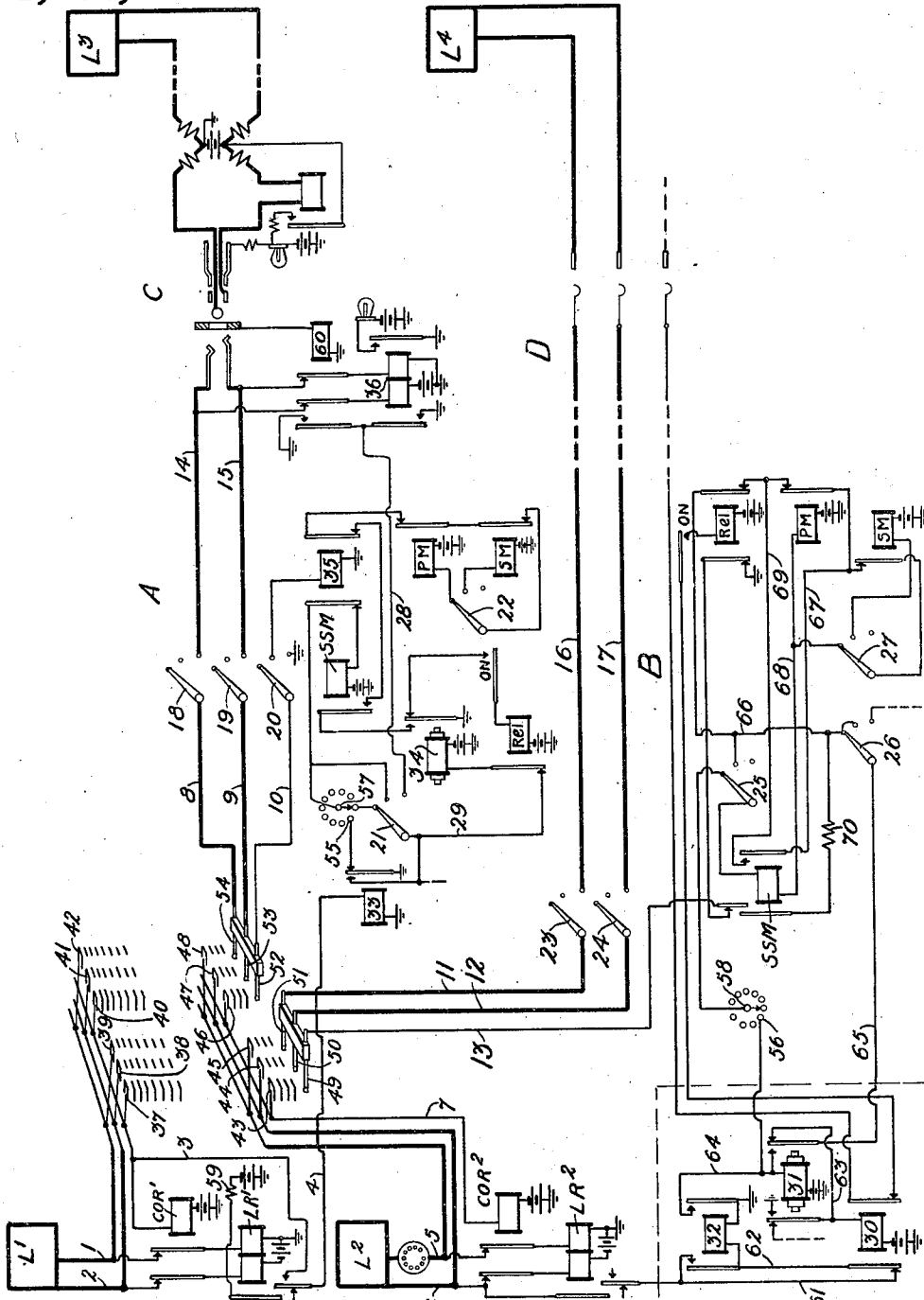


C. L. GOODRUM.
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED OCT. 29, 1917.

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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, CHARLES L. GOODRUM, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telephone exchange systems, and has to do more particularly with automatic line finders. The object of the invention is to provide effective and simplified means associated with the lines and switches for testing and extending the connections of calling lines to other means for handling different classes of service.

