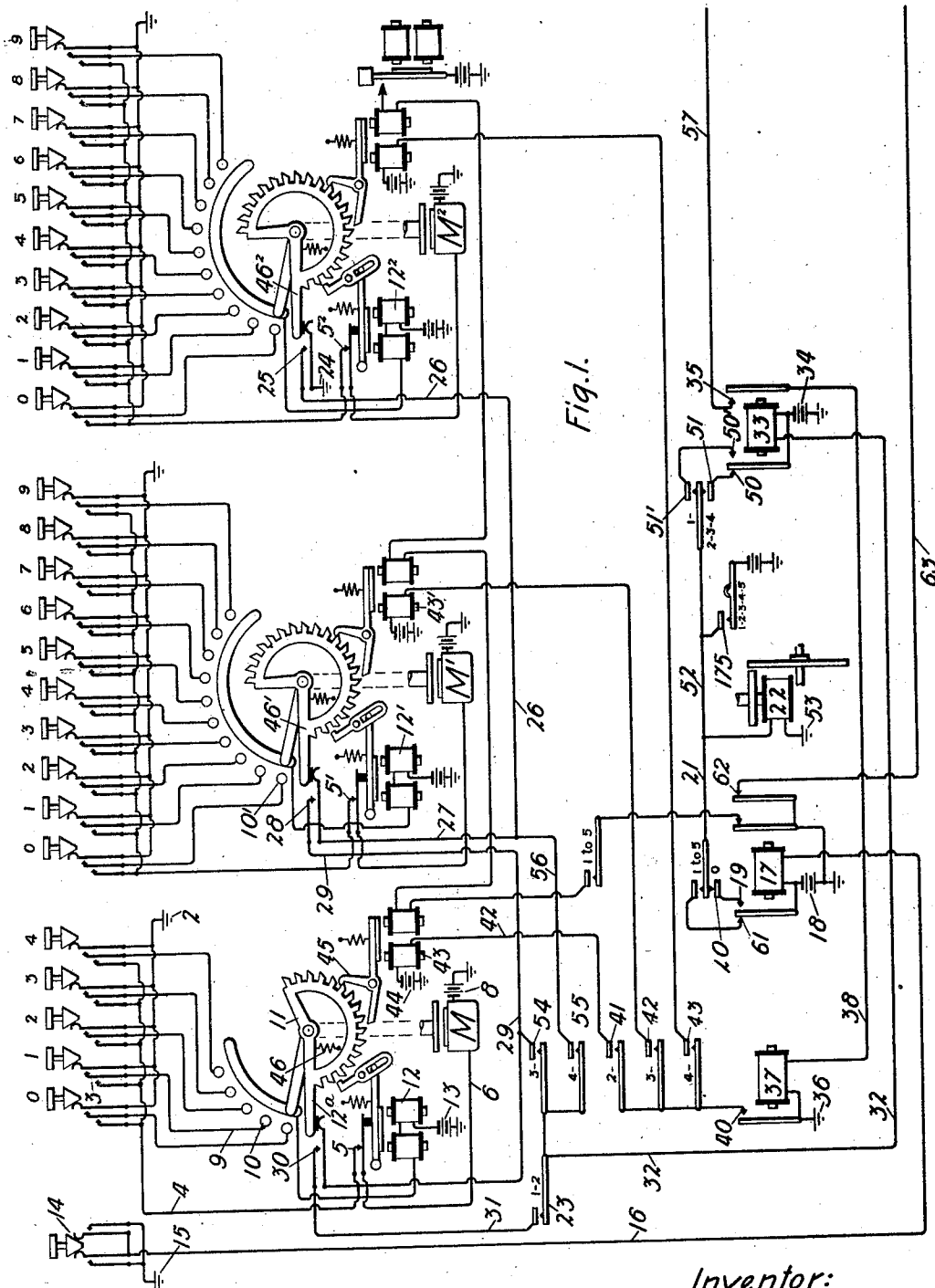


J. N. REYNOLDS.
TELEPHONE EXCHANGE SYSTEM.
APPLICATION FILED JULY 8, 1911.

Patented Apr. 15, 1913.

2 SHEETS-SHEET 1.

1,058,903.



