A. E. LUNDELL.

TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED SEPT. 22, 1916.

1,237,531.

Patented Aug. 21, 1917.

2 SHEETS—SHEET 1.

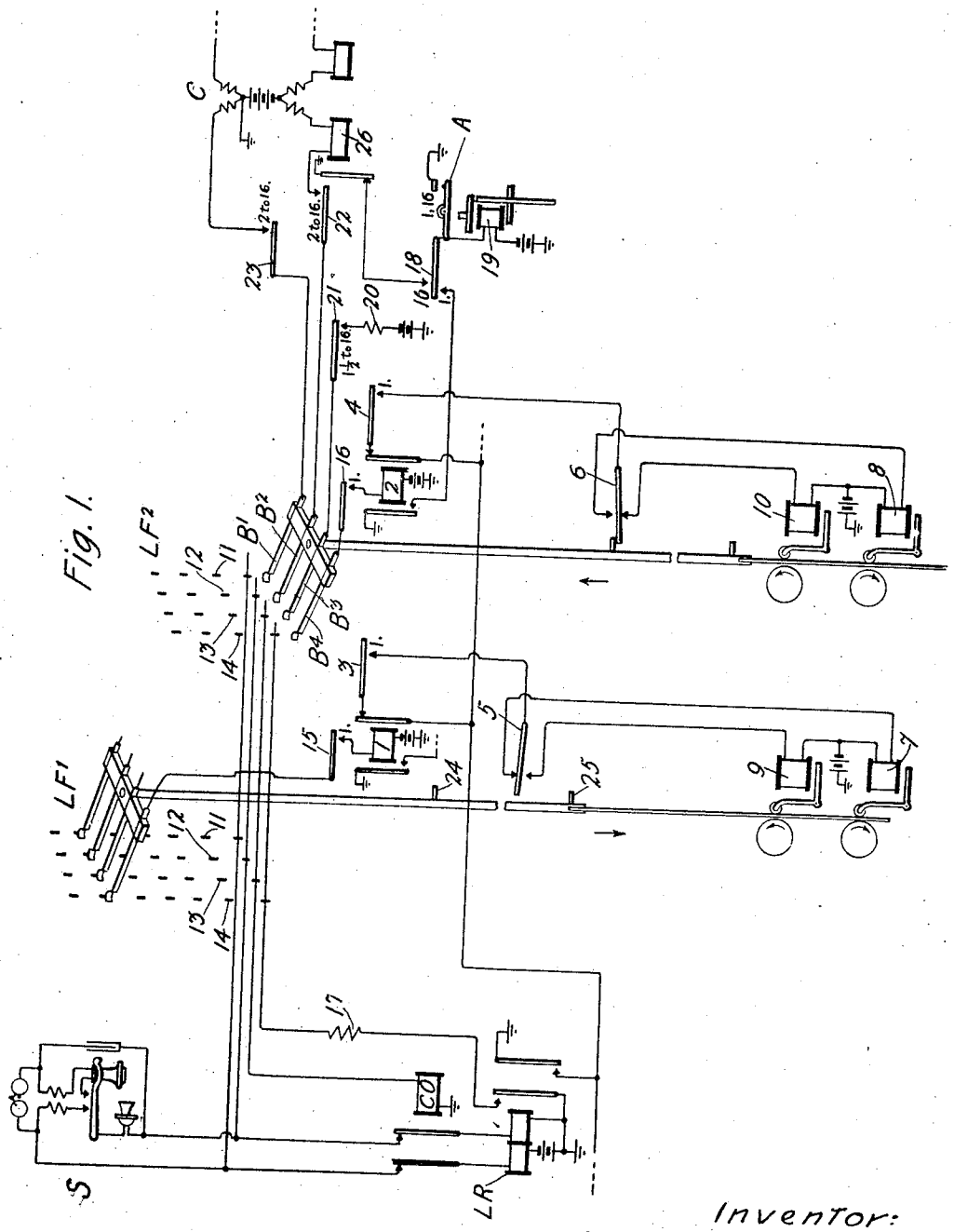


Fig. 1.

