

May 29, 1923.

1,456,508

A. E. LUNDELL ET AL

NUMBER INDICATING SYSTEM

Filed July 26, 1919

3 Sheets-Sheet 1

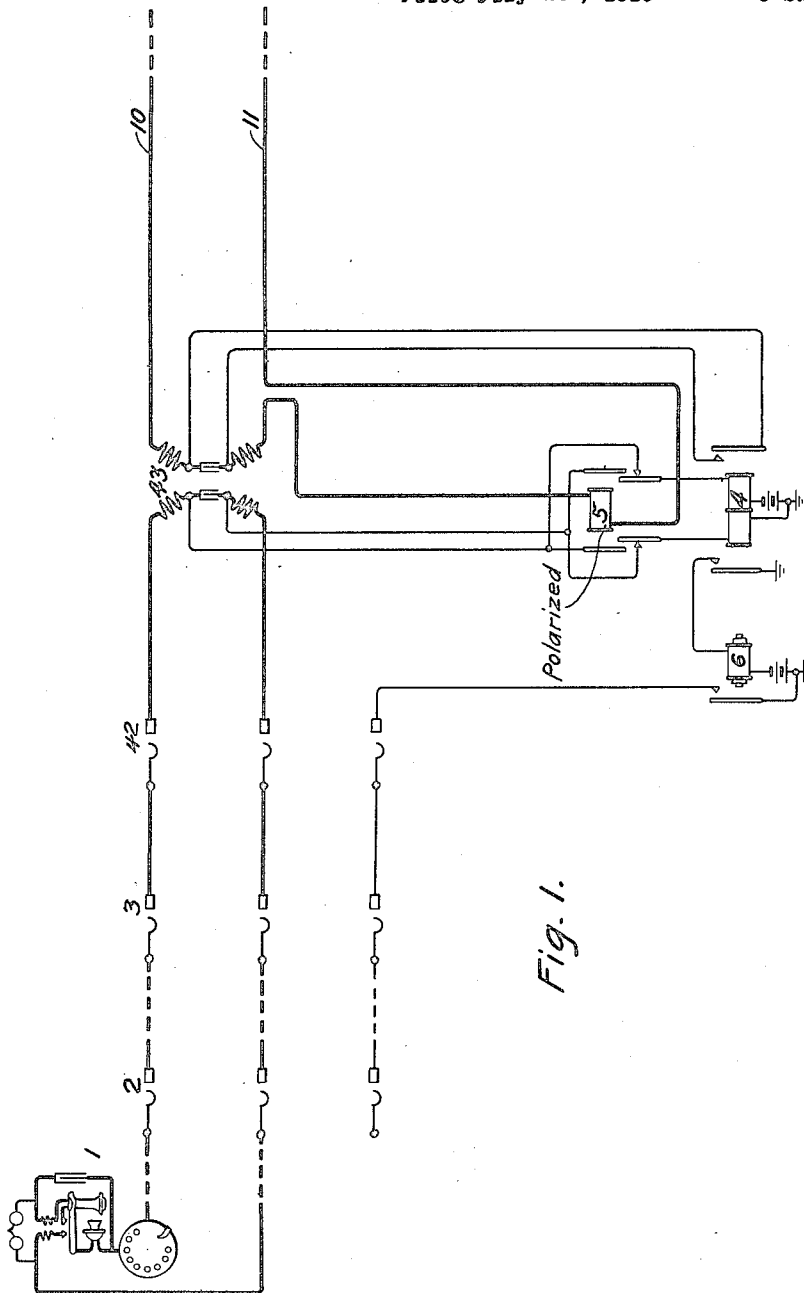


Fig. 1.

Inventors:
Alben E. Lundell
Tudor VanAmstel
by *J. Roberts* Atty.

May 29, 1923.

