Jan. 14, 1941. G. KINER 2,228,392

TELEPHONE SYSTEM

Filed Feb. 27, 1937 6 Sheets-Sheet 1

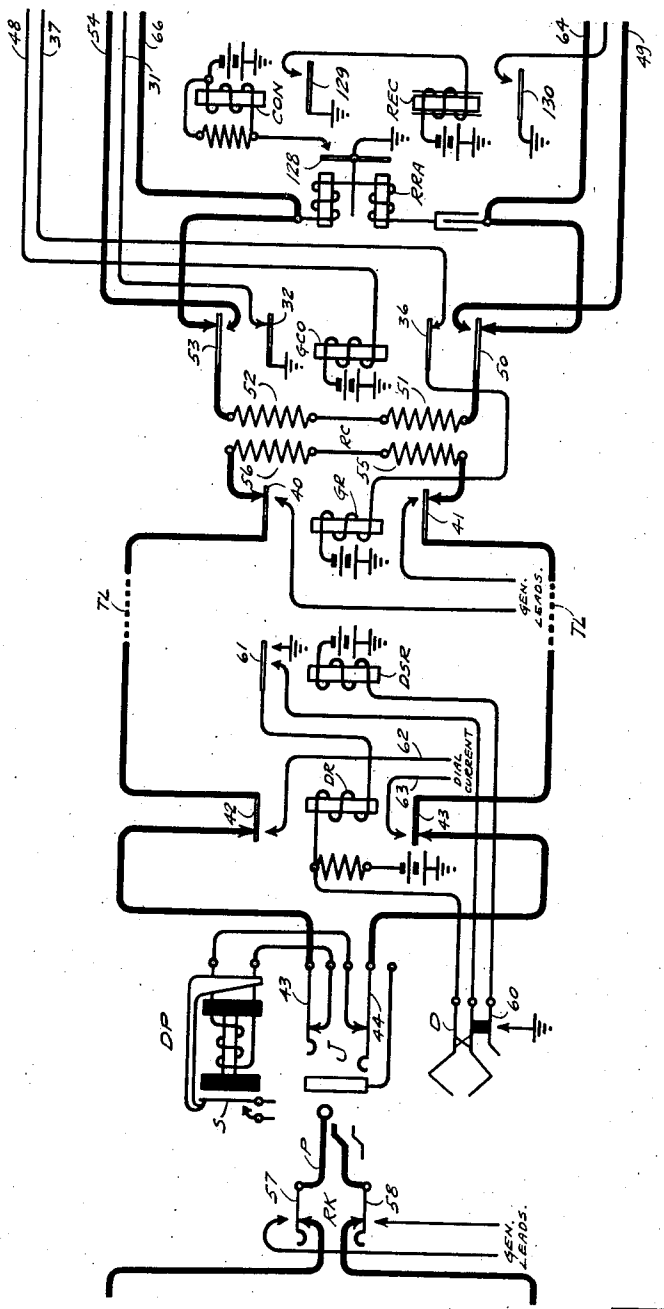

Fig. 1.

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TELEPHONE SYSTEM

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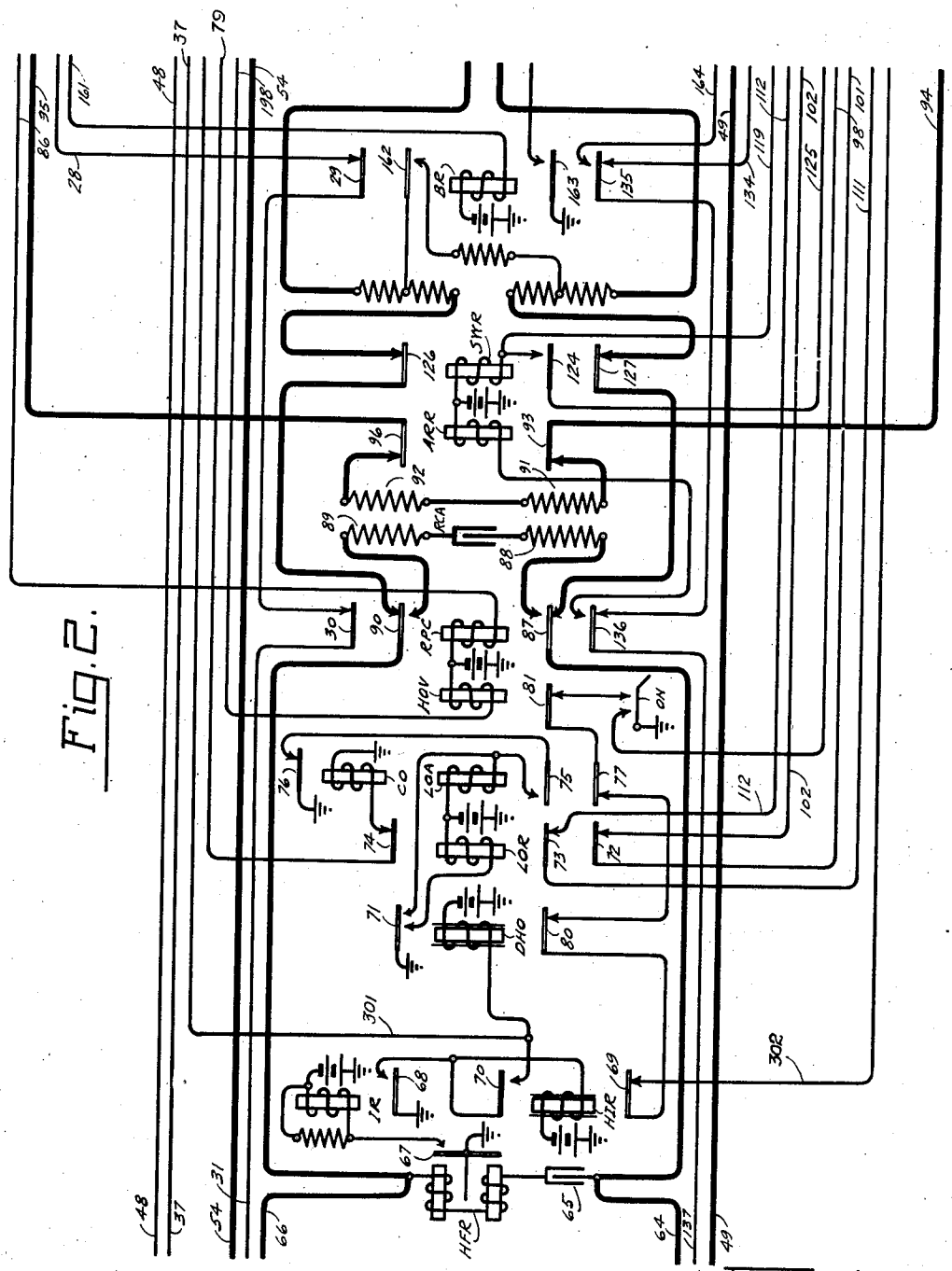

Fig. 2.