In a central office where both manual and automatic service is given, there is a continual demand for a transfer of certain lines from one kind of service to the other. Such a change necessitates the use of different central office equipment and a change in the subscriber's telephone number.

It is a further object of this invention to afford a flexible means for meeting this demand and to do so without the addition of relays or other switching apparatus. It is still a further object of this invention to meet this demand without the necessity of a change in the subscriber's telephone number, it being necessary, so far as the central office is concerned, merely to make a minor change in the connections at the line relay of the changed line in order to transfer from manual service to automatic or vice versa.

In the preferred form of the invention, two kinds of line finders are used to serve a group of lines. The circuit arrangements in the two kinds of line finders are different and they will serve only the lines provided for their respective classes of service. The lines referred to are not arranged in sub-groups according to their classes of service but appear indiscriminately in the line bank. The line finders are set in motion by the closure of a line circuit of their particular class, and will stop on the terminals of lines of their class only.

The various features of the invention will be more fully understood upon reference to the following description taken in connection with the accompanying drawings, and

the scope of the invention will be pointed out in the appended claims.

Referring now to the drawings, L' represents a substation of a well known manual arrangement. LR' and COR' represent line and cut-off relays connected to substation L' by lines 1 and 2 and to multiply connected passive bank terminals 37, 38, 39 and 40, 41, 42. L² represents another substation of a well known automatic arrangement with its line and cut-off relays LR² and COR² connected to substation L² by lines 5 and 6 and to multiply connected passive bank terminals 43, 44, 45 and 46, 47, 48.

The telephone lines are divided into groups of one hundred lines each. For each group of one hundred lines there is provided a plurality of line finders A and B, each having one hundred sets of line terminals as 37, 38, 39 and 43, 44, 45 for line finder B, and 40, 41, 42 and 46, 47, 48 for line finder A.

These one hundred sets of contacts are further divided into sub-groups of ten sets of contacts each, so that in the operation of the switches A and B their brush sets 49, 50, 51 and 52, 53, 54 are first positioned corresponding to sub-groups containing the terminals of a calling line, and subsequently operated to select the desired line in the sub-group.

In order to control the selection of the sub-group containing the terminals of a calling line, each line finder is provided with a set of group contact terminals as 55 and 56 shown, one for each sub-group of lines, also a rotatable brush 57 and 58 arranged to cooperate with the sub-group contacts.

Each sub-group of lines is provided with a resistance 59 and relay 33 for manual lines, and relays 30, 31 and 32 for automatic lines.

The switches used for line finders A and B are provided with ten brush sets consisting of three brushes each. Each set serves a sub-group of bank terminals. These brush sets are arranged spirally on a brush carrier (not shown) and are adapted to be rotated step by step by the primary magnet PM, until one of the brush sets is positioned so that a vertical step-by-step movement by the secondary magnet SM will cause the brushes of the positioned set to successively make contact with the bank terminals of

the sub-group. In order to effect a disconnection of the brushes from the terminals of a calling line each switch is provided with a release magnet Rel, which restores the
5 brush sets to their normal position responsive to the energization of this magnet.

Line finder A is permanently associated with a well known manual switchboard arrangement C, by means of which connections
10 are established with other subscribers' lines as L³. Line finder B is permanently associated with an automatic selector arrangement D of a well known type, by means of which connections are established
15 with other subscribers' lines as L⁴.

In order to more fully understand the operation of the illustrated arrangement, assume that a subscriber at substation L' desires a connection with some other subscriber
20 as substation L³. By removing his receiver from its switchhook a circuit is closed to energize the line relay LR' from grounded battery, left-hand winding of line relay LR',
25 left-hand contact of cut-off relay COR', line conductor 2, substation L' line conductor 1, right-hand contact of cut-off relay COR', right-hand winding of line relay LR' to ground.

The operation of relay LR' closes a circuit
30 from grounded battery, resistance 59, armature and front contact of relay LR', conductor 4, the winding of relay 33 to ground, thereby energizing relay 33. A connection is also closed from battery, resistance 59,
35 armature and second front contact of relay LR', and conductor 3 to contacts 37 and 40.