A. E. LUNDELL ET AL

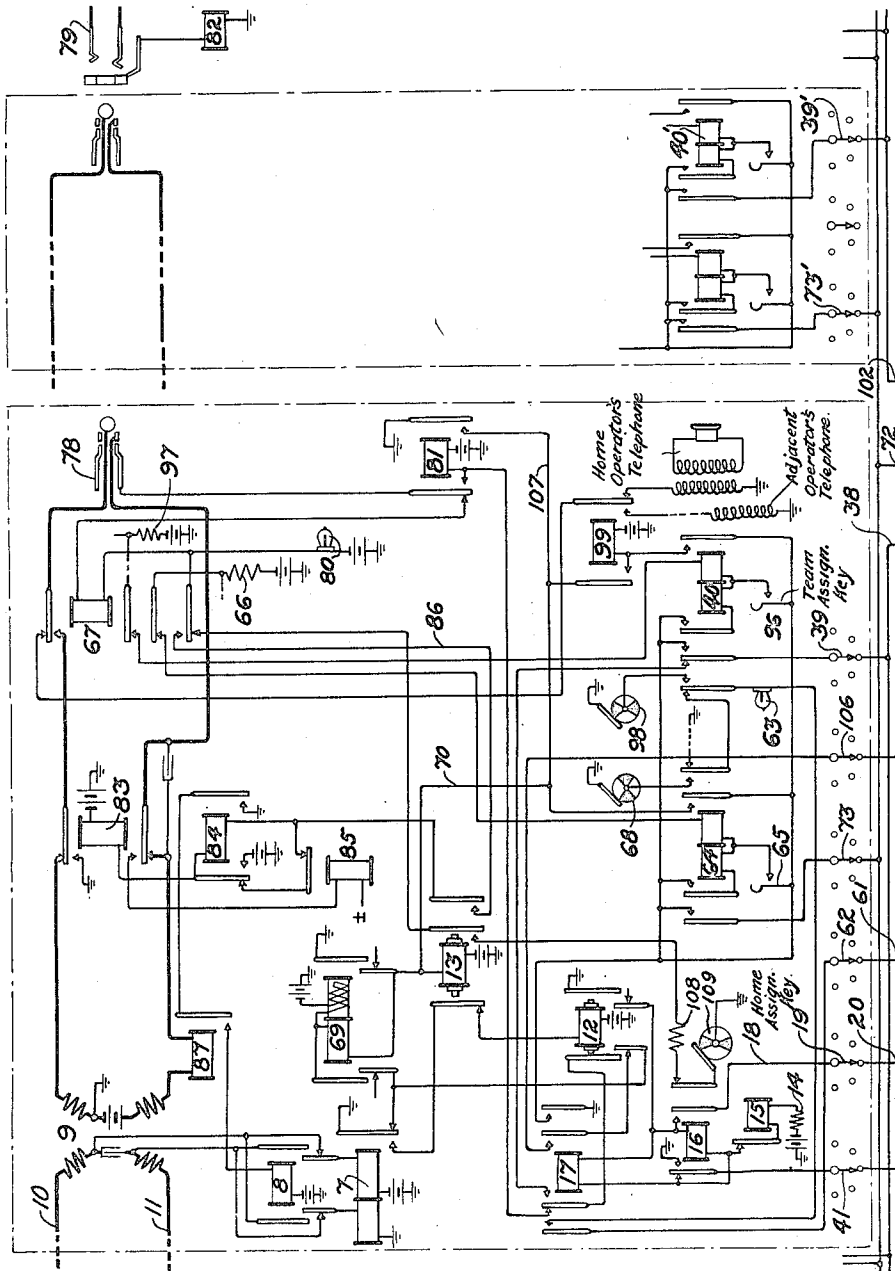
1,456,508

NUMBER INDICATING SYSTEM

Filed July 26, 1919

3 Sheets-Sheet 2

Fig. 2.



Inventors:
Alben E. Lundell
Tudor Van Amstel
by *J. E. Roberts* Att'y.

May 29, 1923.