Inventor:
Alben E. Lundell.
by J. E. Roberts
Atty.

A. E. LUNDELL.

TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED SEPT. 22, 1916.

1,237,531.

Patented Aug. 21, 1917.

2 SHEETS—SHEET 2.

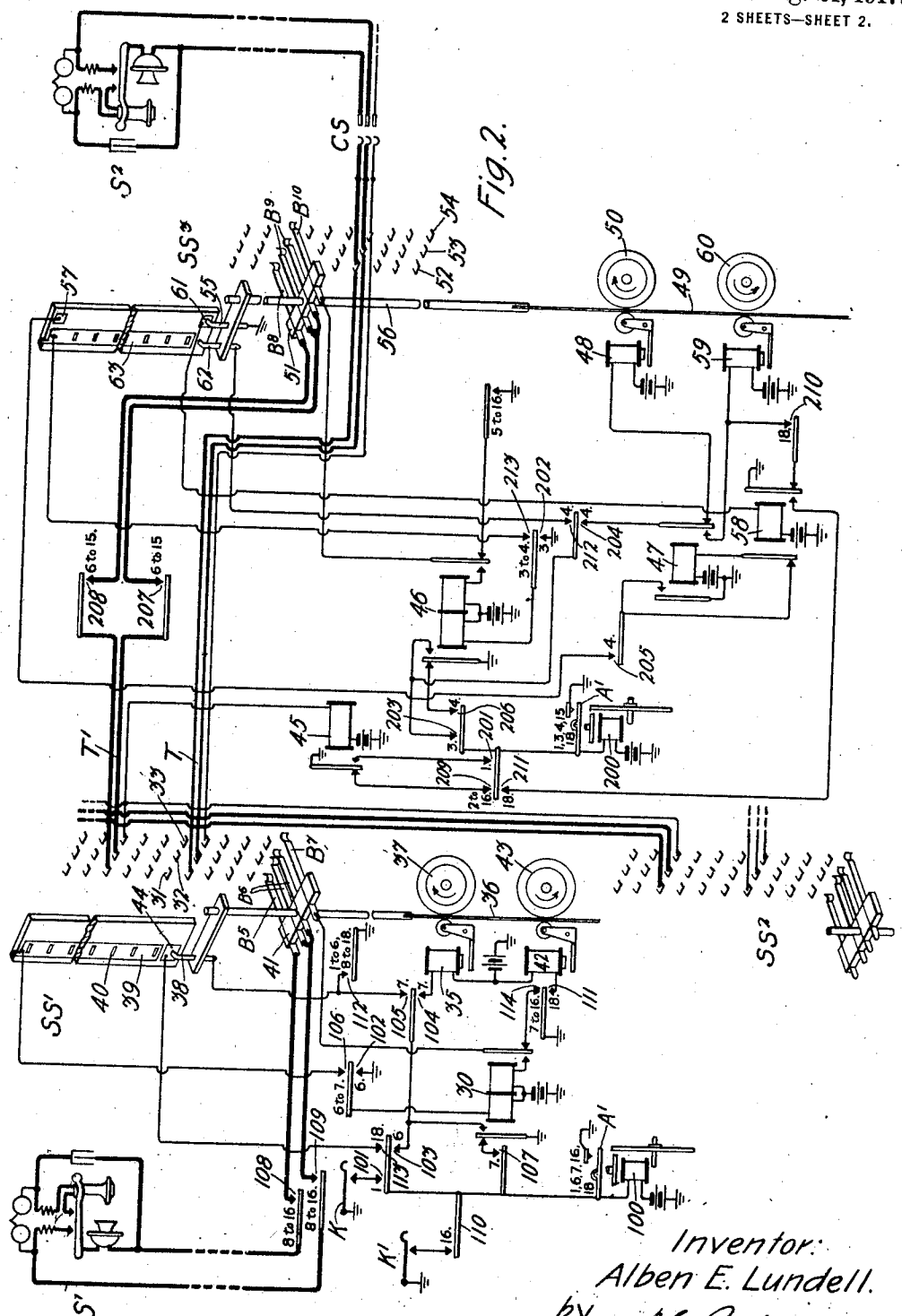


Fig. 2.