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TELEPHONE SYSTEM

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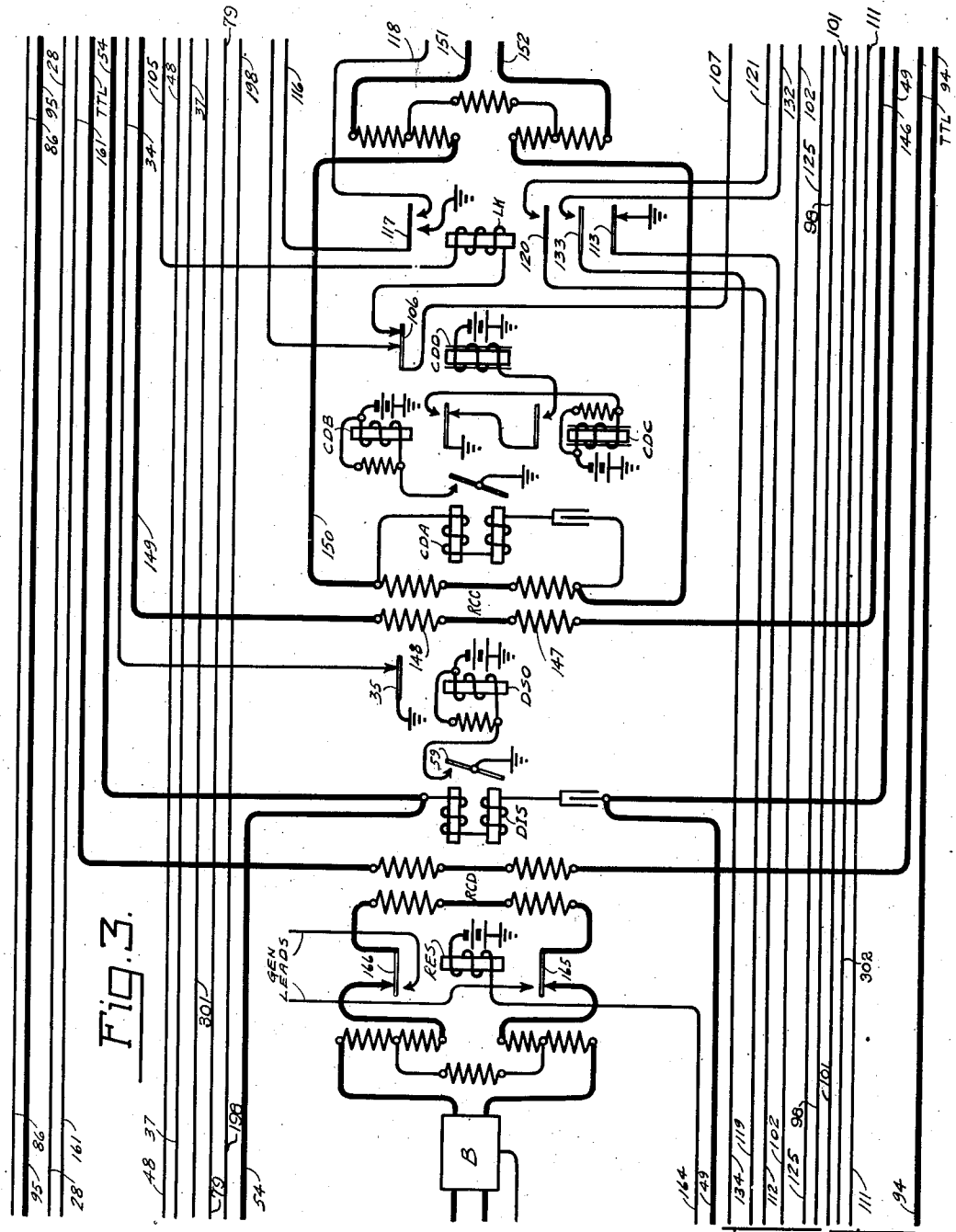

Fig. 3.

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TELEPHONE SYSTEM

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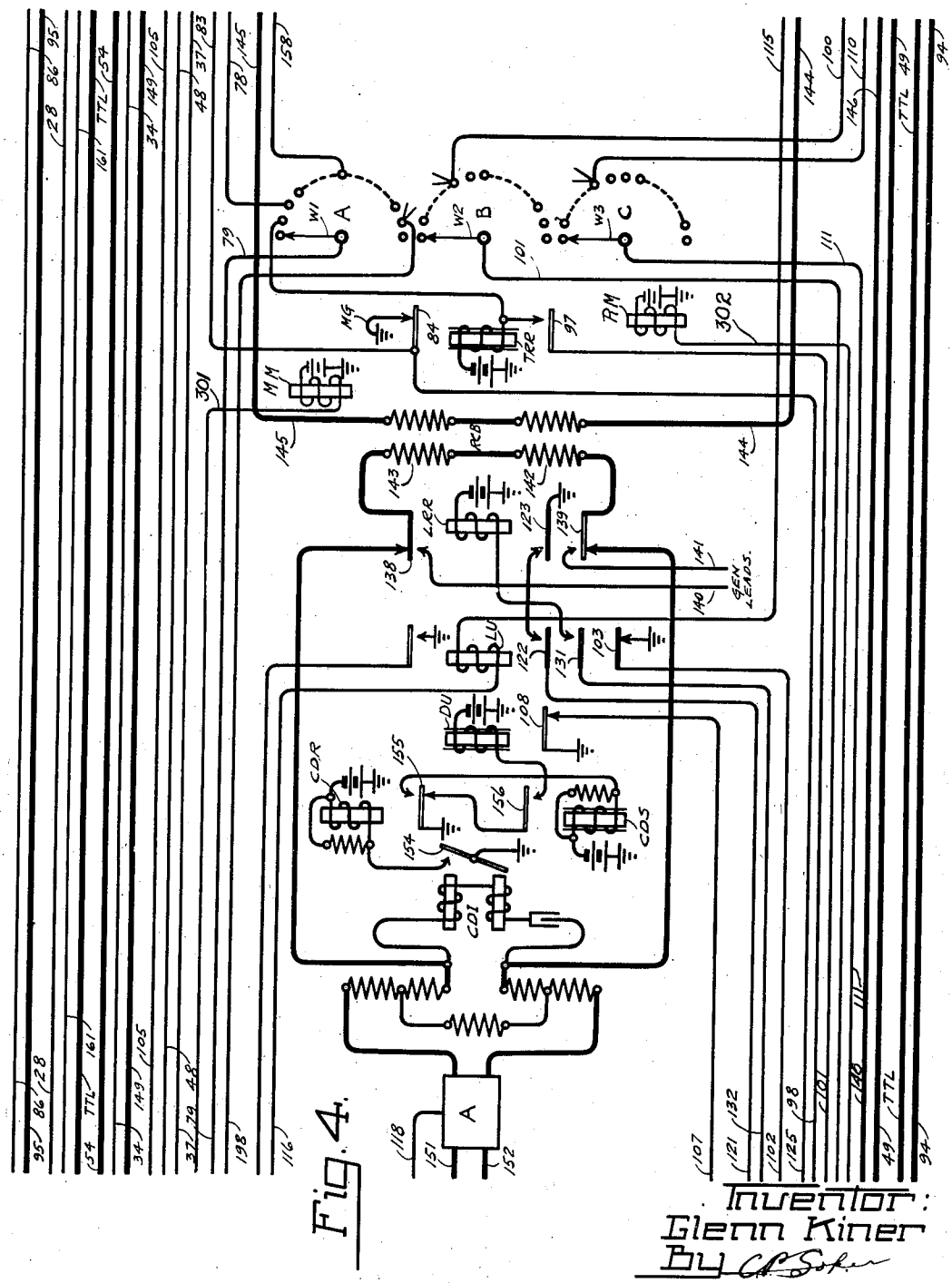

Fig. 4.