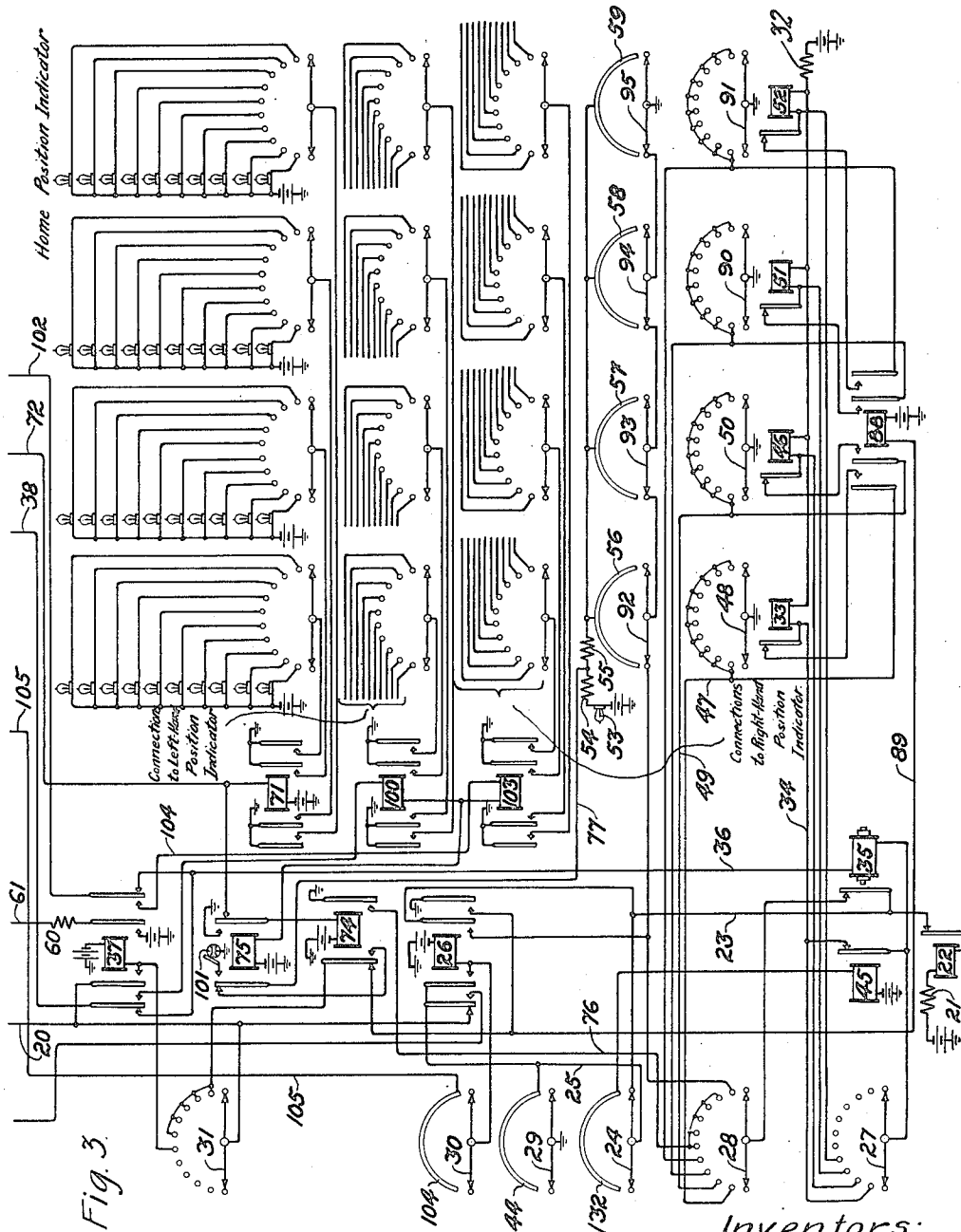
1,456,508

A. E. LUNDELL ET AL

NUMBER INDICATING SYSTEM

Filed July 26 , 1919

3 Sheets-Sheet 3



Inventors:
Alben E. Lundell
Tudor Van Amstel
by *J. Roberts* Att'y.

UNITED STATES PATENT OFFICE.

ALBEN E. LUNDELL, OF NEW YORK, AND TUDOR VAN AMSTEL, OF DOUGLASTON, NEW YORK, ASSIGNORS TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

NUMBER-INDICATING SYSTEM.

Application filed July 26, 1919. Serial No. 313,524.

To all whom it may concern:

Be it known that we, ALBEN E. LUNDELL, a citizen of the United States, and TUDOR VAN AMSTEL, a subject of the King of Great Britain, residing at New York, in the county of Bronx, State of New York, and Douglaston, Long Island, in the county of Queens and State of New York, respectively, have invented certain new and useful Improvements in Number-Indicating Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telephone exchange systems and more particularly to interoffice automatic telephone exchange systems.

In installing an automatic telephone exchange system in a large city, it will usually occur that a number of mechanical offices will be installed, arranged to operate in conjunction with various manual offices present in the same general area.

In order that an automatic subscriber may establish a connection to a called line in a manual office without the necessity of conversing with an operator, the usual practice is to select the manual office by means of automatic switches and then to operate a number indicator before the operator's position at such manual office to indicate to such operator the number of the desired line.

In proposed systems of the power-drive type, the subscriber has been able to dial in to his mechanical office and set registers under the control of his substation dial, and these registers will then be operated to control switches, which will select the desired office and then send impulses to operate the number indicator. In a step-by-step system it is not usual to employ registers and it becomes necessary to provide means by which the number indicator at the operator's position may be controlled by the subscriber's dial.

It is the object of this invention to provide a circuit arrangement such that a full mechanical subscriber may accomplish office selection by means of automatic switches under the control of the substation dial and then continue to send impulses, in the same

manner as he would to set up a call through an office provided with automatic switches, to control a number indicator before an operator.

A feature of the invention is an arrangement such that after the call indicator has been set, an operator on either side of the operator at whose position such setting has occurred may cause the number of the wanted line to be displayed at her own position by pressing a team assignment key.

A more specific feature of the invention resides in the method of wiring the contact of the banks of the register selector in such a way that if the call is incoming over a trunk which appears as a cord circuit in the left-hand portion of the operator's position, the depression of the team assignment key by the operator on the left of the home operator will cause the left-hand operator's indicator to display the called number. Similarly, the operator on the right of the home operator may transfer the setting of the register to her indicator.

Another feature of the invention resides in the means provided for restoring the indicator to its normal condition in case of uncompleted or mutilated calls.

It is thought that the invention will best be understood from the following detailed description, reference being had to the accompanying drawings.

In the drawings, Fig. 1 shows a subscriber's substation set and indicates diagrammatically a first and second selector by means of which the desired office may be selected. The circuits of a repeater used to repeat the impulses over a two-wire trunk to the selected manual office are also shown in this figure. Fig. 2 shows an operator's cord circuit and a step-by-step register pre-selecting switch. The circuits shown in the dotted square are those associated with the cord circuit in which the outgoing trunk of Fig. 1 terminates. This cord is assumed to be located on the left-hand half of the operator's position. In the dotted rectangle to the right of the square are indicated portions of a cord circuit of the same operator's position, but cords of this type will be lo-

cated in the right-hand half of the operator's position. Fig. 3 shows a set of registers and lamps and the controlling circuits therefor.

5 Assuming that the subscriber at substation 1 desires a connection with subscriber No. 7854 in a manual office, and assuming that the number of this manual office is 63, the operation will be as follows:

10 When the calling subscriber removes his receiver from the hook, circuits will be completed to cause the operation of a line switch indicated generally at 2, which will connect the calling line to a first selector
15 whose brushes are shown at 3. He will then operate his dial to send six impulses, whereupon the selector will be operated to select a trunk in the sixth level of its contact bank. The subscriber will then send
20 three impulses to operate the selector whose brushes are indicated at 42, which will then operate to select an idle trunk in the third level of its contact bank. The calling subscriber has now selected an idle trunk leading
25 ing to the desired office. No description of the operation of the line switch and first and second selector switches, or office selectors, as they may be termed, has been given since they may be any one of a number
30 of types of step-by-step switches, well known in the art.

