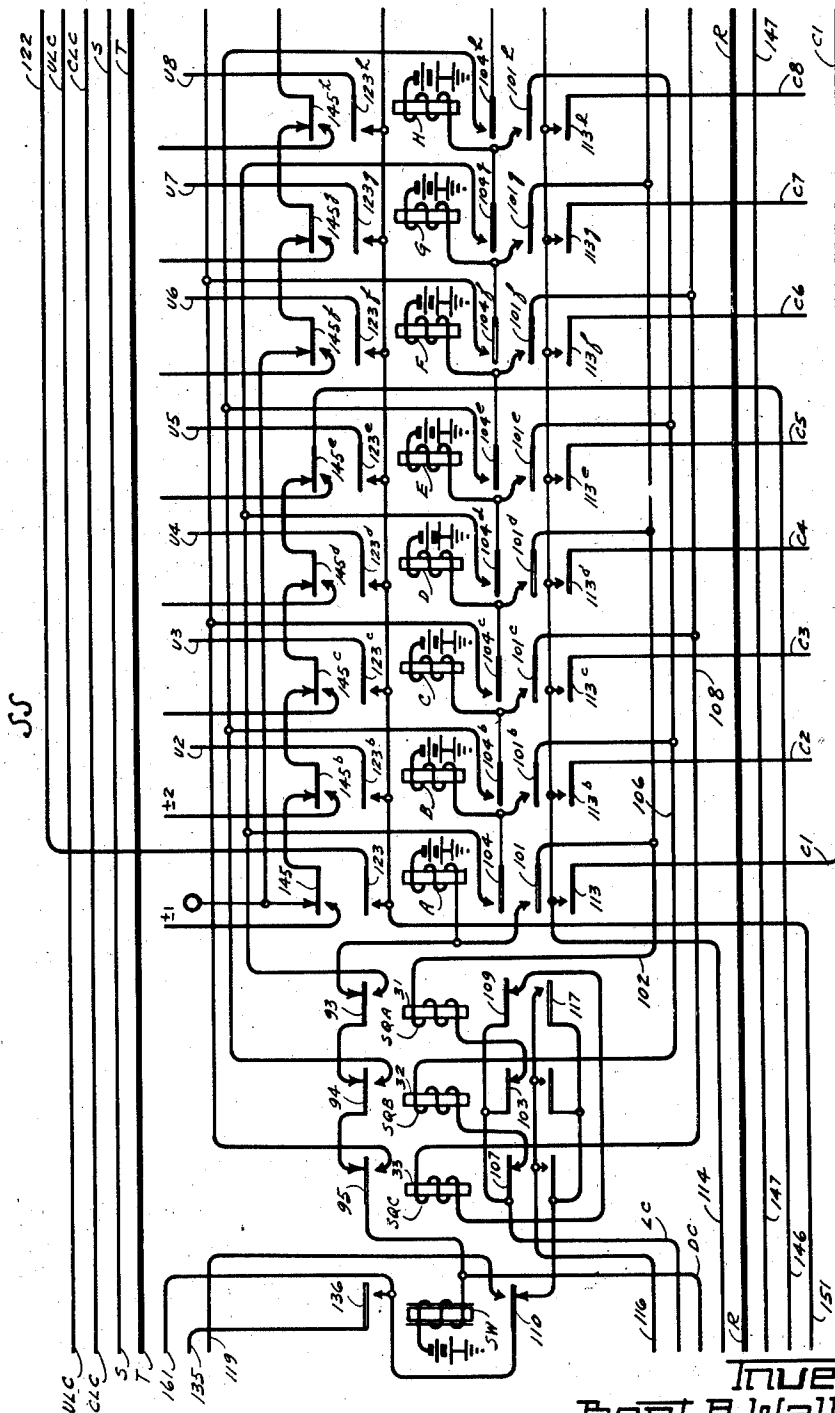
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TELEPHONE SYSTEM

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Fig. 3.



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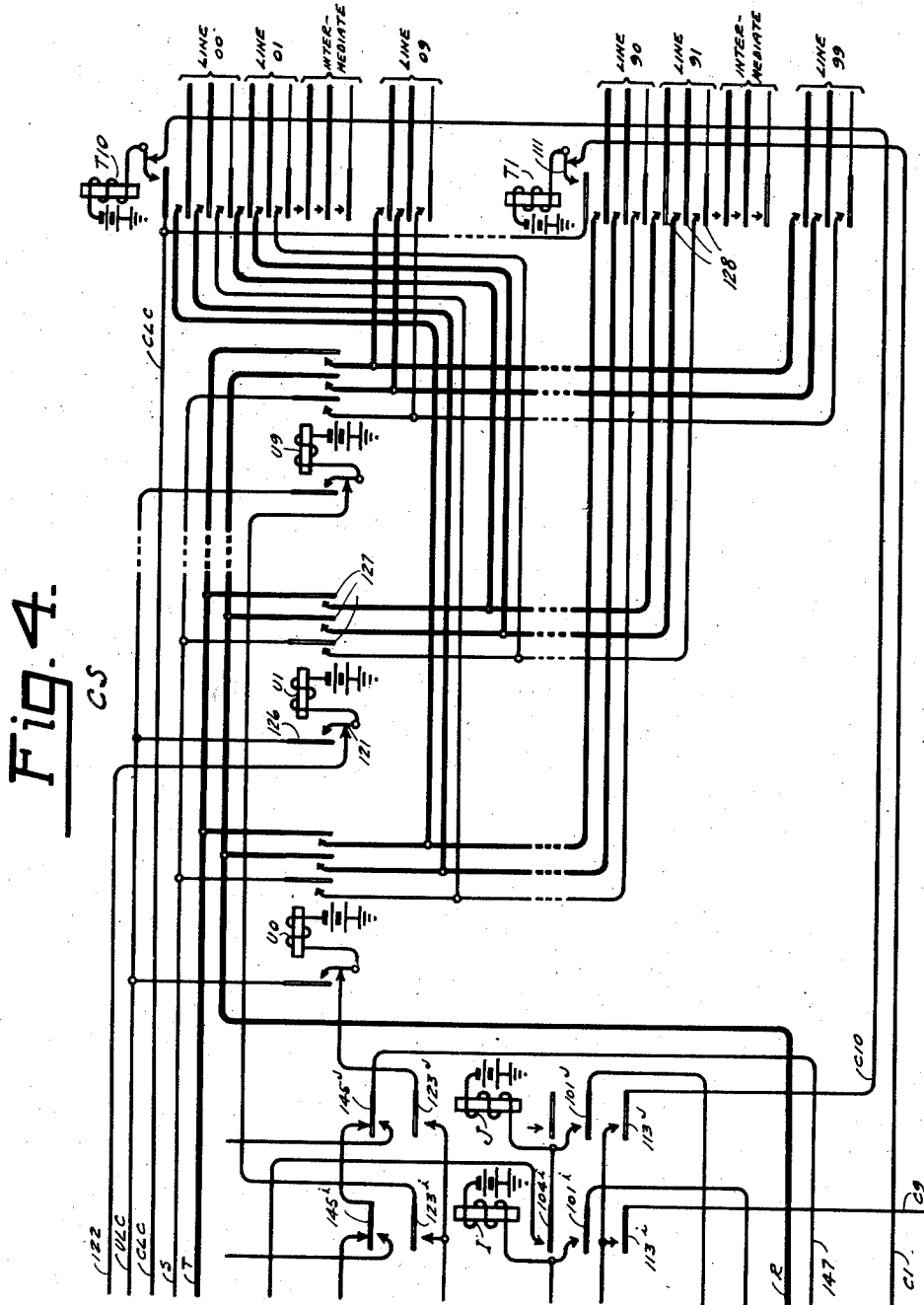
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B. A. WALLACE
TELEPHONE SYSTEM