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TELEPHONE SYSTEM

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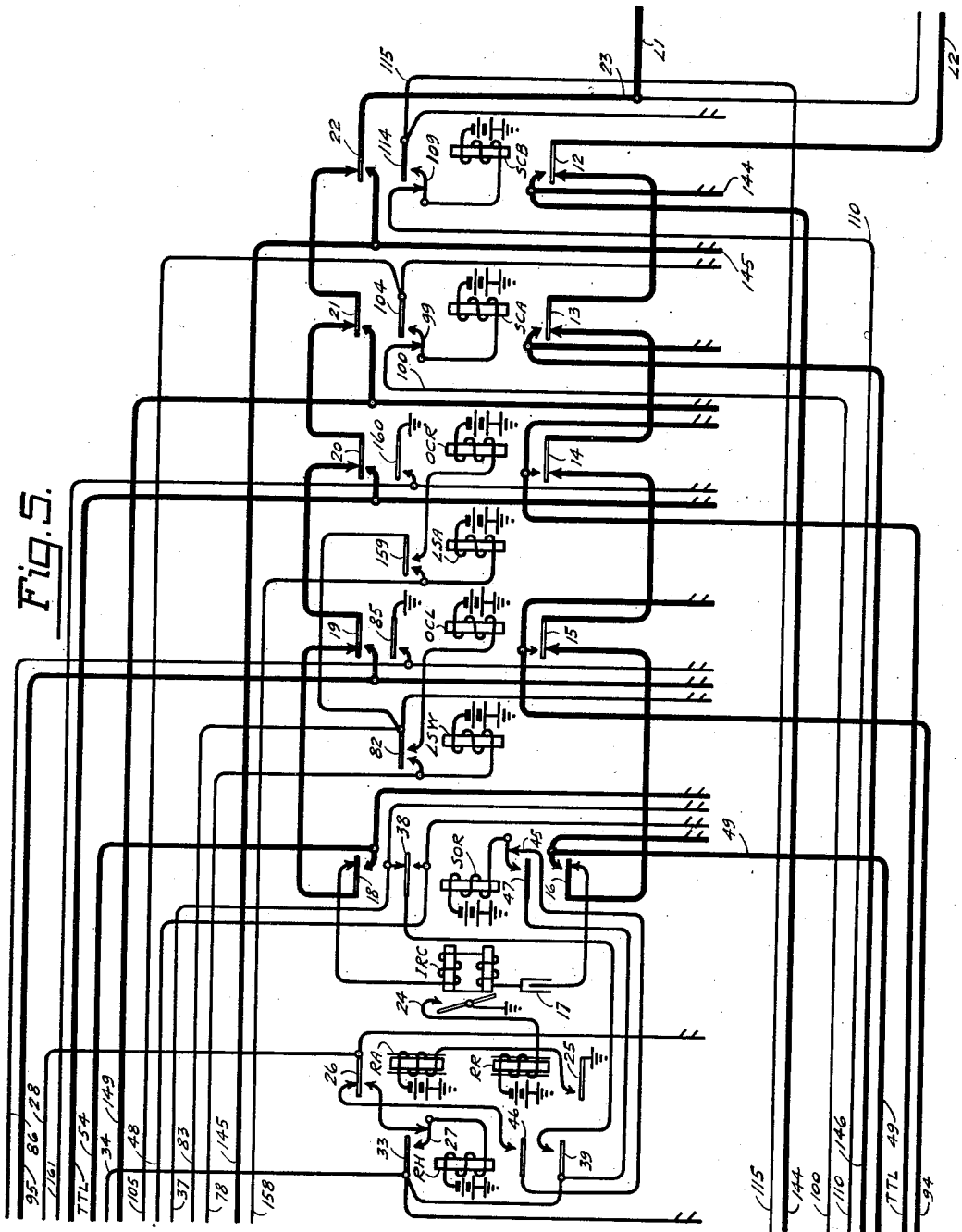

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TELEPHONE SYSTEM

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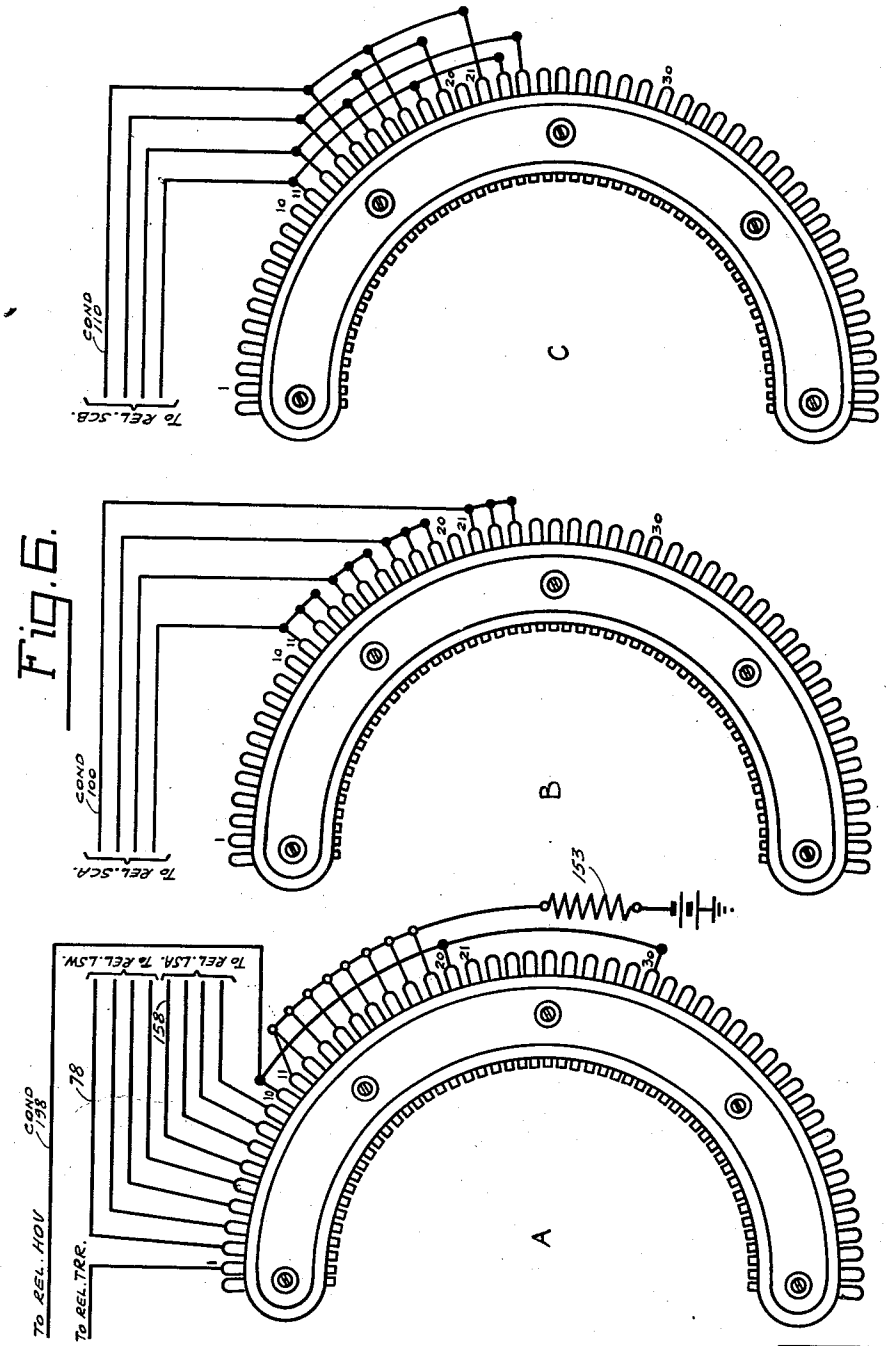

Fig. 6.

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Patented Jan. 14, 1941 2,228,392

UNITED STATES PATENT OFFICE

2,228,392

TELEPHONE SYSTEM

Glenn Kiner, Park Ridge, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill., a corporation of Illinois

Application February 27, 1937, Serial No. 128,051

6 Claims. (Cl. 179—17)

My invention relates to telephone systems and more particularly to telephone systems of the type in which remotely located lines terminating at a satellite exchange are interconnected at a central point by apparatus which is controlled by an operator located at a distant main exchange.

Systems of this kind are used in rural districts where the number of lines is so small that the expense of maintaining an operator at the central point to establish the connection is prohibitive.

My system contemplates the use of lines of the magneto or local battery type in which a plurality of stations may be bridged across each line and provided with code ringing.

A feature of my invention comprises means, located at a central point at which the various lines converge, controlled by an operator over a trunk line to interconnect stations on any two of said lines or any two stations on any one of said lines.