As soon as the selector 42 has seized a trunk, a circuit is completed from grounded battery, right-hand winding of relay 4, inner
35 right-hand normal contacts of relay 5, over the upper side of the line, through the subscriber's substation apparatus, over the lower side of the line, left-hand normal contacts of relay 5, and left-hand winding
40 of relay 4 to ground. Relay 4 attracts its armatures and completes a circuit from grounded battery, winding of slow-release relay 6, left-hand armature and front contact of relay 4 to ground. The energiza-
45 tion of relay 6 supplies busy ground to the test terminals of the trunk. The energization of relay 4 also completes a circuit from grounded battery, winding of relay 7 (Fig. 2), right-hand normal contacts of relay
50 8, upper left-hand winding of repeating coil 9, trunk conductor 10, upper right-hand winding of repeating coil 43, right-hand armature and front contact of relay 4, lower right-hand winding of repeating coil 43,
55 winding of polarized relay 5, trunk conductor 11, lower left-hand winding of repeating coil 9, left-hand normal contacts of relay 8, left-hand winding of relay 7 to ground. Current flow at this time is in
60 such a direction as not to energize polarized relay 5. Relay 7 is, however, energized in this circuit and completes a circuit from grounded battery, winding of relay 12, left-hand armature and back contact of relay
65 13, armature and front contact of relay 7

to ground. Relay 12 is energized in this circuit and completes a circuit from grounded battery, resistance 14, winding of stepping magnet 15, armature and back contact of relay 15, windings of relays 16 and 17
70 in parallel, right-hand armature and front contact of relay 12 to ground. Relays 16 and 17 are energized in this circuit but due to their relatively high resistance stepping magnet 15 does not function.

Relay 16 by attracting its left-hand armature applies busy ground to the terminal on which brush 41 is resting, so as to render this set of registers busy to other hunting register selector switches. It might be
80 well to note at this point that the register selector is a pre-selecting switch and in construction may be any one of the rotary step-by-step switches of small capacity, well known in the art. The various registers are
85 of similar construction, as is also the side switch for controlling such registers. It is thought that the mechanical construction of these switches will be readily understood without further description.

It has been assumed that at the time the trunk incoming to the cord circuit shown in Fig. 2 was seized, its associated register selector had seized an idle set or registers and that the various brushes were in
90 connection with the terminals, as shown. The operation of the selector will be further described hereinafter.

The energization of relay 16 also completes a circuit from grounded battery, resistance 21 (Fig. 3), escape magnet 22, armature and back contact of escape magnet 22,
100 conductor 23, side-switch brush 24 in its normal position, conductor 25, outer left-hand armature and back contact of relay 26, conductor 20, brush 19, conductor 18, inner right-hand armature and front contact of relay 16 to ground at the right-hand armature and front contact of relay 12. Escape magnet 22 is energized in this circuit and advances the side-switch arms 27,
105 28, 24, 29, 30 and 31 into their second positions. As soon as the side switch reaches position 2, relays 16 and 17 are locked up through the inner right-hand armature of relay 16, conductor 18, brush 19, conductor 20, outer left-hand armature and back contact of relay 26, conductor 25, side-switch arm 29 and conducting segment 44, to which arm 29 is closed in any off-normal position
110 of the side switch, to ground.

The calling subscriber now dials the first digit of the wanted line number, which, it will be remembered is 7. Upon the first interruption of the line circuit, line relay 4
115 will be deenergized, opening the circuit of relay 7. A circuit is then completed from grounded battery, resistance 32 (Fig. 3), stepping magnet 33 of the thousands register, conductor 34, side-switch arm 27 and
120 130

its second contact, winding of slow-release relay 35, conductor 36, outer left-hand armature and back contact of relay 37, conductor 38, brush 39, middle left-hand armature and back contact of relay 40, inner left-hand armature and front contact of relay 17, left-hand armature and front contact of relay 12, armature and back contact of relay 7 to ground. Stepping magnet 33 is energized in this circuit and advances the thousands register one step.

It is to be noted that the first pulse will not be lost by the thousands register stepping magnet 33 in case the side switch is slow in moving into its second position, since the armature and back contact of relay 45 is bridged across the side-switch arm 27 and its second contact. As soon as the side switch moves into its second position, however, relay 45 will be energized to remove this bridge, over a circuit extending from grounded battery, winding of relay 45, segment 132, side-switch arm 24, conductor 25, outer left-hand armature and back contact of relay 26, conductor 20 to ground at the right-hand armature and back contact of relay 12 over a path previously described.

The subsequent interruptions in the circuit of relay 7, in response to the sending of the first series of impulses, cause the stepping magnet 33 to advance the thousands register into position 7. Relay 35, being slow to release, is maintained energized during the sending of these impulses. At the termination of the first series of impulses relay 7 will remain energized for a relatively long period, thus causing the deenergization of relay 35. The release of relay 35 completes a circuit from grounded battery, resistance 21, side-switch magnet 22, armature and back contact of relay 35, side-switch arm 28, in its second position, conductor 47, thousands register arm 48 to ground. Magnet 22 is energized and advances the side-switch arms from position 2 to position 3.

The calling subscriber now sends the second series of impulses. Upon the first deenergization of line relay 7, a circuit is completed from grounded battery, resistance 32, winding of hundreds register stepping magnet 46, side-switch arm 27 and its third contact, winding of slow-release relay 35, conductor 36, outer left-hand armature and back contact of relay 37, conductor 38, register selector brush 39, middle left-hand armature and back contact of relay 40, inner left-hand armature and front contact of relay 17, left-hand armature and front contact of relay 12, armature and back contact of relay 7 to ground. Relay 35 is energized in this circuit and remains energized during the sending of the series of impulses. Magnet 46 is also energized and its energization causes the hundreds register to be

advanced one step. When all the impulses of the second series have been sent, the hundreds register will be in position 8, and when relay 7 remains energized over a relatively long period, relay 35 is deenergized and completes a circuit from grounded battery, resistance 21, winding of side-switch magnet 22, armature and back contact of magnet 22, armature and back contact of relay 35, side-switch arm 28 and its third contact, conductor 49, hundreds register arm 50 and its associated contact to ground. Side-switch magnet 22 is energized and advances the side switch out of position 3 and into position 4.