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,187,186

TELEPHONE SYSTEM

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Application November 4, 1937, Serial No. 172,680

17 Claims. (Cl. 179—17)

My invention relates to automatic telephone systems of the two wire or metallic line type, in which means located at the central exchange are operated in response to a series of rapid interruptions of the subscriber's line circuit to connect the calling subscriber to the contacts of the line being called. In the usual system of this type a subscriber removes his receiver to initiate a call, a line finder switch connects his line to a selector, whereupon he receives a dialing tone. He then operates his dialing device to step the switch wipers of a rotary selector switch into engagement with contacts leading to a connector switch, which in turn is operated to cause its switch wipers to connect to the contacts of a desired line.

It is an object of my invention to provide an improved circuit arrangement including a line finder switch, but using a plurality of counting relays in the selector circuit and a plurality of relays in the connector circuit to eliminate the use of switches and their associated banks of contacts.

A feature of my invention is the inclusion in such a system of means whereby a calling subscriber may be automatically connected to another subscriber's station on his own party line, without the necessity of dialing a special number or necessitating the intervention of an attendant.

Another feature is the inclusion in such a telephone system of ringing means permitting the signaling of any one of the ten subscribers on the same party line.

Further features, provided in the telephone system of my invention, are a revertive ringing tone to the calling subscriber; dialing tone to the calling subscriber indicating a through channel, busy tone to the calling subscriber when the called line is busy; automatic starting of interrupter and tone machine and pole changer.

Another feature is the provision in an automatic telephone exchange of a relay type connector arranged for handling revertive calls, the control of which does not require additional bank contacts or bank wiring and which will function through any number of selector stages. This control is accomplished over the tip and ring conductors of the line and consists of a momentary reversal of supervisory battery current on the calling line at the time a busy test is made of the called line. If the connection is to the same line at both ends, the link is switched for handling the revertive call so as to ring the called party when the calling party hangs up his receiver. A high resistance polarized relay

is bridged across the tip and ring conductors on the calling end of the link and this relay controls the operation of a slow release secondary relay which provides for locking in the revertive call switch when the momentary reversal of battery current is encountered on the called line at the instant the busy test is made. This type of revertive call connector is not limited to use with the circuit shown herein but is equally adapted for use with other automatic systems.

Other features will become apparent upon a further perusal of the specification and together with the features pointed out will be explained fully hereinafter, reference being had to the accompanying drawings, comprising Figs. 1 to 4 inclusive, in which:

Fig. 1 is a schematic drawing of the apparatus and circuit connections therefor, comprising the line circuit and line finder switch of my invention;

Fig. 2 shows the connector circuit;

Fig. 3 shows the selector circuit; and

Fig. 4 illustrates the connecting relays circuit.

The present invention will be best understood from a consideration of the following detailed description, taken in connection with the accompanying drawings forming a part of this specification, with the understanding, however, that the invention is not confined to any strict conformity with the showing of the drawings, but may be changed or modified so long as such changes and modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

Referring particularly to Fig. 1 of the drawings, the line conductors 1 and 2 at the left of the drawing connect the subscriber's station A, which is equipped with the usual automatic substation equipment, such as is well known to those skilled in the art, to an automatic exchange where they terminate in a line circuit L which consists of a line relay LR and a cut-off relay CO which control the usual line finder switches one of which is shown as FS. Conductors 1a and 2a extend the line to multiple connections and the group of conductors MC extend the lines through multiple connections to the other line finder switches of the group.

The line finder switch apparatus comprises a motor magnet MM, which automatically operates when a call is initiated by a subscriber to step the wipers 3, 4, 5, and 6 over the bank contacts 7, 8, 9, and 10 to select the contacts of the calling line. A bridging relay BG is provided, which energizes when the calling line is seized,

by the switch FS to open the circuit of motor magnet MM to prevent further advancement of the wipers 3, 4, 5, and 6 and to connect the calling line to the selector mechanism of switch SS.

5 The sleeve relay SL energizes upon the actuation of relay BG to extend the starting conductor 11 to the next finder switch FS (not shown) of the group. A polarized reversing relay POL, which is the revertive call testing relay, and a polarity reversing relay PRR, and a revertive call control relay RCC are provided to permit a calling subscriber to be directly connected to another party on the same line without the necessity of dialing another number.