Inventor:
Alben E. Lundell.
by J. E. Roberts Atty.

UNITED STATES PATENT OFFICE.

ALBEN E. LUNDELL, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

1,237,531. Specification of Letters Patent. Patented Aug. 21, 1917.

Application filed September 22, 1916. Serial No. 121,566.

To all whom it may concern:

Be it known that I, ALBEN E. LUNDELL, a citizen of the United States, residing at New York, in the county of Bronx 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 more particularly to improvements in systems employing machine switching.

The object of the invention is to secure a continuous hunting action in an automatic switch.

According to one feature of the invention, means are provided to cause a switch to hunt over a row of terminals in both its forward and return movements.

According to another feature of the invention a plurality of line-finder switches, each in a different position over its bank of terminals, are adapted to take up the search for a calling line simultaneously. When one is successful in finding the line which has initiated a call, all are arrested in the position which they have at that time reached, and remain in such a position until the initiation of a new call. At that time all of those line-finders which are still idle start on a new search. Each one of these switches is provided with means to cause it to move in the opposite direction when it has reached either end of its travel in one direction, and to hunt for the calling line during its movement in either direction.

A further feature of the present invention is the provision of means to cause the line-finder to remain in its set position upon the release of other apparatus concerned in the establishment of a connection at the termination of a conversation. Such line-finder is adapted thereupon to take up the search for a newly initiated call with other similar idle switches.

Another feature of the invention is its application to trunk-hunting switches, where, upon the failure of the ordinary selector to find an idle trunk, the connection is switched to a selector embodying the present invention, which takes up the search and perseveres therein until an idle trunk is found.

In the drawings, Figure 1 represents diagrammatically a telephone exchange system employing a plurality of line-finder switches, of which only two are shown, and which embody the present invention.

Fig. 2 is a diagrammatic representation of a telephone system in which the present invention is applied to a trunk-hunting selector.

Referring now especially to Fig. 1, S represents a subscriber's substation, LF′ and LF² represent two line-finders of a group of several which serve the group of lines of which S is one. Line-finder LF′ is shown in such a condition that its next movement will be downward, while line-finder LF² is shown in the extreme downward position ready to move in an upward direction.

When the subscriber at substation S removes his receiver from its switchhook, a circuit is established through the well-known line relay LR, which attracts its armatures and establishes a circuit to start several idle line finders. This circuit extends from ground to outer armature and contact of relay LR, right-hand armature and contact of relay 1, sequence switch contact 3, transfer switch 5 and its upper contact, winding of down-drive magnet 7 to grounded battery. A parallel circuit is set up from ground, outer right-hand armature and contact of relay LR, right-hand armature and contact of relay 2, sequence-switch contact 4, transfer switch 6 and its lower contact, winding of up-drive magnet 10 to grounded battery. Like parallel circuits for other idle line finders are set up, but not shown here. Line finder LF′, in the well-known manner, is caused to move downward, and line finder LF² in like manner is caused to move upward.

We will assume that line finder LF², whose brushes are B′, B², B³ and B⁴, are nearest to the terminals 11, 12, 13 and 14 of the calling line, is the first to reach these terminals. A circuit is thereupon established from grounded battery, winding of relay 2, sequence-switch contact 16, brush B⁴, terminal 14, resistance 17, contact and inner armature LR to ground. Relay 2 attracts its armatures, thereby opening the circuit of up-drive magnet 10 and bringing the brushes of the line finder LF² to rest upon the terminals of the calling line. A second circuit is established from ground, left-hand armature and contact of relay 2, sequence-switch contact 18, winding of se-

quence-switch power magnet 19 to grounded battery, causing the sequence switch to move under the control of its contact A into position 16. As this sequence switch moves out of position 1, and into position 1½, a circuit is set up from grounded battery, resistance 20, sequence-switch contact 21, brush B^3, terminal 13, winding of cut-off relay CO to ground. The consequent energization of relay CO opens the energizing circuit of line relay LR in the well-known manner, allowing relay LR to retract its armatures. The circuit for causing the movement of the rest of the line finders is now opened at the outer armature and contact of relay LR, and they come to rest in the position reached at that time.