The calling subscriber now sends the tens impulses and in response to the completion of circuits similar to those previously described, stepping magnet 51 of the tens register advances the tens register into position 5. The side switch is then advanced into position 5 in a manner substantially similar to that previously described.

In response to the units impulses, the units register stepping magnet 52 advances the units register into position 4, and upon the termination of this series of impulses, the side switch is moved out of position 5 and into position 6.

While the registers are being set, a circuit is completed from grounded battery, lamp 53, resistances 54 and 55, and thence through the register segments 56, 57, 58, 59 and their associated brushes in series, or partially in series, in accordance with how many of the registers have been set, to ground. The lamp 53, due to the presence of resistances 54 and 55, is lighted dimly to inform the operator that the registers are being set.

As soon as the side switch reaches position 6, a circuit is completed from grounded battery winding of relay 37, side-switch arm 31 and its sixth contact, conductor 20, to ground over a path previously described. Relay 37 is energized and locks up to conductor 20 through its inner left-hand armature and front contact. At the same time a circuit is completed from grounded battery inner right hand armature and front contact of relay 37, resistance 60, conductor 61, register selector brush 62 and its associated contact, outer left-hand armature and front contact of relay 17, assignment lamp 63, outer left-hand armature and back contact of relay 40, outer right-hand armature and back contact of relay 64 to ground. Assignment lamp 63 is lighted to inform the operator that the registers are set.

The operator, upon observing the lighting of assignment lamp 63, depresses home assignment key 65, thus completing a circuit from grounded battery, resistance 66, lower middle armature and back contact of relay 67, right-hand low resistance winding of

relay 64, contacts of key 65, outer right-hand armature and front contact of relay 17 to ground. Relay 64 is energized in this circuit.

5 At the outer right-hand armature and front contact of relay 64, the circuit of assignment lamp 63 is extended to an interrupter 68, which will cause this lamp to flash in a distinctive manner to indicate that the call
10 on the trunk to which this assignment lamp is individual is to be handled by the home operator. At its inner left-hand armature and front contact, relay 64 locks itself to ground at the outer right-hand armature
15 and front contact of relay 17, this circuit including the high resistance left-hand winding of relay 64. Circuits for relays 69 and 13 are completed in parallel—in the first case, from grounded battery, through the
20 non-inductive winding of relay 69, the left-hand winding of relay 69 to conductor 70,—in the other case from grounded battery, winding of relay 13, to conductor 70, thence through the inner right-hand armature and
25 front contact of relay 64 to ground at the outer right-hand armature and front contact of relay 17. Relays 13 and 69 are energized and lock up to ground at the right-hand armature and front contact of relay 69.
30 The energization of relay 64 also completes a circuit from grounded battery, winding of relay 71 (Fig. 3), conductor 72, register selector brush 73 and its associated contact, outer left-hand armature and front contact
35 of relay 64, to ground at the outer right-hand armature and front contact of relay 17. Relay 71 is energized and at its armatures and front contacts supplies ground for lighting the lamps at the home operator's position.
40 In accordance with the setting of the registers, lamp 7 in the thousands group, lamp 8 in the hundreds group, lamp 5 in the tens group and lamp 4 in the units group will be lighted.

45 Relay 74 is energized in parallel with relay 71 over a circuit extending from grounded battery, winding of relay 74, right-hand armature and back contact of relay 75, conductor 72 to ground over the path described.
50 Relay 74, upon energization, completes a circuit from grounded battery, resistance 21, winding of side-switch stepping magnet 22, armature and back contact of magnet 22, armature and back contact of relay 35, side-
55 switch arm 28 in its sixth position, conductor 76, right-hand armature and front contact of relay 74, to ground. Stepping magnet 22 is energized and continues to interrupt its circuit to advance the side switch
60 into position 10. As soon as relay 74 is energized, a circuit is also completed from grounded battery, lamp 53, resistance 54, conductor 77, left-hand armature and back contact of relay 75, left-hand armature and
65 front contact of relay 74, side-switch arm 31

and its associated contact to grounded conductor 20. Lamp 53 burns steadily and brightly in this circuit, due to the elimination of resistance 55.

As soon as the operator has noted the number of the wanted line, she inserts plug 78 into jack 79 of the desired line. A circuit is then completed from grounded battery, lamp 80, winding of relay 67, left-hand armature and back contact of relay 81, contacts of plug
75 78 and jack 79, winding of cut-off relay 82 to ground. Lamp 80 is lighted and relays 67 and 82 are energized in this circuit. The energization of relay 82 removes the called subscriber's control of his line relay in the well known manner. Energization of relay
80 67 completes a circuit for the application of ringing current.