10 A supervisory relay SR supplies talking battery to the subscriber's line and is alternately energized and deenergized when the subscriber actuates his dialing mechanism to cause the actuation in succession of the counting relays shown in Fig. 3. A busying relay BR is provided to cause the operation of an associated part of the group busying means and to start a tone machine operating, as is well known in the art. This machine also connects dialing tone

15 to the line of the calling subscriber to inform him that the apparatus is in condition to properly handle his call. A release magnet RE, under the control of the supervisory relay SR, operates to restore the switch wipers 3, 4, 5, and 6 to normal. While separate batteries are shown in the drawings it is to be understood that battery current may be obtained from one or any other convenient number of batteries without departing from the spirit of my invention.

20 The apparatus shown in Fig. 2 comprises a "tens" locking relay TLR, a "units" locking relay ULR, and a unit switching relay USR, which switches the locking conductor from the "tens" relays ground to the "units" relay ground. The party line switching relay PTS, which permits the calling subscriber to select ringing current of the proper frequency for summoning the desired party, ringing control relay RCR, ringing cut-off relay RCO, and ringing interrupter relay RI cooperate to control the application of ringing current to the called line. A busy test relay BTR operates, when the called line is busy, to cause the operation of relays PRR and RCC in Fig. 1 and the revertive call-locking relay

25 RCL in Fig. 2. A cut through relay CTR operates to extend the conductors of the calling line through to the conductors of the called line and a called supervisory relay CSR operates when the called subscriber lifts his receiver from its switch hook to answer a call.

30 Fig. 3 discloses a switching relay SW, sequence relays SQA, SQB, and SQC, and counting relays A to H. Certain of these relays operate three times in each connection; the first operation energizes a "tens" relay, which selects a group of tens lines; the second operation actuates a "units" relay, which selects the individual line in the group of tens previously selected, and the third operation selects generator current of the proper frequency to operate the ringer at the called station.

35 The apparatus shown in Fig. 4 comprises two of the counting relays of the counting chain and also shows certain of the "tens" and "units" switching relays. Only two of the "tens" relays, T1 and T10 are shown, but it is to be understood that one of these relays is provided for each group of ten lines in a one hundred line system. Each of these relays is provided with a

40 locking contact and thirty other contacts, which

are divided into groups of three, which are connected to the tip, ring, and sleeve conductors of ten lines. When the relay T1 operates, the ten lines from 10 to 19 are connected to conductors leading to "units" relays. Ten "units" relays are provided but only three are shown in the drawings. Each of the "units" relays has a locking contact and three contacts, which extend the tip, ring, and sleeve conductors of the switching apparatus to corresponding contacts associated with the "tens" relays. When the unit relay UO operates it connects the tip, ring, and sleeve conductor of the switching apparatus to the tip, ring, and sleeve conductor of the first line associated with the "tens" relay which is operated. A connection is established by first selecting the "tens" relay having the desired line within its group and then selecting the proper "units" relay to select the individual line desired in that group and then connecting the proper ringing current to that line.

Having described in general the circuit of the apparatus used in my invention, I will next describe the operation of the same in establishing the different connections.

25 If the subscriber at station A whose line terminates in Fig. 1 desires to converse with another subscriber whose line also terminates at the private branch exchange, he will remove his receiver from its switch hook thereby establishing an energizing circuit for the line relay LR of line circuit L. This circuit may be traced from ground through the upper winding of relay LR, normal contact 32 of relay CO, conductor 2, through the closed switch hook contacts at the calling subscriber's station back over conductor 1, normal contact 33 of relay CO, and through the lower winding of relay LR to battery. The line relay LR energizes and closes its alternate contact 29. The closure of contact 29 grounds the conductor 11 and causes the motor magnet MM to operate to step the wipers 3, 4, 5 and 6 into engagement with the first set of contacts 7, 8, 9 and 10. The energizing circuit of motor magnet MM may be traced from battery, resistance R, conductor 22, motor magnet MM, normally closed contact 34, contact 36 of the off normal springs ON, conductor 37, normally closed contact 38 of sleeve relay SL, conductor 11, the ground at alternate contact 29 of relay LR. The circuit of the motor magnet MM is opened upon the first step of the wipers 3, 4, 5 and 6 due to the opening of contact 36 of the off normal springs ON which assume their alternate position upon the first movement of the wipers 3, 4, 5 and 6. The closure of alternate contact 36 of ON establishes an illuminating circuit for an off normal pilot lamp OFL. This off normal pilot lamp remains illuminated during the time the switch is hunting the calling line and if the switch does not find the calling line the burning lamp will indicate to an attendant which switch is giving the trouble.

A substitute circuit for the motor magnet MM is established if the first set of contacts 7, 8, 9 and 10 are not the contacts of the line of the calling subscriber. This circuit may be traced from battery, resistance R, motor magnet MM, closed contact 34, alternate contact 39 of the off normal springs ON, conductor 40, normally closed contact 41, conductor 42 to ground at normally closed contact 30 of the bridging relay BG. The contact 34 of the motor magnet MM is moved to its alternate position upon the energization of the motor magnet MM and thus opens the ener-

energizing circuit of the same which immediately releases its armature and again closes the contact 34 to establish another energizing circuit for the magnet MM to step the wipers 3, 4, 5 and 6 into engagement with the next set of contacts. The alternate opening and closing of the contact 34 causes the wipers to be stepped over the contacts 7, 8, 9 and 10 in search of the contacts of the calling line. Condenser *x* is bridged across the motor magnet MM to prevent sparking during the rapid opening and closing of the contact 34.

The instant wiper 5 engages the contact 9 associated with the calling line, a shunt circuit for the motor magnet MM is established and prevents the further operation of the motor magnet so that the wipers remain in engagement with contacts 7, 8, 9 and 10 of the calling line. This shunt circuit which is also an energizing circuit for the bridging relay BG may be traced from battery through resistance R, lower winding of the relay BG, conductor 44, normal closed contact 45 of the relay BR, conductor 46, normal closed contact 47 of the sleeve relay SL, wiper 5, contact 9, to ground at alternate contact 29 of relay LR. Due to the relative resistances of MM and BG the flow of current through MM will be insufficient to energize MM and the wipers will remain in engagement with the contacts of the calling line.