When sequence switch 19 enters the second position and comes to rest in the sixteenth position, talking conductors of the calling line are connected to the repeating coil C at the sequence-switch contacts 22 and 23, brushes B^1, B^2 and terminals 11 and 12, and the further progress of the call is taken care of in any well-known manner.

When a new call is initiated, line finder LF^2 will be busy, and cannot be started in search of the calling line due to the open circuit found in sequence-switch contact 4. However, line finder LF′, whose associated sequence-switch contact 3 is still closed in position 1, will be available and will start with other idle line finders on the search.

When, after one or more movements, line finder LF′ reaches its extreme downward position, projection 24, making physical contact with transfer switch 5, will act to transfer the power circuit for this line finder from the down-drive magnet 7 to the up-drive magnet 9. At the end of a full upward movement which may be accomplished in several searches, projection 25 will act in conjunction with transfer switch 5 to cause the further movement of this switch to be in a downward direction.

At the conclusion of the conversation held over substation S and the connection established therewith, the actuation of the well-known supervisory relay 26 will cause sequence switch 19 to move from its sixteenth to its first or normal position, through a circuit extending from ground, armature and contact of relay 26, sequence switch contact 18 (position 16), winding of motor magnet of sequence switch 19 to battery and ground, where line finder LF^2 is again in condition to search for a calling line.

Referring now especially to Fig. 2, S′ represents a calling subscriber's substation, S^2 represents a called subscriber's substation, SS′ and SS^2 selector switches of ordinary construction, SS^3 a selector switch embodying the present invention and CS a connector switch.

It will be assumed that the subscriber at substation S′ removes his receiver from its hook, and that connection is established through the well-known cord finder and operators' circuits indicated by the broken lines leading from substation S′ to the selector switch SS′. Such indicated circuits are more fully described in patent granted to Lundell, 1,168,319. Upon ascertaining from the calling subscriber the number desired, the operator sets the well-known register and presses a key K. A circuit is thereupon established from ground, through the key K, sequence-switch contact 101, the winding of motor magnet 100 to grounded battery. Under the control of its contact A′, the sequence switch moves from position 1 to position 6. In this position a circuit is established from grounded battery, left-hand winding of relay 30, sequence-switch contact 102 to ground, thereby energizing relay 30, which in turn attracts its armatures. A circuit is now established from ground, left-hand armature and alternate contact of relay 30, sequence-switch contact 103, to the winding of motor magnet 100, and thence to grounded battery. This results in the movement of the sequence switch under control of its contact A′ into position 7.

In their normal position the brushes B^5, B^6, B^7 of the selector switch SS′ rest on the lowermost set of contacts 31, 32 and 33. Contact 33 is the test terminal of the trunks leading from this selector switch, and when it is busy will be grounded in a manner to be described later. Brush B^7 making contact with the terminal 33 of the lowermost set of such terminals will, if connected to a busy trunk, establish a circuit from ground, terminal 33, brush B^7, right-hand armature and alternate contact of relay 30, right-hand winding of relay 30 to grounded battery. Hence, when the sequence switch moves into position 7, relay 30 will be maintained in an energized position.

Under these conditions a circuit is now established from grounded battery, winding of magnet 35, sequence-switch contact 104, alternate contact and left-hand armature of relay 30 to ground. The energization of magnet 35 causes the armatures of this magnet to be attracted, thereby bringing driving-rod 36 into frictional contact with the constantly rotating roller 37 to drive the brushes B^5, B^6 and B^7 in an upward direction. Another circuit is at the same time established from ground, left-hand armature and alternate contact of relay 30, sequence-switch contact 105, brush 38 to the commutator segment 39, and thence through sequence-switch contact 106 to the left-hand winding of magnet 30, and ground.

Suppose, now, in its upward movement, brush 7 strikes a contact 33 of an idle trunk, the energizing circuit for this relay 30,

traced through its right-hand winding, will be broken. Relay 30 will, however, remain energized until the brush 38 moves on to an insulating segment 40 of the commutator 39, whereupon the energizing circuit for the right-hand winding of relay 30 will also be broken. Brush 38 will strike the insulating segment 30 when the brushes B^5, B^6 and B^7 are accurately centered on the terminals 31, 32 and 33.