This circuit is as follows: Grounded battery, winding of relay 83, left-hand armature and back contact of relay 84, armature and back contact of relay 85, outer right-hand armature and front contact of relay 13,
85 conductor 86, lower-most armature and front contact of relay 67, winding of relay 67 to ground as described. The low resistance of relay 83 shunts out lamp 80 and this lamp is extinguished. The energization of relay 83 completes a circuit from a source of ringing current, the winding of
90 relay 85, lower armature and front contact of relay 83, ring contacts of plug 78 and jack 79, over the loop of the called substation line, the called substation apparatus, the tip side of the line, tip contacts of jack 79 and
95 plug 78, upper armature and front contact of relay 67, upper armature and front contact of relay 83 to ground. In response to the completion of this circuit, the bell at the called station is caused to ring. When the
100 called subscriber answers, relay 85 is allowed to operate and in so doing removes the shunt from about the winding of relay 84. Relay 84 is then energized and locks up through its left-hand armature and front
110 contact. The battery feed at the left-hand armature and front contact of relay 84 operates to shunt down relay 83. As soon as relay 83 deenergizes the talking circuit is complete and the subscribers may converse.
115

As soon as relay 83 is deenergized, current flow from the battery in repeating coil 9 energizes a supervisory relay 87 and since relay 84 is also energized, a circuit is completed from grounded battery, winding of
120 relay 8, armature and front contact of relay 87, right-hand armature and front contact of relay 84 to ground. Relay 8 is energized in this circuit and reverses the direction of current flow in the incoming end of the
125 trunk. This reversal of current flow operates polarized relay 5 of the repeater shown in Fig. 1. The operation of relay 5 reverses the direction of current flow in the calling subscriber's line for the purpose of oper-
130

ating a coin collect device or a message register device, in a manner well known in the art.

As soon as relay 67 was energized the battery supply for relay 64 is cut off at the middle lower armature of relay 67 and relay 64 deenergizes, thus breaking the circuit of relays 71 and 74. A circuit is then completed from grounded battery, winding of relay 88, conductor 89, left-hand armature and back contact of relay 74, side-switch arm 31 in its tenth position, conductor 20, left-hand armature and back contact of relay 26, conductor 25, segment 44, side-switch arm 29 to ground. Relay 88 is energized and completes circuits for the stepping magnets of the various registers. The register magnets are self-interrupting in these circuits and continue to advance their registers until the arms 48, 50, 90 and 91 reach their respective normal positions. It is thought that these circuits are so obvious as to need no description.

As soon as all the registers have reached their normal positions, a circuit is completed from grounded battery, resistance 21, winding of side-switch stepping magnet 22, armature and back contact of magnet 22, armature and back contact of relay 35, side-switch arm 28 and its tenth contact, through the register brushes 92, 93, 94 and 95 and their respective normal contacts to ground. Stepping magnet 22 advances the side switch into its normal position, thus breaking the holding circuit for relay 37, which now deenergizes. The registers are now in their normal condition and are ready for re-use. The removal of holding ground from lead 20 results in the deenergization of relays 16 and 17. Relay 12 was deenergized at the time relay 13 was energized.

The set of registers may now be seized by the register selector associated with any of the cords at this position. The register selector shown will remain in the position indicated in the drawing since it is now in connection with an idle set of registers. Should, however, this set of registers be seized by the register selector of another cord circuit, busy ground on the terminal associated with brush 41 would complete a circuit from grounded battery, resistance 14, winding of stepping magnet 15, armature and back contact of magnet 15, armature and back contact of relay 16, test brush 41 and its associated contact to ground. This will cause the stepping magnet 15 to operate until an idle set of registers is found.

When the conversation is completed and the calling subscriber has replaced his receiver, line relay 7 is deenergized as a result of the deenergization of line relay 4. Direct ground on the back contact of the armature of relay 7 shunts down relay 69,

and the release of relay 69 causes in turn the release of relay 13. Relay 69 is shunted down due to the fact that its left-hand inductive winding is shunted at the right-hand armature and back contact of relay 7. The right-hand winding of relay 69 is non-inductive and therefore, current flow through this winding has no effect to maintain the relay energized. The circuit of relay 84 is therefore broken at the outer right-hand contact and armature of relay 13, and the shunt is removed from about lamp 80, causing this lamp to burn steadily as a disconnect signal. The operator thereupon removes plug 78 from jack 79. This leaves the cord in position for re-use.

The manner in which operators may assist one another will now be described. For this purpose, the description will be referred back to that point at which all the registers were set. The side switch is in position 6 and the assignment lamp 63 was caused to burn steadily. If now the operator on the left of the home operator notices that the home operator is busy and decides to take the call, she will depress team assignment key 96. A circuit will thereupon be completed from grounded battery, resistance 97 at the adjacent position, inner lower armature and back contact of relay 67, right-hand low resistance winding of relay 40, contacts of key 96 to ground at the outer right-hand armature and front contact of relay 17. Relay 40 is energized in this circuit and locks up through its right and left-hand windings in series to ground at the outer right-hand armature and front contact of relay 17. At its outer left-hand armature and front contact, relay 40 connects an interrupter 98 to the lamp 63 to cause it to flash in a distinctive manner to indicate that the call is being handled by the operator at the adjacent position. At its right-hand armature, relay 40 completes a circuit from grounded battery, winding of relay 99, right-hand armature and front contact of relay 40 to ground. The energization of relay 99 transfers at its right-hand armature the busy test lead from the coil in the adjacent operator's head set to the tip of the cord circuit shown, by way of the upper armature and back contact of relay 67.

At its middle left-hand armature, relay 40 completes a circuit from grounded battery, winding of relay 75, winding of relay 100, outer left-hand armature and front contact of relay 37, which relay it will be remembered, was energized in position 6 of the side switch, conductor 38, register selector brush 39 and its associated contact, middle left-hand armature and front contact of relay 40, to ground. Relays 75 and 100 are energized in this circuit. Relay 100 at its armatures supplies ground to the lamps at the left-hand adjacent position to cause the

indication of the number set up on the register shown in Fig. 3, that is, No. 7854. Relay 75, upon energizing, connects an interrupter 101 by way of its left-hand armature and front contact, conductor 77, and resistance 54 to lamp 53 and grounded battery. The lamp 53 is caused to flash brightly under the control of the interrupter to indicate that the number is being indicated at the adjacent position.