Upon energizing, bridging relay BG also opens the circuit of the motor magnet MM at its contact 30 and establishes an energizing circuit for the sleeve relay SL, and the cut-off relay CO which circuit may be traced from battery, through the upper winding of relay SL, conductor 48, alternate closed contact 49 of relay BG, conductor 50, wiper 4, contact 8, conductor 51, through the winding of relay CO to ground. The cut-off relay CO energizes and opens its contacts 32 and 33 to deenergize relay LR which restores contact 29 and thereby removes ground from contact 9 and starting conductor 11. The removal of ground from contact 9 allows the wipers of another finder switch of the group to pass over the line of this calling subscriber should another finder switch of the group be operated during the present connection.

The heavily marked talking conductors TC and TC' are closed at alternate contacts 52 and 53 of the bridging relay BG to extend the talking circuit through to the connector circuit. The closing of alternate contact 54 of the relay SL opens the circuit of the off normal pilot lamp OFL and also establishes a locking circuit for the said relay which may be traced from battery through the lower winding of the relay SL, alternate contact 54, conductor 55, to ground at alternate contact 56 of the off normal springs ON. This circuit maintains the sleeve relay SL in its energized position until the off normal springs ON are restored to normal which restoration does not take place until the wipers 3, 4, 5 and 6 have been restored to their normal position by the operation of the release magnet RE. The conductor 11 is a common starting conductor and is associated with the contact 29 of all the relays LR of the group. Upon the energization of relay SL its contact 38 assumes its alternate position to extend the common starting conductor 11 through to the next finder switch of the group by way of connection *p*. Battery potential on conductor 3a will cause the line of subscriber A to test busy should it be seized as a called line during the connection.

Upon the closure of alternate contacts 52 and 53 of BG an energizing circuit is established for

the supervisory relay SR which circuit may be traced from battery through the lower winding of relay SR, conductor 57, alternate contact 53 of relay BG, wiper 6 and contact 10, over the subscriber's line and back through contact 7 and wiper 3, alternate contact 52 of BG, conductor 58, through the upper winding of relay SR to ground. Relay SR energizes and closes its alternate contact 59 which establishes an energizing circuit for busying relay BR. This circuit may be traced from battery, through the relay BR and alternate contact 59 to ground. The opening of contact 47 of relay SL interrupted the original energizing circuit of the bridging relay BG but as the relay BG is slow to release a substitute circuit is closed through alternate make-before-break contact 60 of relay BR and the bridging relay BG is maintained energized by current flowing from battery, through resistance R, lower winding of relay BG, conductor 44, make-before-break contact 60 and the upper winding of BG to ground.

The closing of alternate contact 61 of relay BR establishes a power starting circuit for a ringing and tone machine (not shown) which supplies ringing current, a dialing tone, and a busy tone. This circuit can be traced from ground at alternate contact 61 of BR, conductor 161, normal contact 180 of CSR to connection MS and then through the machine.

Dialing operation

As soon as the relay BG operates to connect the finder switch FS to the selector switch SS the calling subscriber will receive a dialing tone which informs the subscriber that the dialing may be started. This dialing tone circuit may be traced from conductor 65 which leads to the dial tone connection DT of the tone machine and is common to the switch group, normal contact 66 of relay RCO of the selector circuit, normal contact 133 of CTR, over the heavily marked talking conductor TC, alternate contact 53 of relay BG, wiper 6, contact 10, conductor 1 to the subscriber's receiver. Upon receiving this signal the calling subscriber will know that the apparatus is in condition for the dialing operation.

Assuming that the called subscriber's number is "412", the calling subscriber will operate the calling device CD to dial the number 4 and thereby interrupt the talking conductors four times in the usual manner. Upon the first interruption of the talking conductors the supervisory relay SR will restore to normal and close its normal contact 59. The relay BR will remain in its operated position due to the copper slugs which make it slow acting, thus grounding the dialing conductor DC and closing the energizing circuits for the switching relay SW, and the first dialing or counting relay A. The circuit for the switching relay SW may be traced from battery through the winding of the relay SW, to the conductor DC; the one for the counting relay A from battery through the winding of the relay A, through normal contacts 93, 94 and 95 to the dialing conductor DC, which dialing conductor is connected to ground at normal contact 59 of relay SR through alternate contact 74 of relay BR.

The switching relay SW remains energized during the rapid interruptions of the line, due to its slow-to-release construction. The counting relay A establishes a locking circuit for itself and an energizing circuit for the sequence switching relay SQA. This circuit may be traced from grounded battery through the winding of relay