The resistance of relay 33 is sufficiently high to prevent the operation of cut-off relay COR' in series with it, and the resistance of
40 coil 59 is sufficiently low to materially increase the potential of test terminals 37 and 40.

Referring now to the circuit of line finder A, the energization of relay 33 establishes
45 a circuit for side-switch magnet SSM from ground, armature and front contact of relay 33, conductor 29, side-switch brush 21 and first position contact, group switch normal position contact and brush 57, left-hand
50 armature and contact of relay 35, winding of side-switch magnet SSM to grounded battery. The energization of relay 33 also establishes a circuit for slow relay 34 from ground, armature and front contact of relay
55 33, conductor 29, contact of release magnet Rel, and the winding of relay 34 to grounded battery.

The operation of relay 34 and side-switch magnet SSM closes the stepping circuit of
60 the primary magnet PM from ground, armature and front contact of relay 34, armature and contact of side-switch magnet SSM, right-hand armature and contact of relay 35, contact of primary magnet PM, contact of
65 secondary magnet SM, side-switch brush 22

and first position contact, winding of primary magnet PM to grounded battery. The operation of the primary magnet PM interrupts its energizing circuit to rotate the
70 brush sets and group switch step by step until the brush 57 of the group switch makes contact with a non-grounded group contact, when the energizing circuit of the side-switch magnet SSM is broken, thereby opening the stepping circuit of the primary mag-
75 net PM and allowing the side switch to step to position 2.

The brush set 52, 53, 54 is now positioned to the group containing the calling line of substation L', and a new circuit is closed
80 for side-switch magnet SSM from ground, armature and front contact of relay 33, side-switch brush 21 and second position contact, left-hand armature and contact of relay 35, winding of side-switch magnet SSM to
85 grounded battery.

The operation of the side-switch magnet SSM now closes the stepping circuit for the secondary magnet SM over the path previously traced to side-switch brush 22, its
90 second position contact and the winding of secondary magnet SM to battery.

The operation of the secondary magnet SM interrupts its energizing circuit to move the brush sets vertically step by step until
95 brush 52 makes contact with the test terminal 40 of a calling line, when a circuit is closed to energize relay 35, from grounded battery, resistance 59, armature and contact of relay LR', conductor 3, terminal 40,
100 brush 52, conductor 10, side-switch brush 20 and second position contact and the winding of relay 35 to ground. The operation of relay 35 opens the stepping circuit of the secondary magnet SM and the holding circuit
105 of the side-switch magnet SSM, both previously traced, thereby stopping the movement of the brush set 52, 53, 54 on the terminals 40, 41, 42 of the calling line and allowing the side switch to move to position 3.
110

In side switch position 3, the circuit of relay 35 previously traced is broken and a circuit is closed to energize the cut-off relay COR', from ground, third position contact
115 and side-switch brush 20, conductor 10, brush 52, terminal 40, conductor 3 and the winding of cut-off relay COR' to grounded battery.

The operation of the cut-off relay COR' breaks the circuit of the line relay LR' previously traced, allowing it to release and thereby open the circuits through resistance
120 59 to terminals 37 and 40 and to relay 33 above traced.

In side switch position 3 a signal circuit
125 is closed at the operator's switchboard from grounded battery, left-hand winding of relay 36, middle armature and contact of relay 60, conductor 14, side-switch brush 18 and third position contact, conductor 8, brush 54, ter-
130

5 minal 42, line conductor 1, subscriber's set L', line conductor 2, terminal 41, brush 53, conductor 9, side-switch brush 19 and third position contact, conductor 15, right-hand armature and contact of relay 60 and the right-hand winding of relay 36 to ground.

10 A new circuit is also completed to maintain the energization of relay 34, from ground, left-hand armature and contact of relay 36, conductor 28, side-switch brush 21 and third position contact, conductor 29, contact of release magnet Rel and the winding of relay 34 to grounded battery.