A circuit is also completed from grounded battery, winding of relay 74, right-hand armature and front contact of relay 75 to ground. Relay 74 is thereupon energized and completes a circuit from grounded battery, resistance 21, side-switch stepping magnet 22, armature and back contact of magnet 22, armature and back contact of relay 35, side-switch arm 28 in sixth position, conductor 76, right-hand armature and front contact of relay 74 to ground, for advancing the side switch into position 10.

The adjacent operator may now reach over and insert plug 78 into the jack 79 of the called line. The operation from this point on will be substantially the same, except that the insertion of plug 78 into jack 79 would cause the energization of relay 67, which at its inner lower armature breaks the holding circuit for relay 40. This relay upon its deenergization causes the deenergization of relays 100 and 75, and the resultant deenergization of relay 74. The circuit previously traced for restoring magnet 88 is then completed, and the registers are restored as previously described. The operation of the cord circuit is identical with that previously described.

It is to be noted that the register selectors individual to the cords on the left-hand half of the position have a brush 39 which engages a set of terminals which are connected to a controlling lead 38. The result is that whenever a register selector associated with a cord on the left-hand half of the position seizes a set of registers and when the team assignment key of such cord is depressed, relays 75 and 100 will be energized as just described.

The register selectors associated with the cords on the right-hand half of the position have brushes which engage multiples of the contacts which are arranged for engagement by brushes 41, 19, 62, 73 and 106, respectively. However, the sixth brush, which I have indicated as 39', does not engage multiples of the contacts served by brush 39, but engages a set of contacts which lead to conductors similar to conductor 102. As a result, when the team assignment key on a cord appearing on the right-hand side of the position is operated, a circuit is completed from grounded battery, winding of relay 75, winding of relay 103, conductor 104, outer right-hand ar-

mature and front contact of relay 37, conductor 102, brush 39', outer left-hand armature and front contact of relay 40' to ground. Relays 75 and 103 are energized in this circuit. Relay 103 at its armature supplies ground to the indicator lamps at the position to the right of the home position. The operation of the circuits is otherwise identical with that previously described, and should be clear without further description.

In case the calling subscriber desires to abandon the connection before all the impulses have been sent, the operation of the system is as follows. The registers may be partially set at this time. The continued deenergization of line relay 7 causes the release of slow release relay 12. A circuit is thereupon completed from grounded battery, winding of relay 26 (Fig. 3), side-switch arm 30, (which may be in any off-normal position), segment 104, conductor 105, brush 106 and its associated contact, inner right-hand armature and front contact of relay 17, left-hand armature and back contact of relay 12, back contact and armature of relay 7 to ground. Relay 26 is energized and locks up to conductor 25.

Restoring relay 88 is energized over a circuit from grounded battery, winding of relay 88, conductor 89, outer right-hand armature and front contact of relay 26 to ground. Under the control of relay 88, the registers are returned to their normal positions. At its outer left-hand armature, relay 26 breaks the holding circuits for relays 16 and 17, and these relays deenergize. However, the terminal on which test brush 41 is resting is maintained busy by a ground supplied through the outer left-hand armature and front contact of relay 26, conductor 25, segment 44 and side-switch arm 29 to ground.

As soon as the call registers have been restored, a circuit is completed from grounded battery, resistance 21, side-switch stepping magnet 22, armature and back contact of magnet 22, inner right-hand armature and front contact of relay 26, to ground through register brushes 92, 93, 94 and 95, and their respective associated contacts, to ground. Magnet 22 interrupts its own circuit and restores the side switch to its normal position wherein ground is removed from the test terminal on which test brush 41 is resting. This leaves all the apparatus in its normal condition.

The conditions arising in case a call comes in while the register selector switch is hunting will now be considered. In this case line relay 7 will be energized causing in turn the energization of relay 12. However, relays 16 and 17 cannot be energized since they have ground on both sides of their windings. due to the busy ground on the register selector test terminals. The relay 12 being

energized, the deenergization of relay 7 upon the first line interruption will complete a circuit from grounded battery, winding of relay 81, inner left-hand armature and back contact of relay 17, left-hand armature and front contact of relay 12, armature and back contact of relay 7 to ground. If the plug 78 has been left in the jack from a preceding call, relay 81 will lock up to the sleeve of the line. Relay 81 will upon energization complete a parallel circuit for relays 13 and 69 to conductor 70, as previously described, and thence by way of conductor 107 to ground at the right-hand armature and front contact of relay 81. A circuit is then completed from grounded battery, lamp 80, lower-most armature and back contact of relay 67, inner right-hand armature of relay 13, resistance 108, outer right-hand armature and back contact of relay 16, through an interrupter 109 to ground. This will cause the lamp 80 to flash to indicate to the operator that a call has come in while the register selector was operating. The operator may then plug into a desk or to a supervisor, where the number desired by the calling subscriber will be inquired for verbally, and the connection ordered up. When relay 13 operates it opens the circuit of relay 12, but if before this happens, relays 16 and 17 should have been energized due to the finding of an idle set of registers, and such registers have been moved off-normal, they will restore automatically in the same manner as previously described for abandoned calls.