A, alternate contact 101 of A, conductor 102, through the winding of relay SQA, normal contact 103, locking conductor LC to ground at the "tens" locking ground TLG of relay TLR. The next succeeding impulse causes the operation of counting relay B. The initial energizing circuit being traced from grounded battery through the winding of relay B, alternate contact 104 of A, alternate contact 93 of SQA, normal contacts 94 and 95, dialing conductor DC to ground at alternate contact 59 of relay SR. Counting relay B energizes and establishes a locking circuit for itself and an energizing circuit for sequence switching relay SQB. These relays are maintained operated by current flowing from grounded battery through the winding of relay B, alternate contact 101, conductor 106, winding of relay SQB, normal contact 107 of SQA, the locking conductor TLC to ground at contact TLG. The opening of contact 103 of SQB causes the de-energization of relays SQA and A. The next impulse causes the operation of counting relay C by current flowing from grounded battery through the winding of relay C, alternate contact 104b of relay B, alternate contact 94 of relay SQB, normal contact 95 of SQA to ground over the dialing conductor DC. The closing of alternate contact 101c establishes a locking circuit for the relay C and an energizing circuit for sequence switching relay SQC. These relays are held operated by current flowing from grounded battery through the winding of relay C, alternate contact 101c, conductor 108, winding of relay SQC, normal contact 109 of SQA, locking conductor LC to ground TLG. The operation of relay SQC opens the holding circuit for the relays B and SQB at its alternate contact 107 and these relays accordingly restore their contacts to their normal positions. The fourth interruption of the line by the dialing contacts causes the operation of counting relay D, which is operated by current flowing from grounded battery, alternate contact 104c, alternate contact 95 of relay SQC to ground over the dialing conductor DC. The closure of alternate contact 101d of relay D establishes a locking circuit for the relay D and an energizing circuit for the relay SQA. The circuit for these relays can be traced from grounded battery through the winding of relay D, alternate contact 101d, the winding of SQA, normal contact 103 of SQB, locking conductor TLC to ground TLG. Relay SQA operates and opens its contact 103 to interrupt the holding circuit for counting relay C and sequence relay SQC, which relays restore to normal. At the end of the impulses the relay SR in Fig. 1 remains energized and ground is removed from the dialing conductor DC a sufficient length of time to permit the deenergization of switching relay SW. The restoration of normal contact 110 of SW closes an energizing circuit for the "tens" relay T4 associated with a group of ten lines in which the desired line is located. This relay is not shown in Fig. 4, but its circuit is similar to that of relay T1. This circuit to be traced from grounded battery through the winding of relay T1, make-before-break contact 111, conductor c10 (in the case of relay T4, this conductor will be conductor c40), alternate contact 113d of relay D, conductor 114, normal contact 115 of relay TLR, conductor 116, alternate contact 117 of relay SQA, normal contact 110 of relay SW, conductor 161, alternate contact 61 of busy relay BR in Fig. 1 to ground. The relay T4 establishes a locking circuit for itself through its alternate contact

111, common locking conductor CLC, winding of relay TLR, conductor 161 to ground at alternate contact 61 of relay BR. The "tens" locking relay TLR is energized by current flowing over this circuit and it opens its contact TLG to remove ground from the locking conductor LC which causes the restoration of counting relay D and sequence relay SQA.

The subscriber A next dials the second digit, which in this case is I. The supervisory relay SR deenergizes to place ground upon the dialing conductor DC. The switching relay SW will be energized and the dialing relay A will also be energized over a circuit previously traced. The unit switching relay USR of Fig. 2 is energized by current flowing from grounded battery through the winding of relay USR, alternate contact 118, conductor 119, alternate contact 110 of relay SW, conductor 161 to ground at busy relay BR in Fig. 1. The dialing relay A establishes a locking circuit for itself and an energizing circuit for the sequence relay SQA over the locking conductor LC, alternate contact 120 to ground at unit locking ground ULG of relay ULR. As there is but one interruption of the line, the supervisory relay SR energizes to remove ground from the dialing conductor DC, which causes the restoration to normal of the switching relay SW, thereby establishing an energizing circuit for the unit relay UI. This circuit can be traced from grounded battery through the winding of relay UI, make-before-break contact 121, conductor 122, alternate contact 123 of relay A, conductor 151, normal contact 124 of ULR, alternate contact 125 of relay USR, conductor 116, alternate contact 117 of SQA, normal contact 110 of SW and conductor 161 to ground at alternate contact 61 of relay BR. Unit relay UI establishes a locking circuit for itself through its alternate contact 126 and unit locking conductor ULC, winding of relay ULR, conductor 161 to ground at alternate contact 61 of relay BR.

The energization of unit relay UI connects the tip, ring and sleeve conductors T, R and S of the switching apparatus to the line desired which, in this instance, is line 41. These conductors are extended through alternate contacts 127 of relay UI and 128 of relay T4 (not shown). Units locking relay ULR will be energized over the previously traced circuit and will open normal contact ULG which removes the unit locking ground from the locking conductor LC and causes the restoration of relays A and SQA, which were used in selecting the desired unit relay. Relay ULR closes its alternate contact 129 to connect test battery TB to the sleeve conductor S of the line. Current flows from test battery TB, resistance RA, alternate contact 129 of ULR, conductor S, alternate contact 127 of UI and alternate contact 128 of relay T4 (not shown) to all the multiple contacts of line 41. This battery potential being on the sleeve conductor S of the line will cause it to test busy should any other switching apparatus be connected thereto, as will be described later. The cut-through relay CTR is operated by current flowing from grounded battery through the winding of relay CTR, normal contact 130 of ringing cut-off relay RCO, alternate contact ULG to ground. The relay CTR closes its alternate contacts 131 and 132 to extend the talking conductors TC and TCI through to the calling line. The opening of contact 133 removes the dial tone from the calling party's line.

Selection of ringing current

Next the operator dials the third digit which selects ringing current of the proper frequency to operate the ringer at the station of the desired party. In our assumption, this number was 2. Therefore, the line conductors will be interrupted twice. The supervisory relay SR will be deenergized two times. The switching relay SW and dialing relay A will operate upon the first impulse. The second impulse will cause the operation of counting relay B which will lock itself up over a circuit previously described. The party line switching relay PTS operates after the first impulse over a circuit traced from grounded battery through the winding of PTS, alternate contact 134 of ULR, conductor 135, alternate contact 136 of SW, conductor 161 to ground at alternate contact 61 of relay BR. Relay PTS closes its alternate contact 137 to lock itself up over conductor 161 and alternate contact 61 of relay BR. At the end of the impulses the switching relay SW reenergizes. The ringing control relay RCR is then energized by current flowing from grounded battery through the winding of relay RCR, alternate contact 138 of relay PTS, alternate contact 125 of USR, conductor 116, alternate contact 117 of SQA, normal contact 110 of SW, conductor 161, alternate contact 61 to ground. Relay RCR energizes and opens its alternate contact 139 to interrupt the dialing conductor DC, opens alternate contact 140 to interrupt the circuit of the polarized relay POL and closes its alternate contact 141 to establish an energizing circuit for the ringing interrupter relay RI. This circuit can be traced from grounded battery, alternate contact 142 of ringing cut-off relay RCO, alternate contact 141 of relay RCR, winding of relay RI to ground through a constantly rotating interrupter not shown but connected to connection INT. The ringing interrupter relay RI is alternately energized and deenergized over this circuit. Each time it is energized its contacts 143 and 144 move to their alternate positions to open the talking conductors TC and TC1 and to apply ringing current to the line of the called party. This ringing current can be traced from one side of the generator source, alternate contact 145b of counting relay B, through normal contacts 145c, 145d and 145e, conductor 146, alternate contact 143 of relay RI, alternate contact 132 of CTR over the heavily marked conductor R, alternate contact 127 of relay UI, alternate contact 128 of relay T4 over the subscriber's line and back through alternate contacts 128 and 127, heavily marked conductor T, alternate contact 131 of relay CTR, alternate contact 144 of relay RI, the conductor 147, normal contacts 145f, 145i, 145h, 145g, 145j to the grounded side of the ringing generator. Ringing current is intermittently applied to the subscriber's line over this circuit. The ringing tone relay RTR was energized, over an obvious circuit, the first time the ringing interrupter relay RI energized. Due to the construction of relay RTR it is slow to release and therefore remains energized a short period after the ringing interrupter relay RI is deenergized, however, it does restore between each ringing period. The ringing tone relay RTR closes its alternate contacts 148 and 149. The closing of alternate contact 149 connects a ringing tone from a ringing tone machine (not shown), which is connected to connection RT. This ringing tone travels from connection RT to alternate contact 149 of relay RTR over