15 The connection is now completed by well known manual means.

It is obvious that the release of line finder A is now under the joint control of the operator and the subscriber at substation L'. When the subscriber at substation L' has replaced his receiver to the switchhook and the operator, having received the disconnect signal thereby, withdraws her plug, the circuit for relay 34 is broken and a path is closed from ground, armature and back contact of relay 34, off-normal contact ON, the winding of release magnet Rel and grounded battery to energize the release magnet Rel and restore line finder A to normal, making it available for another call.

20 Assuming now that a subscriber at substation L² desires a connection, by removing his receiver from the switchhook, he closes a circuit for line relay LR² from grounded battery, left-hand winding of line relay LR², left-hand armature and contact of cut-off relay COR², line conductor 6, subscriber's set L², line conductor 5, right-hand armature and contact of cut-off relay COR² and the right-hand winding of line relay LR² to ground.

25 The operation of line relay LR² closes a circuit for the energization of relay 32 from grounded battery, left-hand winding of line relay LR², left-hand armature and contact of cut-off relay COR², armature and front contact of line relay LR², conductor 61, left-hand armature and contact of relay 30, conductor 62 and the winding of relay 32 to ground. Thereupon relay 32 locks up over the circuit previously traced to conductor 61, the front contact and armature of relay 32 and the winding of relay 32 to ground.

30 Relays 30, 31 and 32 are common to the group of ten lines including line L². Relay 32 closes at its right-hand armature and contact, a circuit from ground over conductor 64 to group switch contact 56, to designate the group containing the calling line L². Relay 32 also closes a circuit through its right-hand armature and contact, from ground, conductor 64, the winding of relay 31 to grounded battery, to operate relay 31 and start line finder B in search of line L².

35 Referring to the circuit of line finder B,

the operating circuit closed by relay 31 is traceable as follows: from ground, right-hand armature and contact of relay 32, conductor 64, right-hand armature and contact of relay 31, conductor 65, side-switch brush 26 and first position contact, conductor 66, right-hand armature and contact of release magnet Rel, armature and contact of the primary magnet PM, armature and contact of secondary magnet SM, side-switch brush 27 and first position contact, conductor 68 and the winding of primary magnet PM to grounded battery. Relay 31 also closes a circuit through its left-hand armature and front contact from ground through the winding of relay 30 to battery to energize relay 30.

The operation of relay 30 opens at its right-hand armature and contact, a circuit to prevent the release of the line finder B until after the finder switch has functioned.

The operation of primary magnet PM interrupts its energizing circuit, thereby moving the switch step by step in search of the group containing line L². When the wiper 58 reaches group contact 56, which contact is grounded as traced above, a circuit is closed through brush 58, side-switch brush 25 and first position contact, winding of side-switch magnet SSM, conductor 68 and the winding of primary magnet PM to battery.

Upon the energization of the side-switch magnet SSM, the side switch is stepped to position 2, where the operating circuit of this magnet is opened and a new holding circuit is established from ground previously traced in the stepping circuit to conductor 65, side-switch brush 26 and second position contact, conductor 66, side-switch brush 25 and second position contact, winding of side-switch magnet SSM, conductor 68 and the winding of the primary magnet PM to battery.

The closure of the right-hand contact of the side-switch magnet SSM completes a circuit for the secondary magnet SM from ground above traced in the stepping circuit to the right-hand contact of the release magnet Rel, conductor 69, conductor 67, armature and contact of the secondary magnet SM, side-switch brush 27 and second position contact, through the winding of the secondary magnet SM to battery.

The operation of the secondary magnet SM interrupts its energizing circuit, and moves the switch brushes 49, 50, 51, previously positioned in operative relation to the group containing line L² by the primary movement of the switch, step by step over the terminals of the lines in this group.

When brush 49 is moved into contact with the test terminal 43 of a calling or non-busy line, a circuit is closed to energize the cut-off relay of such line. This circuit is trace-

able from ground above traced in the stepping circuit to conductor 65, side-switch brush 26 and second position contact, through resistance 70, armature and front contact of side-switch magnet SSM, conductor 13, brush 49, terminal 43, conductor 7 and the winding of cut-off relay COR² to grounded battery.