What is claimed is:

1. In a telephone exchange system, a plurality of operators' positions, a number indicating device individual to each of said positions, a registering device at one of said positions, and means to operate any one of said number indicating devices in accordance with the complete setting of said registering device.

2. In a telephone exchange system, a plurality of operators' positions, a number indicating device individual to each of said positions, a plurality of registering devices associated with each position, a register selector switch, means to operate said register selector switch to bring into use an idle registering device, means to operate said selected registering device, and means to operate any one of said number indicating devices in accordance with the setting of said registering device.

3. In a telephone exchange system, a calling subscriber's line, a sending device individual thereto, a plurality of operators' positions, a number indicating device individual to each of said positions, means to extend said calling line to one of said positions, a registering device at the position to which said calling line has been extended, means to

operate said registering device under the control of said impulse sending device, and means to operate any one of said number indicating devices in accordance with the complete setting of said registering device.

4. In a telephone exchange system, a home operator's position, a right-hand adjacent operator's position, a left-hand adjacent operator's position, a number indicating device individual to each of said positions, a registering device at said home operator's position, means to operate said registering device, and means to operate any one of said number indicating devices in accordance with the setting of said registering device.

5. In a telephone exchange system, a home operator's position, a right-hand adjacent operator's position, a left-hand adjacent operator's position, a number indicating device individual to each of said positions, a plurality of cord circuits at said home position, a team assignment key and a home assignment key associated with each of said cord circuits, a registering device at said home position, means to associate said registering device with any one of said cord circuits, means to operate said registering device, means responsive to the depression of said home assignment key to operate the number indicating device individual to the home position in accordance with the setting of said registering device, and means responsive to the depression of a team assignment key to operate the number indicating device at either the right-hand adjacent position or the left-hand adjacent position in accordance with whether the cord circuit with which the registering device is associated appears on the right-hand or left-hand half of the home position.

6. In a telephone exchange system, an operator's position, a plurality of cord circuits thereat, a plurality of registering devices associated with said position, a register selecting switch individual to each of said cord circuits, means to operate said register selecting switches to preselect idle registering devices, controlling circuits for each of said registering devices extending through contacts of a register selecting switch, means to operate said registering devices, and means to complete a desired controlling circuit in accordance with the relative position of the associated cord circuit at said operator's position.

7. In a telephone exchange system, an operator's position, a plurality of cord circuits thereat, a plurality of registering devices associated with said position, a register selecting switch individual to each of said cord circuits, means to operate said register selecting switches to preselect idle registering devices, controlling circuits for each of said registering devices, one of said controlling circuits extending to multiple contacts of all

of said selector switches, another of said controlling circuits extending to multiple contacts of register selecting switches associated with cord circuits appearing in the
5 right-hand half of the operator's position, and another of said controlling circuits extending to multiple contacts of register selecting switches individual to cords appearing on the left-hand half of the operator's
10 position, means to operate said registering devices, and means to complete a desired controlling circuit.

8. In a telephone exchange system, a home operator's position, a right-hand adjacent
15 operator's position, a left-hand adjacent operator's position, a number indicating device individual to each of said positions, a plurality of cord circuits at said home position, a team assignment key and a home assignment
20 key associated with each of said cord circuits, a registering device at said home position, means to associate said registering device with any one of said cord circuits, relays included in said registering device,
25 there being a controlling relay individual to each of said positions, means to operate said registering device, and means under the control of said assignment keys to energize a desired one of said relays to operate the
30 number indicating devices at a desired position in accordance with the setting of said registering device.

9. In a telephone exchange system, a plurality of operators' positions, a number indicating device individual to each of said
35 positions, a plurality of cord circuits at each of said positions, an assignment lamp at each of said positions, a registering device at one of said positions, means to operate said registering device, means to operate any one of
40 said number indicating devices in accordance with the setting of said registering device, and means to operate said assignment lamp in a distinctive manner dependent upon which one of said number indicating
45 devices has been put into operation.

10. In a telephone exchange system, a calling subscriber's line, a sending device individual thereto, a plurality of operators'
50 positions, a number indicating device individual to each of said positions, means to ex-

tend said calling line to one of said positions, a registering device at the position to which said calling line has been extended, means to operate said registering device under the
55 control of said impulse sending device, means to operate any one of said number indicating devices in accordance with the setting of said registering device, and means to restore said registering device to its normal
60 condition if the calling subscriber abandons the call before said registering device has been completely set.

11. In a telephone exchange system, a calling subscriber's line, a sending device individual thereto, an operator's position, a
65 plurality of cord circuits thereat, a plurality of registering devices associated with said position, a register selecting switch individual to each of said cord circuits, means to operate said register selecting switches to preselect idle registering devices, means to extend said calling line to one of said cord
70 circuits, means to operate a selected registering device under the control of said impulse sending device, a number indicator, means to operate said number indicator in accordance with the setting of said registering device, a signal at said operator's position, and means to operate said signal in case impulses
75 are sent during the movement of said register selecting switch.

12. In a number indicating system, a plurality of sets of lamps, a set of registering devices, means to selectively position said
85 registering devices, control relays, and means to operatively associate a desired set of lamps with said registering devices under the control of said relays.

13. In a number indicating system, a plurality of sets of lamps, a set of registering devices, means to selectively position said
90 registering devices, control relays, keys for controlling the energizing circuits of said relays, and means to operatively associate a desired set of lamps with said registering devices under the control of said keys.

In witness whereof, we hereunto subscribe our names this 22nd day of July, A. D. 1919.

ALBEN E. LUNDELL.
TUDOR VAN AMSTEL.