conductor TC to the subscriber's station and informs the subscriber that ringing current has been applied to the called line. The closing of alternate contact 148 of relay RTR connects the talking conductors together through conductor 152. This connection is momentarily maintained after relay RI restores and serves to discharge the residual ringing current on the called line to prevent any kick back of the current into the finder switch circuit.

If the called subscriber removes his receiver during a ringing period, no action will take place until the end of that ringing period, at which time the ringing interrupter relay RI deenergizes. Ringing tone relay RTR remains energized momentarily to discharge the residual ringing current on the called line and then closes normal contacts 143 and 149. The closing of these contacts establishes an energizing circuit for the called supervisory relay CSR. This relay is energized by current flowing from grounded battery through the winding of relay CSR, normal contact 149, over the heavily marked talking conductor through the receiver at the subscriber's station, back over the other side of the line to normal contact 148 of relay RTR and the upper winding of relay CSR to ground. The relay CSR closes alternate contact 162 to establish an energizing circuit for the ringing cut-off relay RCO, which relay is energized by current flowing from grounded battery, alternate contact 162 of relay CSR, conductor 163, the winding of relay RCO to ground. Relay RCO energizes and closes alternate contact 142, which opens the energizing circuit for the ringing interrupter relay RI which will remain deenergized and close normal contacts 143 and 144 to complete the talking circuit. The closing of alternate contact 142 establishes a locking circuit for the ringing cut-off relay RCO which may be traced from grounded battery, alternate contact 142, conductor 63, alternate contact 62 of relay BR, conductors 64 and 163 to ground through the winding of the relay RCO. The cut through relay CTR remains energized through its alternate contact 164 and alternate contact 130 of relay RCO. The relay CTR is slow to release and remains energized during the movement of alternate contact 130 from its normal to its alternate position. When the called supervisory relay CSR operated and closed alternate contact 180 it interrupted the energizing circuit of the ringing and tone machine and connected ground to conductor 161. This ground at alternate contact 180 of relay CSR is the holding ground for all the apparatus of the connector and selector of my system.

Disconnection

Upon the termination of the conversation the subscribers replace their receivers upon their respective switch hooks. The replacing of the receiver at the calling station A will open the energizing circuit of the supervisory relay SR, which relay will restore its contact 59 to its normal position, thereby opening the energizing circuit of the busying relay BR, which relay will also restore its contacts to their normal position. The opening of contact 60 will cause the deenergization of the bridging relay BG which will open its contacts 52 and 53 to open the talking conductors at that point. The opening of contact 49 breaks the energizing circuit of cut-off relay CO which restores and also removes battery potential from test conductor 3a which

will permit line A to test idle. The closing of normal contact 30 establishes an energizing circuit for the release magnet RE, which will be operated by current flowing from grounded battery through the winding of release magnet RE, alternate contact 41 of relay SL, conductor 42 and normal contact 30 of relay BG to ground. The release magnet RE energizes and restores the switch wipers 3, 4, 5 and 6 and the off-normal contacts ON to their normal positions. The opening of the off-normal contact 56 breaks the locking circuit of the sleeve relay SL but relay SL does not restore due to ground at contact 180 of CSR being connected to conductor 161.

When the relay BR restored, it opened contact 62, which interrupted one energizing circuit of the ringing control relay RCO. Relay RCO does not open the energizing circuit for the cut through relay CTR as it is held operated over another circuit. The remaining apparatus is held under the control of the called subscriber. When he replaces his receiver the energizing circuit for the called supervisory relay CSR is opened and it restores its contact 162 to open the second energizing circuit of the ringing control relay RCO. Relay CSR removes the holding ground from the conductor 161 and causes the restoration to normal of the sleeve relay SL in Fig. 1, the party switching relay PTS, the unit locking relay ULR, the unit switching relay USR, the unit relay UI in Fig. 4. The operated "tens" relay T4 is also deenergized and the called line is severed from the connection and the apparatus is in condition to establish another connection.

If called line is busy

If the called line is busy when it is seized by the operation of the relay UI its S conductor will have a battery potential thereon. The operation in establishing a connection to a busy line is exactly the same up to the point where the unit relay UI operates. If the battery potential is present on the S conductor an energizing circuit for the busy test relay BTR will be established.