The deënergization of relay 30 results in the retraction of its armatures, whereupon the energizing circuit for magnet 35 is broken at the alternate contact and left-hand armature of relay 30. At the same time a circuit is established from ground, left-hand armature and normal contact of relay 30, sequence-switch contact 107, winding of the sequence-switch magnet 100 to grounded battery, thereby driving the sequence switch under control of its contact A′ into position 16.

It should be noted at this point, that if the first set of contacts 31, 32 and 33, on which the brushes B^5, B^6 and B^7 rested had been connected to an idle trunk, then the movement of the sequence switch into position 7 would have broken the energizing circuit of relay 30 at sequence-switch contact 102. Relay 30 would have retracted its armatures before magnet 35 had become energized, and no elevation of the brush carriage 41 would have taken place. Moreover, the sequence switch would have continued its movement under control of the circuits previously described into position 16.

We will assume that an idle trunk has been found in the conductors T. Therefore, circuit for the subscriber at substation S′ is extended from his substation, through the operator's circuits indicated by the broken lines, through the sequence switch contacts 108, 109, through the brushes B^5 and B^6, the terminals 31 and 32 of the trunk T to the connector switch CS, where this switch will be directed in a well-known manner to the terminals of the called subscriber's substation S^2.

Upon completion of the conversation, well-known supervisory signals indicate this fact to the operator, who thereupon depresses a key K′. This completes a circuit from ground, key K′, sequence-switch contact 110, winding of the sequence switch magnet 100 to grounded battery, thereby driving the sequence switch under control of its contact A′ into the eighteenth position. In this position a circuit is completed from ground, sequence switch contact 111, through the winding of magnet 42 to grounded battery. Magnet 42 attracts its armature, thereby bringing the driving rod 36 into frictional engagement with the constantly rotating roller 43, to restore the brushes B^5, B^6 and B^7, and 38 to their normal position. When such a normal position has been reached, circuit is established from ground, sequence-switch contact 112, brush 38, commutator segment 44, sequence-switch contact 113, winding of motor magnet 100 to grounded battery. Sequence switch 100 is moved under control of its contact A′ into its normal position 1.

It should be noted at this point that when the brushes B^5, B^6 and B^7 have seized an idle trunk, this trunk is thereafter made busy through a circuit which extends from ground, sequence-switch contact 114, normal contact and right-hand armature of relay 30, brush B^7, to the test terminal 33 of the trunk T.

Now let us assume that in their upward travel the brushes B^5, B^6 and B^7 failed in their normal movement to seize an idle trunk. For this purpose special trunks at the top of the bank of contacts 31, 32 and 33 are connected to a few special selector switches such as SS^3. It will be understood, therefore, that these special selector switches are seized only when all of the trunks located in the panel of the selector switch SS′ are busy. The seizure of trunk T′, providing it is idle, is followed by the establishment of a circuit from grounded battery, winding of the relay 45, terminal 33 of the special set, brush B^7, right-hand armature and normal contact of relay 30, sequence-switch contact 114 to ground. Relay 45 is energized and attracts its armature, thereby establishing a circuit from ground, armature and alternate contact of relay 45, sequence-switch contact 201, winding of the motor magnet 200 to grounded battery. Sequence switch 200 moves under the control of its contact A^2 into position 3.

In position 3 relay 46 energizes over a circuit from ground, sequence switch contact 202, left-hand winding of relay 46 to grounded battery, whereupon a circuit is set up from ground, left-hand armature and alternate contact of relay 46, sequence-switch contact 203, winding of sequence-switch magnet 200 to grounded battery. Sequence switch 200 is energized through this circuit, and under control of its contact A^2 moves into position 4.