Witnesses:

O. M. Guttie
Irving Mac Donald

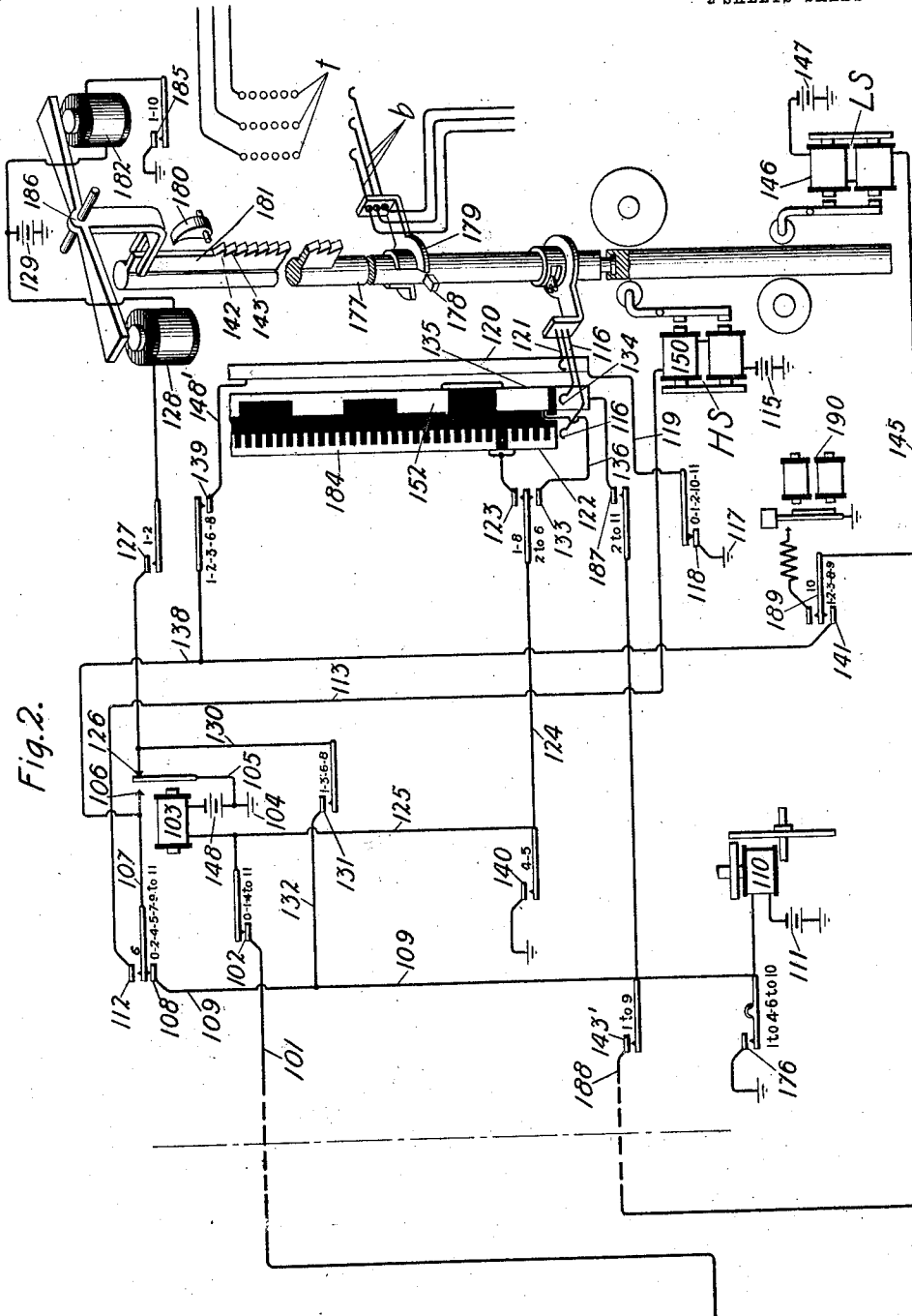
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1,058,903.

2 SHEETS—SHEET 2.



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UNITED STATES PATENT OFFICE.