Another feature of my invention is the provision of means in the above described system which permits the use of repeaters between certain of the connections.

Still another feature of my invention is the provision of means whereby a line can be connected at the central point through a repeater and to another line.

Another feature of my invention permits the connection of a line terminating at the central point through a repeater to a trunk line extending to the exchange.

Another feature of my invention is the provision of means located at the central point to interconnect a pair of subscribers' lines through one repeater and to interconnect two other lines through another repeater simultaneously with the existence of the first connection.

Another feature of my invention is the provision of means whereby in order to establish a connection between two of said lines, the operator dials a number which corresponds to a combination of the lines rather than, as is usual, the number of the station desired.

Before going into a detailed description of the present system, perhaps it will be helpful to outline in a general way the manner in which it operates. A series of line connecting relays, such as disclosed in Fig. 5, is provided for each of the lines terminating at the local central point or station. At the local station there is also provided a step by step switch which is operated under the control of a sending device at the main exchange actuated by an operator at the said main exchange. The purpose of the present construction is to provide relays located at the central point which will establish the desired connection and will then be locked up. These relays are energized in various combinations due to the setting of the step by step switch under the control of the operator's dial. For instance if it is desired to connect a calling line at the local central point to another line terminating at said central point, the operator will dial a number corresponding to the connection desired and the setting of the switch under the control of the operator's dial will automatically operate to energize and lock up the relays, individual to the respective lines, which are necessary to establish and maintain the connection. After the called party has been signalled, the switch may be released to be employed in establishing subsequent connections, the connection being maintained by the relays which are locked up during conversation.

In establishing a connection between two lines terminating at the local central point, one of the line connecting relays, such as shown on Fig. 5, individual to each of the lines, will be energized and locked up. While the present application discloses but four local lines, it is obvious that the number of lines may be considerably increased. The number of line connecting relays in each line circuit, such as shown on Fig. 5, and individual to the lines respectively will also be somewhat increased by the increase in the number of lines terminating at the local central point.

The system also provides for revertive calls and calls from subscribers at the local exchange to those whose lines terminate at the main exchange and vice versa.

For a more complete understanding of my invention reference may be had to the drawings comprising Figs. 1 to 6 inclusive, Figs. 1 to 5 of which, when placed consecutively from left to right, show a schematic circuit drawing of my telephone system.

The apparatus disclosed in Fig. 1 to the left of the dotted lines, which indicate the trunk line extending from the exchange to the central point or station, shows the equipment necessary at the exchange. The apparatus in Fig. 1 located to the right of the dotted lines and all the apparatus in Figs. 2, 3, 4, and 5, is located at the local central station or satellite.

My system in its present embodiment contemplates the use of four separate lines, each having a plurality of substations thereon. It is so arranged that different connections can be established by the operation of individual relays, only one of such relays in each line circuit being operated on each respective connection and each respective relay establishing a different connection.

The line circuit apparatus shown in Fig. 5 is furnished for each one of the lines terminating at the central station and certain of the conductors terminating in Fig. 5 are shown as being multipled through the relays in the other line cir-

cuits. These conductors are connected to contacts in all the other line circuits corresponding to those shown in Fig. 5. Each of these line circuits has four conductors extending to various contacts of the selector switch partially shown in Fig. 4. Certain of the contacts of the switch have been omitted as shown by the dotted lines, but Fig. 6 shows all the contacts of the switch and their connections. A more complete description of these connections will be given later on.

The relays of the line circuit associated with line L1 shown in Fig. 5 establish connections as follows:

The operation of line connecting relay SOR connects the calling subscriber on line L1 to the operator at the distant exchange. The operation of line connecting relay OCL connects the operator at the distant exchange to line L1 when a subscriber on line L1 desires to be connected to another subscriber on line L1. The operation of line connecting relay OCR connects the operator or any line at the exchange, to called line L1 through a repeater and the operation of line connecting relays SCA and SCB establishes connections through a repeater between any two of the local lines.

It is believed a better understanding of my invention can be had by following the operation of my system in the establishment of the various connections which are as follows:

Subscriber calls operator

Let us assume that the subscriber on line L1, L2 desires to call the operator to supply her with certain information. The subscriber on L1 initiates the call by operating the hand generator located at the substation to give one long ring. The operator of the hand generator sends ringing current over the line conductors to operate the ringing call relay IRC. This circuit can be traced from one side of the generator at the substation, conductor L2, contacts 12, 13, 14, 15, and 16, condenser 17, through the winding of the polarized relay IRC, normal contacts 18, 19, 20, 21, and 22, and conductor 23, to the other side L1 of the line and hand generator. Ringing call relay IRC closes contact 24 to establish an obvious energizing circuit for the ringing relay RR which closes its contact 25 to establish an energizing circuit for the ringing relay RA, which closes its alternate contact 26 to complete an energizing circuit for the ringing hold relay RH. This relay RH is operated by current flowing from grounded battery, through the winding of relay RH, make-before-break contact 27, alternate contact 26 of relay RA, conductor 28, normal contact 29 of busying relay BR in Fig. 2, normal contact 30 of relay RPC, conductor 31, normal contact 32 of generator cut-off relay GCO to ground. Relay RH establishes a locking circuit for itself which can be traced through its make-before-break contacts 27 and 33, conductor 34, and normal contact 35 of disconnect relay DSO, in Fig. 3, to ground.

Relays RA and RR are constructed so that they are slow to release their contacts and therefore remain energized for a short time after the ringing called relay IRC has deenergized. After the lapse of this time the relays RA and RR restore their contacts to normal and the original energizing circuit for relay RH is interrupted but this relay remains energized through the previously described locking circuit. An energizing circuit for the generator relay GR in Fig. 1 is now closed. This circuit may be traced from grounded battery through the winding of relay GR, normal contact 36 of generator cut-off relay GCO, conductor 37, normal contact 38 of relay SOR, in Fig. 5, alternate contact 39 of relay RH, conductor 34, and over the previously traced locking circuit for relay RH to ground at normal contact 35 of disconnect relay DSO.

Generator relay GR operates and closes its alternate contacts 40 and 41 to connect generator current to the trunk line (shown in dotted lines) which extends from the connecting or central station to the exchange at which the supervising operator is located. The circuit for this generator current can be traced from the generator leads, Fig. 1, through alternate contact 40 of relay GR, trunk line conductor TL, normal contact 42 of dial relay DR, normal contact 43 of jack J, through the winding of the drop DP, normal contact 44 of jack J, normal contact 431 of relay DR, trunk line conductor TL, alternate contact 41 to the other generator lead. The drop DP is actuated by this flow of generator current and the signal S is displayed before the operator to indicate to her that a subscriber desires attention.

Meanwhile, the ringing relay RA has restored its contact 26 to normal to establish an energizing circuit for the subscriber-to-operator connecting relay SOR. This relay is energized by current flowing from grounded battery, normal contact 45, alternate contact 46 of relay RH, normal contact 26 of relay RA, conductor 28, normal contact 29 of busying relay BR in Fig. 2, normal contact 30 of repeater connecting relay RPC, conductor 31 in ground at normal contact 32 of relay GCO in Fig. 1.

The line connecting relay SOR establishes a locking circuit for itself through its alternate contact 47 and conductor 34 to ground at normal contact 35 of relay DSO in Fig. 3.

Relay SOR closes its alternate contact 38 to establish an energizing circuit for the generator cut-off relay GCO in Fig. 1. The relay GCO is energized by current flowing from grounded battery through the winding of generator cut-off relay GCO, conductor 48, alternate contact 38 of relay SOR, alternate contact 39 of relay RH, conductor 34, normal contact 35 of relay DSO to ground. The generator cut-off relay GCO opens its contact 36 to interrupt the energizing circuit for the generator relay GR which restores its contacts 40 and 41 to normal and disconnects the generator current from the trunk line. The opening of contact 32 of relay GCO removes ground from the original energizing circuit of the relay SOR in Fig. 5 but the said relay SOR is maintained energized through its locking circuit.