When the cut-off relay COR² is operated, thereby breaking the circuit of the line relay LR², the circuit of group relay 32 is in turn broken by the opening of the line relay contacts. The release of relay 32, in turn, by opening its right-hand contact, breaks the circuits of relay 31, side-switch magnet SSM, primary magnet PM and secondary magnet SM, each above traced, thereby causing the switch to stop with brushes 49, 50, 51 on line terminals 43, 44, 45 respectively, and moving, by the release of the side-switch magnet SSM, the side switch to position 3.

The release of relay 31 opens the circuit of relay 30 and thereupon places the group circuit in condition receptive to a new call. The release of the side-switch magnet SSM by closing its normal contact completes a circuit from ground, through the left-hand contact of the release magnet Rel, to conductor 13, brush 49, terminal 43, conductor 7 and the winding of the cut-off relay COR² to battery, to hold the cut-off relay operated.

In side switch position 3 the line connections are extended through conductor 16, side-switch brush 23 and third position contact, conductor 11, brush 51, terminal 45, line conductor 5, substation L², line conductor 6, terminal 44, brush 50, conductor 12, side-switch brush 24 and third position contact and conductor 17 to a selector switch.

The completion of a connection to a subscriber's station L⁴ is accomplished by well known automatic means through the agency of a sender in the calling subscriber's substation and automatic selector switches D.

The resistances of the cut-off relays COR' and COR² are of the same value. It is to be noted therefore, since it is necessary in order to arrest the upward motion of line finder A to bring brush 52 in contact with a line terminal of higher potential than that of a non-calling line, that line finder A will not select a line as L² of an automatic type.

It is also to be noted, since it is necessary, in order to arrest the upward movement of line finder B, to operate the cut-off relay of the calling line through a resistance 70 of a specified value, and the cut-off relay COR' of a manual line L' will not operate except when dead ground is applied to one of its terminals 37 or 40, that line finder B will not select a manual line.

What is claimed is:

1. In a telephone system, a line bank,

two classes of lines terminating in said line bank, cut-off relays for said lines, a line finder arranged to traverse the terminals of all of said lines in said line bank, a test relay for said line finder effective to arrest the movement of said line finder on the terminals of a calling line of one of said classes, another line finder arranged to traverse the terminals of all of said lines in said line bank, and means associated with said other line finder for operating the cut-off relays of the lines of the other of said classes, and means actuated by the operation of the cut-off relay of a calling line of said other class for stopping said other line finder.

2. In a telephone system, a line bank, manual and automatic lines terminating in said line bank, line finders arranged to cooperate with the terminals of said line bank, and means associated with said line finders for differentiating between said manual and automatic lines in order to supply each with its respective class of service.

3. In a telephone system, the combination of a line terminating in a line bank, a line finder arranged to test all lines in said bank, a second line terminating in said line bank, a second line finder arranged to test all lines in said line bank, means for rendering said first line ineffective to said second line finder, and means for rendering said second line ineffective to said first line finder.

4. In a telephone system, a plurality of line finders, a plurality of manual and of automatic link circuits, a plurality of manual and of automatic lines each multiply connected relative to each of said line finders, means for connecting said manual lines to said manual link circuits, and means for connecting said automatic lines to said automatic link circuits.

5. In a telephone system, a line multiply connected to fixed terminals in each of a plurality of line finders, a manually operable switch permanently associated with one of said line finders, means for actuating said line finder to connect said line to said manually operable switch, a second line multiply connected to fixed terminals in each of said plurality of line finders, a selectively operable switch permanently associated with a second one of said line finders, means for actuating said second line finder to connect said second line with said selectively operable switch, means for rendering said first line finder ineffective to said second line, and means for rendering said second line finder ineffective to said first line.

6. In a telephone system, a finder switch multiple terminal bank, a plurality of subscribers' lines of different classes appearing

indiscriminately in terminals of said bank, finder switches of different classes arranged to traverse all the terminals of said bank but to serve only the class of lines to which
5 each is allotted, means for starting the operation of any switch upon the initiation of a call by a line of the class to which such switches is allotted, and means for stopping any switch upon the terminals of only such a calling line as the class to which such 10 switch is allotted.

In witness whereof, I hereunto subscribe my name this 24th day of October, A. D. 1917.

CHARLES L. GOODRUM.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."