This circuit can be traced from ground through the winding of relay BTR, normal contact 129 of relay ULR, conductor S, alternate contact 127 of relay UI and 128 of relay T4 over the sleeve conductor and the multiple contacts and through operated contacts of a "tens" and "unit" relay in the connector circuit of the established connection over the sleeve conductor S of that connector, through alternate contact 129 of the relay ULR in the other connector to the test battery. An alternative circuit is present when the busy line is a calling line. In such instances the circuit for relay BTR is through conductor S, conductor 3a in Fig. 1 of the busy line, contact 8, wiper 4, conductor 50, alternate contact 49, upper winding of SL to battery and ground. The busy test relay BTR energizes and establishes an obvious energizing circuit through its alternate contact 164 for the ringing cut-off relay RCO, which operates to prevent the connection of ringing current to the called line, which in this instance is busy. The closing of alternate contact 66 of relay RCO connects a busy tone to the line of the called subscriber and he is thereby informed that the called line is busy. He will thereupon replace his receiver and cause the restoration of the apparatus to normal, as previously explained.

Connection between subscribers on same line

If, however, the calling party is calling another subscriber located on the same line, the calling

subscriber will not replace his receiver at this time. The energization of busy test relay BTR closed its alternate contact 165 to establish an energizing circuit for the polarity reversing relay PRR in Fig. 1. This relay will be energized by current flowing from grounded battery, winding of PRR, conductor 266 and alternate contact 165 of relay BTR to ground. The operation of relay PRR closes alternate contacts 166 and 167, which reverses the polarity of the battery on the talking conductors and causes the operation of the polarized relay POL. This circuit can be traced from grounded battery, lower winding of relay SR, make-before-break contacts 31 and 166, conductor 58, over the talking conductor, wiper 3, contact 7, conductor 2a, multiple contacts and through the alternate contacts 128 of the operated "tens" relay, alternate contacts 127 of relay UI, the talking conductor, to normal contact 131 of relay CTR, conductor 168, upper winding of polarized relay POL, conductor 169, normal contact 140 of relay RCR, conductor 170, lower winding of relay POL, conductor 171, normal contact 132 of relay CTR, the talking conductor, alternate contacts 127 and 128 of UI and T4, multiple contacts to conductor 1a, contact 10, wiper 6, talking conductor to alternate contact 53 of relay BG, alternate contact 167, upper winding of relay SR to ground. The polarized relay POL energizes over this circuit and closes an energizing circuit for the reverte call relay RCC. This relay is operated by current flowing from grounded battery through the winding of relay RCC, alternate contact 172 of POL, conductor 173 to ground at PLG of relay PTS. Relay BTR is operated only while the units relay is not energized; as soon as relay ULR energizes contact 129 opens the energizing circuit of relay BTR which then deenergizes. Relay BTR is provided with a copper sleeve and is therefore slow in releasing but when it does release relay PRR releases and restores normal polarity to the line conductors from battery through the winding of relay SR. Polarized relay POL releases contact 172 which opens the operating circuit of relay RCC. Relay RCC is also slow to release and maintains its contact 201 closed a sufficient time to cause the energization of the reverte call locking relay RCL by current flowing from battery, normal contact 162 of CSR, winding of relay RCL, alternate contact 201 of RCC, normal contact 172 of POL, conductor 173 to ground at PLG of relay PTS. Relay RCL locks up through its own contacts 202 and 203 to ground. The closing of alternate contact 203 keeps ground MG on lead 161 to hold the calling line end of the circuit during the period that the calling subscriber replaces his receiver to permit the application of ringing current to the line.

The busy test relay BTR and the polarity reversing relay PRR operate each time the link circuit selects a busy line and the polarity of the current is reversed in the calling end of the link each time but this reversal of current has no effect except when both ends of the link are connected to the same line.

The calling party, having tested the line to determine its busy condition at the time he initiated the call knows that the busy signal is caused by his operation of the connector switch and will proceed to dial to connect the proper generator current to the line to operate the call bell at the station of the desired subscriber. In our assumption, 2 was considered the last digit of the called line number. The subscriber will dial the digit 2, which will interrupt the line con-

ductors two times to cause the supervisory relay SR to deenergize and energize twice. As previously explained, the grounding of the dialing conductor DC causes the operation of the switching relay SW and of the dialing relay A. The second time the relay SR falls off the dialing relay B is operated and locks up through its alternate contact 161b to ground at PLG of relay PTS. After the subscriber has dialed he will replace his receiver upon its switch hook, which operation will cause the restoration to normal of the finder switch FS, as previously explained, with the exception that the sleeve relay SL will not restore due to the fact that there is a ground at contact 15 MG of relay RCL. The deenergization of busy-
ing relay BR opens the locking circuit of the ringing control relay RCO, which relay closes its normal contact 142 to establish an energizing circuit for the ringing interrupter relay RI through alternate contact 141 of ringing control relay RCR. RCO releasing cuts off the busy tone and also establishes an energizing circuit to operate relay CTR. Ringing interrupter relay RI is alternately energized and deenergized to intermittently connect the generator current from the alternate contacts of relay B out over the line. The removal of the receiver at the station, of either the called or calling party, establishes an energizing circuit for the called supervisory relay CSR, which relay energizes to again operate the ringing cut-off relay RCO to stop the application of ringing current to the line and to connect the subscribers into a conversational circuit in which talking current is supplied through the windings
of relay CSR.

The restoration of both receivers is required to cause the deenergization of the called supervisory relay CSR. Relay CSR deenergizing opens its alternate contact 180, which removes holding ground from the conductor 161 and permits all the relays to restore to normal to again place the connecting apparatus in condition for the establishment of another connection.

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

1. A telephone system including an exchange, a plurality of lines terminating at said exchange, a plurality of stations on certain of said lines, link means at said exchange for interconnecting any of said stations, a source of battery current associated with said link means, means for rendering any of said lines busy, means responsive to the engagement of said link with a busy line for immediately reversing the flow of said battery current.

2. A telephone system including a subscriber's line, a plurality of stations on said line, a link circuit having an answering end and a calling end for interconnecting any of said stations, a source of current connected to said line, and means responsive to the connection of both of said ends to said line to reverse immediately the polarity of said current on said line.

3. A telephone system including a subscriber's line, a plurality of stations on said line, an automatic link circuit having an answering end and a calling end for interconnecting any of said stations, a source of current connected to said link circuit, means responsive to the connection of both of said ends to said line to reverse immediately the polarity of said current on said link, and secondary means comprising a polarized relay responsive to said polarity reversing means.