The operator at the central exchange noticing the displayed signal S will insert the plug P associated with the usual cord circuit into the jack J which will disconnect the drop DP from the jack connections and will also establish a talking circuit between the operator and the calling subscriber. This talking circuit can be traced from the subscriber's line conductor L2, over line conductor 11, normal contacts 12, 13, 14, and 15 of the line relays, alternate contact 16 of relay SOR, conductor 49, alternate contact 50 of relay DCO in Fig. 1, through the windings 51 and 52 of the repeating coil RC, alternate contact 53 of relay DCO, conductor 54, alternate contact 18 of relay SOR in Fig. 5, normal contacts 19, 20, 21, and 22, line conductor 23, through the substation apparatus, back to the line conductor L1. The current through windings 51 and 52 of repeating coil RC sets up an induced current in windings 55 and 56 which current travels over the heavily marked

talking conductors through the jack J and plug P to the operator's set. The subscriber at line L1 is enabled to convey the message to the operator over the talking circuit just traced.

Disconnection of subscriber from operator

After the termination of the conversation between the operator and the subscriber, the connection can be severed and the apparatus restored to normal by either the subscriber or the operator ringing off. Let us first assume that the connection is destroyed by the subscriber operating his hand generator to sever the connection.

Current will flow from one side of the hand generator through line conductor L2, normal contacts 12, 13, 14, and 15, alternate contact 16 of relay SOR, conductor 49, through the disconnect relay DIS, conductor 54, alternate contact 18 of relay SOR, normal contacts 19, 20, 21, and 22, and line conductor 23 to the other side of the line and hand generator.

If the operator also rings off the disconnect relay DIS will be operated by current flowing through alternate contact 57 of ringing key RK, plug P, contact 43 of jack J, normal contact 42, over the trunk line TL, normal contact 40, windings 56 and 55 of repeating coil RC, normal contact 41, trunk line TL, normal contact 431 of DR, contact 44 of jack J, alternate contact 58 of the ringing key RK, back to the source of ringing current. This current passing through windings 55 and 56 of repeating coil RC induces a like current in the windings 51 and 52 which current passes through the alternate contacts 50 and 53 of generator cut-off relay GCO to conductors 49 and 54 and thence through the winding of the disconnect relay DIS. Current from either or both of these sources passing through the disconnect relay DIS causes the said relay to close its contact 59 to establish an obvious energizing circuit for the disconnect relay DSO which opens its contact 35 to disconnect ground from the locking circuits of relays RH and SOR, which accordingly restore to normal. The relay DSO deenergizes as soon as the ringing current is removed from the line due to the opening of contact 59 of relay DIS and the apparatus is then at normal. The same result is obtained if only one party rings off.

Subscriber calls party on the same line

The operation of the system in establishing a connection between two subscribers located on the same line is the same as previously described up to the point where the subscriber is connected to the operator at the exchange.

Assuming that the subscriber is connected to line L1—L2 and desires to be connected to another subscriber on the same line, the calling subscriber will inform the operator of the desired connection and will then operate the hand generator as above explained to disconnect his line. The operator will dial "2" which is the calling number for line 1 in establishing such a connection. The operation of the dial D in Fig. 1 will establish an obvious energizing circuit for the dial start relay DSR through the off-normal contact 60 of the dial D which will close its alternate contact 61 to establish an energizing circuit for the dial relay DR. The operator by dialing "2" will interrupt the circuit for the dialing relay DR two times and two impulses of high frequency dialing current will be sent over the trunk line. The circuit for this high frequency dialing current can be traced from lead 62, alternate contact 42 of DR, trunk line TL, normal contact 40 of generator relay GR, windings 56 and 55 of repeating coil RC, normal contact 41 of relay GR, trunk line TL, alternate contact 431 of dialing relay DR and lead 63 to the source of high frequency dialing current. This current passing through the windings 55 and 56 of the repeating coil RC will set up a like current in the windings 51 and 52 of the repeating coil RC. This current will flow from winding 51, normal contact 50 of generator cut-off relay GCO, which relay restored its contacts to normal when the calling subscriber rang off, conductor 64, condenser 65, high frequency dialing relay HFR, conductor 66, normal contact 53 of relay GCO and winding 52 of repeating coil RC. This current passing through the winding of the high frequency dialing relay HFR will cause the said relay to energize and close its contact 67 to establish an energizing circuit for the impulse relay IR which closes its contact 68 to establish an obvious energizing circuit for the holding impulse relay HIR. The relay HIR opens normal contact 69 to prevent the premature operation of the switch release magnet RM (Fig. 4) and closes its alternate contact 70 to establish an energizing circuit for the dial hold-over relay DHO. The relay DHO is energized by current flowing from grounded battery through the winding of DHO, alternate contact 70 of relay HIR to ground at alternate contact 68 of relay IR. The closing of contact 70 of relay HIR also establishes an energizing circuit for the motor magnet MM (Fig. 4) which circuit can be traced from grounded battery through the winding of motor magnet MM, conductor 301, closed contact 70 of relay HIR (Fig. 3), closed contact 68 of LR to ground. Motor magnet MM will energize and deenergize two times in accordance with the "2" dialed by the operator.

Each time the motor magnet MM is deenergized the wipers W1, W2, and W3, Fig. 4, are moved one step over the contact banks A, B, and C.

In the meantime, the relay DHO has energized and closed alternate contact 71 to establish obvious energizing circuits for the lead opening relays LOR and LOA. The lead opening relay LOR opens its normal contacts 72, 73, and 74 to prevent the disturbing of any existing connections or the setting up of any false or undesired connections as the wipers pass over the contacts of the contact bank. The relay LOA establishes a locking circuit for itself through its alternate contact 75 to ground at normal contact 76 of control relay CO. It also opens its contact 77 to prevent the operation of the release magnet RM at this time. As soon as the dialing stops the relays HFR, IR, and HIR are deenergized and shortly thereafter the dial hold-over relay DHO, which is of the slow-to-release type, deenergizes and opens the energizing circuit for the lead opening relay LOR which accordingly restores its contacts to normal to close the switch wiper leads.

After the dialing has ceased an energizing circuit for the line switching relay LSW in Fig. 5 is established and this relay is operated by current flowing from grounded battery through the winding of the relay LSW, conductor 78, wiper W1 of contact bank A, which has been stepped two contacts, conductor 79, normal contact 74 of relay LOR, through the winding of control relay CO to ground. The relay CO is also energized by current flowing over this circuit and opens its contact 76 to destroy the locking circuit for relay

LOA which is accordingly deenergized and closes its normal contact 77 to establish an energizing circuit for the release magnet RM, which magnet is energized by current flowing from grounded battery through the winding of release magnet RM, conductor 302, normal contact 69 of HIR, normal contact 80 of relay DHO, normal contact 77 of relay LOA, normal contact 81 of hold over relay HOV, to ground at the off-normal contacts ON which assume their off-normal position upon the first movement of the wipers W1, W2, and W3. The release magnet RM restores the wipers W1, W2, and W3 to their normal positions.

The relay LSW which operated over the previously described circuit closes a locking circuit for itself which may be traced through its alternate contact 82, conductor 83, normal contact 84 of the trunk release relay TRI to ground at the master ground MG. The operator called line connecting relay OCL is also energized over this circuit and closes its alternate contact 85 to establish an energizing circuit for the repeater connecting relay RPC in Fig. 2. This relay is energized by current flowing from grounded battery through the winding of RPC, conductor 86 to ground at alterntae contact 85 of relay OCL.