In this fourth position, a circuit is established from ground, left-hand armature and alternate contact of relay 46, sequence-switch contact 204, right-hand armature and normal contact of relay 47, winding of magnet 48 to grounded battery. Magnet 48 attracts its armature and brings the driving rod 49 into frictional engagement with the constantly rotating roller 50, thereby causing the brush carriage 51 of the selector switch SS^3 to be elevated. The brushes B^8, B^9 and B^{10} travel over the bank of contacts 52, 53 and 54 hunting for an idle trunk.

The trunks appearing in this terminal

bank are in some cases multipled to the trunks from the terminal bank of switch SS′, and in other cases from the terminal bank of the switch SS².

Let us assume that all trunks in this bank are busy. Brush carriage 51 will, therefore, be elevated the total distance which it may travel. In its extreme upward position, a brush 55 carried by the rod 56, to which brush carriage 51 is also attached, strikes a commutator segment 57, thereby establishing a circuit from ground, brush 55, commutator segment 57, sequence-switch contact 205, contact and left-hand armature of relay 58, winding of relay 47 to grounded battery. Relay 47 attracts its armatures and transfers the energizing circuit of magnet 48 to magnet 59. This circuit may now be traced from ground, left-hand armature and alternate contact of relay 46, sequence-switch contact 204, right-hand armature and alternate contact of relay 47, winding of magnet 59 to grounded battery. Magnet 59 attracts its armature and brings the driving rod 49 into frictional engagement with the roller 60, constantly rotating in the direction opposite to that of roller 50, whereby the brush carriage 51 is caused to move in a downward direction.

When relay 47 attracts its armatures, it establishes a locking circuit from ground, its left-hand armature and contact, to the contact and right-hand armature of relay 58, the winding of relay 47 to grounded battery. Thus, after brush 55 leaves commutator segment 57, as the brush carriage 51 moves in a downward direction, the relay 47 is maintained in its energized position.

As soon, however, as the brush carriage 51 reaches its extreme downward position, a circuit is established from ground, brush 55, commutator segment 61, winding of the magnet 58 to grounded battery. Magnet 58, upon attracting its armature, opens the locking circuit of relay 47, previously traced, at the contact and left-hand armature of test relay 58.

The energizing circuit of magnet 59 is now transferred by the right-hand armature of relay 47 back again to magnet 48, and the brush carriage 51 is again elevated.

Suppose that by this time the trunk to connector switch CS has become idle, so that when brush B^{10} in its upward movement strikes terminal 54 of this trunk, the usual ground will not be found. The circuit, which may be traced from grounded battery, right-hand winding of relay 46, alternate contact and right-hand armature of relay 46, brush B^{10} to ground through terminal 54 of the busy trunks, is now broken, as just stated. When the brush 62, by its position on an insulated portion of the commutator segment 63, breaks the circuit from ground, left-hand armature and alternate contact of relay 46, sequence-switch contact 212, brush 62, commutator segment 63, sequence-switch contact 213, left-hand winding of relay 46 to grounded battery, and the brushes B^8, B^9 and B^{10}, are accurately centered on the terminals of the selected trunk, relay 46 will be deënergized. A circuit is now established from ground, left-hand armature and normal contact of relay 46, sequence-switch contact 206, winding of the sequence-switch magnet 200 to grounded battery. Sequence switch 200 moves under control of its contact A^2 into the fifteenth position.

As the sequence switch moves out of its fourth position, the energizing circuit for either relay 48 or 59 is broken at the sequence-switch contact 204, and the brush carriage 51 remains in the position selected, at this time until the final release of this switch. In this position (15), sequence-switch contacts 207 and 208 are closed, thereby extending the subscriber's circuit through to the connector switch CS.

Under the control of the apparatus at the operator's position, connector switch CS is caused to select the terminals of the called subscriber's substation S^2 in a well-known manner.