JOHN NEWBERRY REYNOLDS, OF GREENWICH, CONNECTICUT, ASSIGNOR TO WESTERN ELECTRIC COMPANY, OF NEW YORK, N. Y., A CORPORATION OF ILLINOIS.

TELEPHONE-EXCHANGE SYSTEM.

1,058,903.

Specification of Letters Patent.

Patented Apr. 15, 1913.

Application filed July 8, 1911. Serial No. 637,435.

To all whom it may concern:

Be it known that I, JOHN NEWBERRY REYNOLDS, citizen of the United States, residing at Greenwich, in the county of Fairfield and State of Connecticut, have invented a certain new and useful Improvement in Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description.

10 This invention relates to switch controlling systems and has for its object to provide a controlling circuit for revertive control power driven automatic switches such as are used in telephone exchange systems
15 of the full automatic or semi-automatic type. It has been found particularly useful in automatic switches of the panel type in which an interrupter or commutator is associated with the switch, and sends back to the controller or sender an impulse for each
20 terminal or group of terminals it passes. The following disclosure illustrates the use of my invention in connection with such a type of switch.
25 According to the present invention a power applying relay, which controls a circuit for the power magnet, also controls another locking or shunt circuit which passes to ground through an armature of said relay and includes an interrupter for independently making and breaking said circuit.
30 A circuit for initially energizing said relay may be under the control of a sender, upon which the call desired is registered, and so arranged as to be closed only when the sender is set, and opened again upon its return to normal. Preferably both the power
35 applying circuit and the locking or shunt circuit are controlled at a front contact of said relay. The interrupter may be in the form of a commutator segment with its arm supported and moving with the brush rod for a complete disclosure of which reference
40 is made to my copending application, Serial No. 637,434, filed July 8, 1911. During unit selection the advantage gained by this arrangement is that when the commutator arm leaves the commutator segment corresponding to the desired line terminal, and
45 in so doing opens the shunt circuit, the power applying relay is rendered inert, since the alternative circuit—the line circuit—was opened at the sender immediately upon the latter's return to normal. Further, since
50 the shunt circuit leads through a front con-

tact and armature of said power applying relay, it cannot be completed again to actuate said relay and cause it to complete the circuit for the power magnet, if for any reason the brush arm should again make
60 contact with a commutator segment. This arrangement is also useful during the brush selecting range of the commutator to prevent the brush rod from stopping below a point where a tooth of its holding rack will
65 come into engagement with its retaining pawl. It maintains the power magnet energized until the locking circuit is opened after the commutator arm passes beyond a commutator segment included in the lock-
70 ing circuit, and so arranged in relation to the rack and pawl as to maintain the power applying relay closed up to a point where a tooth will surely be engaged when the power circuit is broken.

75 Referring to the drawings—Figures 1 and 2 illustrate the controlling system of my invention, Fig. 1 representing the sending apparatus or controller, and Fig. 2 the selector controlled by such sender.

80 The selector shown is capable of making connection with any one of five hundred lines and is controlled by a sender having hundreds, tens and units registers. The depression of a key of each of the registers
85 grounds corresponding contact points and closes circuits through the motor magnets M , M^1 , and M^2 of the respective registers and causes the respective finder brushes to move directly and rapidly to the grounded
90 point where they are stopped abruptly and with precision by the energization of the respective magnets 12 , 12^1 and 12^2 opening the respective driving circuits at 5 , 5^1 and 5^2 .
95 The call thus stored up is made effective to govern the travel of the distant selector by causing its arm to travel in synchronism with the successive restoring movements of the finder brushes. The local controlling
100 circuits at the sender and selector, which must be established in definite order at successive stages of the operation to bring into service the different devices and parts as they are required, are established by auto-
105 matic switch appliances known as sequence switches, there being one for the sender and one for the selector. Such a device is illustrated in British patent to McBerty No. 20,839 of 1909, and in the present showing
110 the switch springs of the sequence switches