The operator at the exchange next throws her ringing key RK to the ringing position which closes alternate contacts 57 and 58 to connect the ringing current leads to the trunk line TL to permit the passage of ringing current over the said trunk line and through the windings 55 and 56 of the repeating coil RC. Current is induced in windings 51 and 52 of the repeating coil RC and travels over normal contact 50 of relay GCO, conductor 64, alternate contact 87 of relay RPC, windings 88 and 89 of the repeating coil RCA, alternate contact 90, conductor 66, normal contact 53 of relay GCO, winding 52 of repeating coil RC. Current traversing the windings 88 and 89 of the repeating coil RCA sets up an induced current in the windings 91 and 92, which current travels through normal contact 93 of relay ARR, conductor 94, alternate contact 15 of relay OCL, normal contacts 14, 13, and 12 of the line relays, line conductor 11, through the call bell of all the stations on line L1—L2, line conductor 23, normal contacts 22, 21, and 20, alternate contact 19 of relay OCL, conductor 95, normal contact 96 of relay ARR and winding 92 of the repeating coil RCA. Ringing current is sent out over the line in the proper code to summon the desired called party and as soon as the call bells stop ringing the calling party and the called party remove their receivers from the switchhooks and the talking circuit is established between the respective stations on the same line.

Release of trunk by operator

The operator next dials "1" to clear the trunk line and render it available for another connection. The dialing relays cause the operation as above described of the motor magnet MM which upon deenergization steps the wipers W1, W2, and W3 to the first set of contacts in the contact banks.

As soon as the dialing ceases the dialing relays HFR, IR, HIR, etc., restore to normal and the circuit is closed for the trunk release relay TRR in Fig. 4. This relay is energized by current flowing from grounded battery through the winding of trunk release relay TRR, the wiper W1, conductor 79, normal ocntact 74 of LOR, the winding of control relay CO to ground. Relay TRR opens its normal contact 84 and removes the master ground MG from the conductor 83 which causes the deenergization of the line switching relay LSW and the relay OCL which restore their contacts to normal. Relay TRR closes a locking circuit for itself and is maintained operated by current flowing from grounded battery through the winding of relay TRR, alternate contact 97, conductor 98, and off-normal contacts ON to ground.

The control relay CO is also energized by current flowing over the previously described path and opens contact 76 to cause the relay LOA to restore its contacts to normal and close an energizing circut for release magnet RM which restores the switch wipers SW1, etc., to normal. The opening of off-normal contacts ON by the restoration to normal of the switch wipers opens the locking circuit for the relay TRR and also for the release magnet RM, both of which relays restore their contacts to normal. All the apparatus used in establishing the connection is now at normal and available for establishing another connection.

When the subscribers have finished conversing they simply restore their receivers to the switchhooks which places the line in its normal condition. There is no necessity for their ringing off as the line apparatus and trunk line have been cleared by the previous operations.

Line 1 calls line 3

In the establishment of a connection between a subscriber on line 1 and a subscriber on line 3, the subscriber on line 1 will operate his hand generator to signal the operator at the exchange in the manner previously described. After the operator is connected to line 1 the subscriber on line 1 will inform the operator that he desires to talk to a subscriber on line 3. After the subscriber has given the operator this information they will ring off as explained above in a previous connection which will disconnect the subscriber on line 1 from the trunk line.

The operator will consult her connection chart and discover that the dialing number to establish the desired connection is "02." The operator's connection chart follows:

Dial number directory

	Dial No.
Line #1 calling line #1	2
Line #2 calling line #2	3
Line #3 calling line #3	4
Line #4 calling line #4	5
Through connection to line #1 with repeater	6
Through connection to line #2 with repeater	7
Through connection to line #3 with repeater	8
Through connection to line #4 with repeater	9
Line #1 calling line #2 with repeater	01
Line #1 calling line #3 with repeater	02
Line #1 calling line #4 with repeater	03
Line #2 calling line #1 with repeater	04
Line #2 calling line #3 with repeater	05
Line #2 calling line #4 with repeater	06
Line #3 calling line #1 with repeater	07
Line #3 calling line #2 with repeater	08
Line #3 calling line #4 with repeater	09
Line #4 calling line #1 with repeater	001
Line #4 calling line #2 with repeater	002
Line #4 calling line #3 with repeater	003
Release	1

In the usual operation the operator will first dial the digit "0" which will cause the operation of the high frequency dialing relay HFR, the impulse relay IR, the hold impulse relay HIR, the dial hold-over relay DHO, and the motor magnet MM. The lead opening relays LOR and

LOA will be energized to open the wiper leads as above described. Due to the slow-to-release construction of relays HIR and DHO, these relays remain energized during the intervals between the dialing impulses. The motor magnet MM is energized and deenergized and steps the wipers W1, W2, and W3 into engagement with the tenth set of contacts in the contact banks. As soon as the wiper W1 engages the tenth contact an energizing circuit for the holdover relay HOV and the control relay CO is established. This circuit can be traced from grounded battery through the winding of the holdover relay HOV, conductor 198, contact 10, wiper W1, conductor 79, normal contact 74 of relay LOR which deenergizes shortly after the last impulse of current in the dialing of the digit "0" to ground through relay CO, Fig 2. The relay HOV is energized over this circuit and opens its alternate contact 81 to prevent the operation of the release magnet RM at this time. Relay CO energizing opens its contact 76 to interrupt the locking circuit of the relay LOA.

Next the operator dials the digit "2" which will cause the switch wipers to be moved two more steps into engagement with the twelfth set of contacts. As soon as the wipers left the tenth contact the relays HOV and CO were deenergized with the result that the relay LOA again locked up through the normal contact 76 of control relay CO. After the cessation of the flow of dialing current the following relays deenergize: Relay HFR, impulse relay IR, hold impulse relay HIR, dialing hold-over relay DHO, and lead opening relay LOR. Relay LOR closing its normal contacts 72 and 73 establishes energizing circuits for the subscriber connecting relay SCA in line circuit 1 and subscriber connecting relay SCB in line circuit 3. The energizing circuit for SCA in line circuit 1 can be traced from grounded battery, winding of SCA normal contact 99, conductor 100, the twelfth contact in the bank B, wiper W2, conductor 101, normal contact 72 of relay LOR, conductor 102 to ground at normal contact 103 of relay LU. Relay SCA energizes over this circuit and closes a locking circuit for itself through its alternate contact 104, conductor 105, the winding of relay LK, normal contact 106 of relay CDD, conductor 107, normal contact 108 of relay DU to ground. The original energizing circuit for the line connecting relay SCB in line circuit 3 will be from grounded battery, through the winding of relay SCB in line circuit 3, normally closed contact 109, conductor 110 to the twelfth contact in the contact bank C, wiper W3, conductor 111, normal contact 73 of relay LOR, conductor 112, normal contact 113 of relay LK to ground.

It is to be understood that while this circuit is shown and described as being the line connecting relay SCB in the line circuit shown in Fig. 5, it is not this relay that is operated but the corresponding relay in the line circuit L3, not shown. The conductor 110 shown in the drawings is connected on the contact bank in the manner shown in Fig. 6; that is, conductor 110 associated with line 1, the line circuit of which is shown in Fig. 5, is connected to contacts 14, 17, and 21, while the conductor 110 shown associated with line 2 is connected to contacts 11, 18, and 22. The conductor 110 associated with line 3 is connected to contacts 12, 15, and 23, while the conductor 110 associated with line 4 is connected to contacts 13, 16, and 19. The locking circuit for the relay SCB can be traced from grounded battery through the winding of the relay SCB in line circuit 3, alternate contact 114, conductor 115, through the winding of locking relay LU, conductor 116, alternate contact 117 of relay LK to ground. The repeater A is of the well known "cold" type which is non-operating until a connection through it is desired. When the contact 117 is closed current flows from battery over conductor 118 to ground at 117. The flow of current over this circuit renders the repeater active and ready to transmit the message. The operation of the relay LU establishes an energizing circuit for the relay SWR in Fig. 2 and this relay is energized by current flowing from grounded battery through the winding of relay SWR, conductor 119, alternate contact 120 of relay LK, conductor 121, alternate contact 122 of relay LU to ground at alternate contact 123 of relay LRR which is energized when the ringing key is operated as described below. The relay SWR establishes a locking circuit for itself through its alternate contact 124, conductor 125, normal contact 84 of trunk release relay TRR to the master ground MG. The relay SWR energizes and opens its contacts 126 and 127 to disconnect the trunk line from the repeater B so that no disturbance will be created by the application of ringing current to the trunk line.