At the termination of the conversation, the usual supervisory signals indicate, as before, to the operator the condition of the call on that particular circuit. In destroying the connection the operator presses the key K′, whereupon the circuit previously described for stepping the switch SS′ into its normal position is established. When the brush B^7 of switch SS′ moves from the terminal 33 of the trunk T′, the energizing circuit for relay 45 is broken. Relay 45 deenergizes and upon the release of its armature, a circuit is established from ground, armature and normal contact of relay 45, sequence-switch contact 209, winding of sequence-switch magnet 200 to grounded battery. Sequence switch 200 moves under the control of its contact A^2 into position 18. In this position circuit is established from ground, right-hand armature and normal contact of relay 58, sequence-switch contact 210, winding of the magnet 59 to grounded battery. Magnet 59 causes the return of brush carriage 51 to its extreme downward or normal position. When this position is reached, energizing circuit for relay 58, heretofore described, is established. Relay 58 attracts its armatures, breaking the circuit of down-drive magnet 59, at its normal contact and right-hand armature, and establishing at its right-hand armature and alternate contact, a circuit from ground to the sequence-switch contact 211, winding of sequence-switch magnet 200 to grounded battery. Sequence switch 200 moves under control of its contact A^2 into the first or nor-

mal position, whereupon energizing circuit for relay 58 is broken and selector switch SS^2 is left in its normal condition.

What is claimed is:

1. In a telephone system, telephone lines, an automatic switch in which said lines terminate in fixed terminals, means for causing said automatic switch to hunt over an entire row of said fixed terminals in a continuous rectilinear reciprocating motion, and means for causing said automatic switch to seize a set of electrically distinguished terminals.

2. In a telephone system, telephone lines, an automatic switch in which said lines terminate in fixed terminals, means for causing said automatic switch to hunt over an entire row of said fixed terminals in a continuous rectilinear reciprocating motion, and means for causing said automatic switch to seize an idle set of terminals.

3. In a telephone system, telephone lines, an automatic switch in which said lines terminate in fixed terminals, means for causing said automatic switch to hunt over an entire row of said fixed terminals in a continuous rectilinear reciprocating motion, and means for causing said automatic switch to seize a calling line, said calling line being connected to one set of said terminals.

4. In an automatic switch, rows of circuit terminals, brushes arranged to travel over and make contact with said terminals, means for causing said brushes to travel over an entire row of said terminals in a continuous rectilinear reciprocating motion, and means for causing said brushes to seize a set of electrically distinguished terminals.

5. In an automatic switch, rows of circuit terminals, brushes arranged to travel over and make contact with said terminals, means for imparting to said brushes a continuous rectilinear reciprocating motion over the entire length of said rows of circuit terminals, and means for causing said brushes to seize a set of terminals in a predetermined electrical condition.

6. In an automatic switch, rectilinear rows of fixed terminals, movable brushes arranged to travel over and make contact with said terminals, means for imparting a reciprocating motion over the entire length of said rows of circuit terminals to said brushes, and means effective during both the forward and return movement of said brushes for causing them to seize an electrically distinguished set of terminals.

7. In a telephone system, a calling line, a plurality of panel type line finders, a switch controlled by said line to control the movement of all idle finders associated with said line, and a switch controlling the direction of movement of and controlled by the movement of said line finders.

8. In a telephone exchange system, a calling line, a plurality of panel type line finders, a circuit controlled by said line to control the actuation of all idle line finders associated with said line, a switch controlling the direction of movement of and controlled by said line finders, and means for arresting all moving line finders upon the seizure of the calling line by any one of said line finders.

9. In a telephone exchange system, a calling line, a plurality of panel type line finders, a circuit controlled by said line to control the actuation of all idle line finders associated with said line, a switch to control the direction of movement of each line finder, said switch being actuated by said line finder at either end of its travel to cause said line finder to travel in opposite direction, a switch to open said circuit to arrest the movement of said line finder, a circuit controlling said last mentioned switch including a brush of said line finder, and a terminal associated with said line, and means for removing the successful line finder from the control of said first mentioned circuit.

10. In a telephone system, a non-numerical switch, a plurality of telephone lines terminating in said switch, a set of wipers arranged in operative relation to said lines, a source of power for moving said wipers, means for applying said source of power to move said wipers in one direction, means for disconnecting said source of power from said wipers, means for applying said source of power to move said wipers in an opposite direction, and means for causing said wipers to seize an electrically distinguished one of said telephone lines while moving in either direction.

In witness whereof, I hereunto subscribe my name this 19th day of September, A. D. 1916.

ALBEN E. LUNDELL.