4. A telephone system including an exchange,

a plurality of subscribers' lines, a plurality of stations on certain of said lines, a two-ended link circuit for interconnecting any of said stations, a source of current connected to said link circuit, means responsive to the connection of both of said ends of said link to the same line to reverse immediately the polarity of said current on said link, a polarized relay responsive to said polarity reversing means and a relay responsive to said polarized relay for holding said link circuit against disconnection.

5. A telephone system comprising an exchange, a plurality of subscribers' lines terminating thereat, a plurality of stations on certain of said lines, a link circuit at said exchange for interconnecting any of said stations, a pair of talking conductors for said link, a source of current connected across said conductors, means for connecting both ends of said link to the same line and means responsive to said connection to reverse immediately the connections between said conductors and said source of current.

6. A telephone system comprising an exchange, a plurality of subscribers' lines terminating thereat, a plurality of stations on certain of said lines, a link circuit at said exchange for interconnecting any of said stations, a pair of talking conductors for said link, a source of current connected across said conductors, means for connecting both ends of said link to the same line, means responsive to said connection to reverse the connections between said conductors and said source of current, and relay means responsive to said reversal for preventing the disconnection of said line and link.

7. A telephone system comprising an exchange, a plurality of lines terminating thereat, a plurality of stations on certain of said lines, a link circuit at said exchange for interconnecting any of said stations, an answering end and a calling end for said link, a source of current connected to said answering end, current reversing means operable when said ends of said link are connected to the same line and means associated with the calling end of said link and controlled by said reversing means for preventing the disconnection of said line and link.

8. A telephone system comprising an exchange, a line terminating thereat, a calling station and a called station on said line, a link circuit for said exchange, means in said link for connecting said line to both ends of said link, a source of current associated with said link, signaling means under the control of the calling station for signaling the called station, means for reversing the connections of said link and said source of current, means responsive to said reversal of current for maintaining the connection of the link and line and for connecting said signaling means to said line.

9. A telephone system including an exchange, a plurality of lines terminating thereat, a plurality of stations on certain of said lines, a link circuit having an answering end and a calling end for interconnecting any of said stations, a source of current connected to a calling line, means responsive to the connection of both of said ends to the same line to reverse immediately the polarity of said current, and means preventing the operation of said last means when said ends of said link are connected to different lines, one of which is idle.

10. A telephone system including an exchange, a plurality of lines terminating at said exchange, a plurality of stations on certain of said lines, a link circuit for interconnecting any of said sta-

tions, a source of current associated with said link circuit, means responsive to the connection of both ends of said link to the same line to reverse immediately the polarity of said current, and secondary means responsive to said polarity reversing means.

11. A telephone system comprising an exchange, a plurality of lines terminating thereat, a plurality of stations on certain of said lines, an interconnecting circuit comprising a plurality of automatic switches for interconnecting any of said stations, a source of current connected to said circuit, and means responsive to the connection of both ends of said circuit to one of said lines for immediately reversing the connections between the said source of current and said circuit.

12. A telephone system comprising an exchange, a plurality of lines terminating at said exchange, a plurality of stations on certain of said lines, a link circuit for interconnecting any of said stations comprising a finder switch and a connector switch, a source of current connected to said link, means responsive to the connection of said finder switch and connector switch to the same line for immediately reversing the connections between said source of current and said link.

13. A telephone system comprising an exchange, a plurality of lines terminating at said exchange, a plurality of stations on certain of said lines, a link circuit for interconnecting any of said stations comprising a finder switch and a connector switch, a source of current connected to said link, means responsive to the connection of said finder switch and connector switch to the same line for immediately reversing the connections between said source of current and said link, and relay means responsive to said reversal for holding said connector switch connected to said line.

14. A telephone system comprising an exchange, a plurality of lines terminating at said exchange, a calling station and a called station on one of said lines, a link circuit for interconnecting said calling and called stations, circuit controlling means at said stations, a finder switch in said link responsive to the circuit controlling means at said calling station to connect one end of said link to the calling station, a connector switch for connecting the other end of said link to the line of the called station, a source of current connected to said link, means responsive to the connection of said connector switch to said line for reversing the connections of said link and said source of current.

15. A telephone system comprising an exchange, a plurality of lines terminating at said

exchange, a calling station and a called station on one of said lines, a link circuit for interconnecting said calling and called stations, circuit controlling means at said stations, a finder switch in said link responsive to the circuit controlling means at said calling station to connect one end of said link to the calling station, a connector switch for connecting the other end of said link to the line of the called station, a source of current connected to said link, means responsive to the connection of said connector switch to said line for reversing the connections of said link and said source of current, relay means in said link circuit responsive to the circuit controlling means at the calling station for disassociating the finder switch from said line.

16. A telephone system comprising an exchange, a plurality of lines terminating at said exchange, a calling station and a called station on one of said lines, a link circuit for interconnecting said calling and called stations, circuit controlling means at said stations, a finder switch in said link responsive to the circuit controlling means at said calling station to connect one end of said link to the calling station, a connector switch for connecting the other end of said link to the line of the called station, a source of current connected to said link, means responsive to the connection of said connector switch to said line for reversing the connections of said link and said source of current, means at said exchange for signaling the called station, relay means in said link responsive to the circuit controlling means at the calling station for connecting said signaling means to said line.

17. A telephone system comprising an exchange, a plurality of lines terminating at said exchange, a calling station and a called station on one of said lines, a link circuit for interconnecting said calling and called stations, circuit controlling means at said stations, a finder switch in said link responsive to the circuit controlling means at said calling station to connect one end of said link to the calling station, a connector switch for connecting the other end of said link to the line of the called station, a source of current connected to said link, means responsive to the connection of said connector switch to said line for reversing the connections of said link and said source of current, relay means in said link circuit responsive to the circuit controlling means at the calling station for disassociating the finder switch from said line and means at said exchange for signaling the called station, relay means in said link responsive to the circuit controlling means at the calling station for connecting said signaling means to said line.

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