The operator next throws the ringing key RK to connect ringing current across the trunk line conductors TL and through the windings of the repeating coil RC. This current is induced in the windings 51 and 52 of the repeating coil RC and passes through the windings of the ringing relay RRA which closes its contact 128 to establish an obvious energizing circuit for the conditioning relay CON, which closes its alternate contact 129, which closes an obvious energizing circuit for repeater control relay REC. The relay REC closes its contact 130 to establish an energizing circuit for the line ringing relay LRR which circuit is energized by current flowing from grounded battery through the winding of relay LRR, alternate contact 131 of relay LU, conductor 132, alternate contact 133 of relay LK, conductor 134, normal contact 135 of busying relay BR, normal contact 136 of relay RPC, conductor 137, alternate contact 130 of relay REC to ground. The line ringing relay LRR opens normal contacts 138 and 139 to disconnect the repeater A and to connect the ringing current which is present on the leads 140 and 141 to the windings 142 and 143 of the repeating coil RCB. This current is induced in the opposite windings of the repeating coil RCB and travels over the heavily marked conductors 144 and 145 to the line conductors of line 3 which are not shown in the drawings. Ringing current passing over this circuit will operate the ringers at all the stations on line 3 and it will be necessary for the operator to use a code ring to inform the subscribers on the line which particular subscriber is wanted. As soon as the operator restores the ringing key RK to the relays RRA, CON, and REC restore to normal and the energizing circuit for the line ringing relay LRR is destroyed and the said relay LRR restores to normal to disconnect the ringing current from the called line and to establish a talking circuit for the subscribers through the repeater A. The subscriber hearing the bell ring his code will remove his receiver from the switchhook and thereby be connected across the line conductors.

In the meantime, the calling subscriber on line 1 will wait an appreciable length of time and then

again remove his receiver to connect his telephone across the line conductors 11 and 23 and the two subscribers will be connected into a conversational circuit through the repeater A. This talking circuit can be traced from line conduct 11 of line 1, normal contact 12 of line connecting relay SCB in line circuit 1, alternate contact 13 of line connecting relay SCA in line circuit 1, conductor 146, windings 147 and 148 of repeating coil RCC, conductor 149, alternate contact 21 of relay SCA in line circuit 1, normal contact 22 of SCB, line conductor 23, over the line L1. The voice current set up in the windings 147 and 148 of the repeating coil RCC are induced in the opposite windings of the repeating coil RCC and flow over conductor 150, the windings of the gain control coil, conductor 151, through the repeater A, the gain control coil, normal contact 136 of LRR, windings 143 and 142 of the repeating coil RCB, normal contact 139 of relay LRR through the coils of the gain control, conductor 152, back to the windings of the repeating coil RCC. The voice currents set up in the windings 142 and 143 of the repeating coil RCB are induced in the opposite windings of the repeating coil RCB and travel over the conductors 144 and 145 to the subscriber on line 3 in the same path as described for the ringing current for that line.

The wipers W1, W2, and W3 of the switch are only momentarily engaged with the twelfth set of contacts in the contact banks to establish the energizing circuits previously traced. The wiper W1 when it engages the twelfth contact of bank A establishes an energizing circuit for the control relay CO which relay is energized by current flowing from grounded battery through the twelfth contact of the bank A, over conductor 79, through normal contact 74 and the winding of the control relay CO to ground. It will be noted in Fig. 6 that contacts 11 to 19 inclusive on bank A are connected to grounded battery through a resistance coil 153. The relay CO energizing opens the locking circuit for the relay LOA which deenergizes and closes its contact 77 to establish an energizing circuit for the release magnet RM. The release magnet RM energizes and returns the switch wipers W1, W2, and W3 to their normal positions which opens the off-normal contacts ON to interrupt the energizing circuit for the release magnet RM.

After the operator has completed the ringing of the called line she will operate her dial D to send one impulse of current over the trunk line. This one impulse of current will cause the stepping of the wipers W1, W2, and W3 to the first contact of the bank. Wiper W1 will establish a previously traced energizing circuit for the trunk release relay TRR which relay will open its contact 84 to remove the master ground MG which will interrupt the locking circuit for the relay SWR which relay SWR deenergizes and again connects the trunk line to the repeater B. The relay TRR locks up through its alternate contact 97 to ground at the off-normal contacts ON. Immediately after the dialing impulse is discontinued an energizing circuit for the release magnet RM is again established with the result that the switch wipers W1, etc., are returned to normal and the trunk line and operator are entirely disconnected from the established connection.

Disconnection by subscribers

After the termination of the conversation either one of the subscribers can restore the connecting apparatus to normal by ringing off. The operation of the hand generator on line 3 will cause the operation of the called subscriber's disconnect relay CDI, the circuit for the current being traced from line 3, conductor 144, through repeating coil RCB, conductor 145 to the other side of line 3. This current is induced in the windings 142 and 143 of the repeating coil RCB and passes through the winding of the relay CDI which relay closes its alternate contact 154, to establish an energizing circuit for the relay CDR which closes its contact 155 to close an obvious energizing circuit for the relay CDS which closes alternate contact 156 to cause the energization of the disconnect relay DU which opens its contact 108 to interrupt the energizing circuit for relay SCA for line circuit 1 and relay SCB in line circuit 3.

The same result can be obtained by the subscriber on line 1 operating his hand generator which will cause the operation of the disconnect relay CDA by current flowing from the hand generator, line conductor 11, normal contact 12 of SCB in line circuit 1, alternate contact 13 of relay SCA in line circuit 1, conductor 146, windings 147 and 148 of repeating coil RCC, conductor 149, alternate contact 21 of relay SCA in line circuit 1, normal contact 22 of SCB in line circuit 1, conductor 23 to the other side of the hand generator. Current flowing over this path causes the energization of the relay CDA and the successive operation of relays CDB, CDC, and CDD. Relay CDD energizing opens contact 106 to interrupt the locking circuit for both relay SCA in line circuit 1 and relay SCB in line circuit 3. These relays deenergize and restore their contacts to normal to sever the connection between the subscribers. The disconnect relays are only momentarily energized and subsequently restore thereby setting all the apparatus in its normal condition.

Through connection over trunk line

Should one of the subscribers desire to converse with a subscriber located beyond the exchange he will call the operator in the usual manner previously described and will inform the operator of his code ring and line together with the code ring and line of the desired subscriber, after which both the subscriber and the operator ring off to disconnect the trunk line.

The operator will proceed to obtain the desired connection, and assuming that the subscriber is located on line 1, the operator will dial the numeral "6" which is the calling number for line 1 in such a connection. The dialing relays will operate in the manner previously described to step the switch wipers into engagement with the sixth contact. When the wipers stop in the said sixth contact an energizing circuit for line relay LSA in line circuit 1 will be established. This relay will be operated by current flowing from grounded battery through the winding of relay LSA, conductor 158, sixth contact of contact bank A, wiper W1, conductor 79, normal contact 74 of relay LOR in Fig. 2, the winding of relay CO to ground. Relay CO is also energized by this flow of current and opens its contact 76 to interrupt the locking circuit for the relay LOA which closes its contact 77 to complete the energizing circuit for the release magnet RM which relay energizes and restores the switch wipers W1, W2, and W3 to their normal positions. The opening of the off-normal contacts ON interrupts the energizing circuit for the release magnet RM which also restores. The relay LSA in operating closed its alternate contact 159 to establish an energizing

circuit for the line relay OCR and it closes a locking circuit for itself to the master ground MG. The relay OCR closes alternate contacts 14 and 20 to connect the line L1 over conductors TTL, to the repeating coil RCD. The closing of alternate contact 130 establishes an energizing circuit for the busying relay BR in Fig. 2 which relay is energized by the current flowing from grounded battery through the winding of the relay BR, conductor 161, alternate contact 160 of relay OCR to ground. The relay BR energizes and closes alternate contact 162 to close the circuit for the repeater B and closes alternate contact 163 to cause the repeater B to be placed in service.

Next the operator will depress her ringing key RK in the proper manner to send the code ring across line 1 to summon the calling subscriber. The ringing current sent from the generator leads and through the ringing key RK will pass over the trunk line TL, through the repeating coil RC, normal contacts 50 and 53 of relay GCO and through the winding of relay RRA which relay operating causes the operation of relays CON and REC. Relay REC closes alternate contact 130 to establish an energizing circuit for the repeater switching relay RES which relay is energized by current flowing from grounded battery through the winding of relay RES, conductor 164, alternate contact 135 of relay BR, normal contact 135 of relay RPC and alternate contact 130 to ground. The repeater switching relay RES will move contacts 165 and 166 to their alternate positions and open the leads extending to the repeater B so that ringing current will not be sent back over the trunk line and to connect ringing current from the generator leads to the repeating coil RCD, and thence over the conductors TTL and through alternate contacts 14 and 20 of relay OCR to line 1. The ringing relay RES energizes and deenergizes in accordance with the operation of the ringing key RK and transmits ringing current in the proper code over the conductors of line 1 to cause the operation of the call bells at all of the subscribers' stations on the line.

After the operator has restored her ringing key the relays RRA, CON, REC and RES restore to normal. Contacts 165 and 166 are disconnected from the generator leads and a talking circuit is established between the subscriber on line 1 and the subscriber at the exchange over the trunk line. The voice currents set up in conductors 11 and 23 of line 1 will travel through alternate contacts 14 and 20 of relay OCR, conductors TTL, and one set of windings of the repeating coil RCD. These voice currents will be induced in the other windings of the repeating coil RCD and will flow through normal contacts 165 and 166 of ringing relay RES through repeater B, normal contacts 126 and 127 of relay SWR, normal contacts 87 and 90 of relay RPC, conductors 64 and 66, normal contacts 50 and 53 of relay GCO, through the windings 51 and 52 of repeating coil RC. Like currents will be set up in the windings 55 and 56 of repeating coil RC, thence over the trunk line TL and through the exchange to the other subscriber.

Of course, the trunk line cannot be used to set up another connection during the establishment of this connection as the opening of contact 29 of the busying relay BR will prevent the operation of any of the subscribers' line relays SOR and as none of these relays can operate a calling subscriber cannot reach the operator.

After the termination of the conversation which can be determined by the operator listening in, the operator will release the circuit by dialing "1." When the switch wiper W1 reaches the first contact in contact bank A the trunk release relay TRR energizes over a circuit previously traced and opens its contact 84 to remove the master ground MG which opens the locking circuits of relay LSA and OCR which restore to normal. Relay OCR opens its alternate contacts 14 and 20 to disconnect the line L1 and opens its alternate contact 160 to interrupt the energizing circuit of the busying relay BR which relay restores its contacts 162 and 163 to deenergize the repeater B. The release magnet RM will also operate to restore the wipers of the switch to their normal positions and the circuit will be ready to establish another connection.

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

1. A communication system including a central station, a plurality of lines terminating thereat, call numbers, each corresponding to a combination of a definite pair of said lines, a plurality of line connecting relays, certain of said relays being individual to each of said lines, respectively, said relays being operable in different combinations to interconnect any two of said lines, an automatic switch, a bank of contacts for said switch, impulse sending means, means actuated incident to the operation of said impulse sending means in accordance with the call number representing two of said lines, for stepping said switch to a corresponding contact position, and circuits of connecting relays arranged, upon actuation, to connect said two of said lines for communication, controlled at contacts of said switch at said position.

2. A communication system including a central station, a plurality of lines terminating thereat, call numbers, each corresponding to a combination of a definite pair of said lines, a plurality of line connecting relays, certain of said relays being individual to each of said lines, respectively, said relays being operable in various combinations to interconnect any pair of said lines, an automatic switch, a bank of contacts for said switch, energizing circuits for said line connecting relays, respectively, each of said circuits being controlled at contacts of said switch, impulse sending means, means actuated incident to the operation of said impulse sending means in accordance with the call number representing two of said lines, for stepping said switch to a corresponding contact position, and circuits of connecting relays arranged, upon energization, to connect said two of said lines for communication, controlled at contacts of said switch at said position.

3. A communication system including a central station, a plurality of lines terminating thereat, call numbers, each corresponding to a combination of a definite pair of said lines, a plurality of line connecting relays, certain of said relays being individual to each of said lines, respectively, said relays being operable in various combinations to interconnect any pair of said lines, an automatic switch, a bank of contacts for said switch, impulse sending means, means actuated incident to the operation of said impulse means in accordance with the call number representing two of said lines, for stepping said switch to a corresponding contact position, circuits of connecting relays arranged, upon actuation, to connect said two of said lines for communication, controlled at contacts of said switch at said position, means for releasing

said switch and means independent of said switch for maintaining the connection between said two of said lines.

4. A communication system including a central station, a plurality of lines terminating thereat, call numbers, each corresponding to a combination of a definite pair of said lines, a plurality of line connecting relays, certain of said relays being individual to each of said lines, respectively, said relays being operable in various combinations to interconnect any pair of said lines, an automatic switch, a bank of contacts for said switch, energizing circuits for said line connecting relays, respectively, each of said circuits being controlled at contacts of said switch, a link circuit, impulse sending means, means actuated incident to the operation of said impulse sending means in accordance with the call number representing two of said lines, for stepping said switch to a corresponding contact position, and circuits of connecting relays arranged, upon energization, to connect said two of said lines and said link circuit into a communication circuit, controlled at contacts of said switch at said position.

5. A communication system including a main station and a branch central station, a trunk line joining said stations, a plurality of lines terminating at said branch station, call numbers, each corresponding to a combination of a definite pair of said lines, a plurality of line connecting relays certain of said relays being individual to each of said lines, respectively, said relays being operable in various combinations to interconnect any pair of said lines, an automatic switch at said branch station, a bank of contacts for said switch, energizing circuits for said line connecting relays, respectively, each of said circuits being controlled at contacts of said switch, impulse sending means at said main station, means actuated over said trunk line, incident to the operation of said impulse sending means in accordance with the call number representing two of said lines, for stepping said switch to a corresponding contact position, and circuits of connecting relays arranged, upon energization, to connect said two of said lines into a communication circuit, controlled at contacts of said switch at said position.

6. A communication system including a main station and a branch central station, a trunk line joining said stations, a plurality of lines terminating at said branch station, call numbers, each corresponding to a combination of a definite pair of said lines, a plurality of line connecting relays, certain of said relays being individual to each of said lines, respectively, said relays being operable in various combinations to interconnect any pair of said lines, an automatic switch at said branch station, a bank of contacts for said switch, energizing circuits for said line connecting relays, respectively, each of said circuits being controlled at contacts of said switch, impulse sending means at said main station, means actuated over said trunk incident to the operation of said impulse sending means in accordance with the call number representing two of said lines, for stepping said switch to a corresponding contact position, circuits of connecting relays arranged, upon energization, to connect said two of said lines into a communication circuit, controlled at contacts of said switch at said position, means for releasing said switch and means for maintaining said established connection after release of said switch.

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