are not shown in their actual arrangement, but are so located as to give the clearest arrangement of circuits. The positions of the rotary element of each sequence switch in which any of its contacts are closed are indicated by the numbers placed adjacent such contacts, each contact being open in all positions except those indicated by the adjacent numbers. Each sequence switch has a special contact governing the local or locking circuit of its motor magnet, such as contacts 175, 176, these contacts being closed while the rotary element of the sequence switch is in transit from one stopping position to the next to insure that it will take the full movement and not stop in intermediate positions. Instead of designating the closed positions of the special contacts 175, 176 of the sender and selector sequence switches, respectively, the open positions are indicated and are placed on the opposite side of the contacts instead of adjacent them as in the other sequence switch contacts. The special contact 175 of the sender sequence switch has no positions to run through without stopping, and merely serves to prevent the switch stopping between positions. For convenience in tracing the circuits separate batteries are shown at various points, but it will be understood that these may, and where located in the same exchange would, in practice be one and the same battery.

The organization and mode of operation of the system will probably be best understood by tracing the successive steps involved in causing the selector to connect with a desired line, performing the requisite incidental operations, and finally restoring the circuits and apparatus to normal. The operator will store up the call on the sender by depressing the necessary keys of the hundreds, tens and units registers, representing the digits of the wanted line. The depression of the hundreds key grounds conductor 9 connected with the contact 10 corresponding to the depressed key of the hundreds register, and completes a circuit from ground 2, contact 3 of the depressed hundreds key, conductor 4, contact 5, conductor 6, motor magnet M to battery 8. The completion of the second circuit energizes the motor magnet M of the hundreds register and causes segmental rack 11 to be driven forward until its arm 12^a strikes the contact 10 which has been grounded, when a circuit is closed from battery 13 through the stop magnet 12 to ground at 2, through contacts 3 of the depressed hundreds key. This operation displaces the hundreds register from normal corresponding to the depressed key. In a similar manner the tens and units registers are each displaced the desired number of steps from their normal positions, thus placing the sending apparatus in readiness for completing the de-

sired connection. The key 14 may then be depressed to start selection.

Depressing the key 14 completes a circuit from ground 15 through wire 16 and relay 17 to battery 18. Relay 17 operates, allowing current to flow from battery 18 through contact 19, sequence switch contact 20, wire 21 to sequence switch clutch 22 and ground 53. The sequence switch takes one step from its normal position to position 1 where contact 20 is opened, and contact 23 closed to complete a circuit from ground 24 of the units register, off normal contacts 25, (closed when the register is displaced) wire 26, wire 27, tens register off normal contact 28, wire 29, hundreds register off normal contact 30, wire 31, sequence switch contact 23, wire 32, stop relay 33 to battery 34. Stop relay 33 now operates, closing front contact 35, which completes the circuit from ground 36, stepping relay 37, wire 38, contact 35, wire 57, wire 101, (Fig. 2), sequence switch contact 102, line relay 103 to battery 148. The closure of front contact 50' of relay 33 closes a circuit from battery 34, said contact, sender sequence switch contact 51', sender sequence switch motor magnet 22 to ground and the sender sequence switch moves to position 2. The closure of the circuit including battery 148 and relay 103 causes the hundreds register to take its first half step toward the normal position when relay 37 in operating completes a circuit from ground 36, contact 40, sequence switch contact 41, wire 42, stepping magnet 43 of the hundreds register to battery 44. At the same time relay 103 is operated to move the selector sequence switch to position 1 by means of the following circuit: ground 104, wire 105, contact 106, wire 107, sequence switch contact 108, wire 109, selector sequence switch clutch 110 to battery 111. At position 1 selector sequence switch contact 141 is closed, completing the circuit through ground 104, relay contact 106, wire 138, selector sequence switch contact 141, wire 145, through the low-speed clutch 146 to battery 147. The operation of the low speed clutch raises the selector rod 177 and the commutator brush 116 intermittently closes and opens a short circuit around controller stepping relay 37 through the following circuit: ground 117, selector sequence switch contact 118, wire 119, commutator contact plate 120, brush 121, brush 116, contact plate 122, selector sequence switch contact 123, wire 124, wire 125, relay 103 to battery 148. Each time this shunt circuit is completed the stepping relay 37 at the sender releases, and each time it is broken said relay pulls up, allowing the stepping magnet 43 of the hundreds controller to operate the pawl 45 to enable the spring 46 to bring the register movement 11 a complete step back to its normal position, for each

make and break of the shunt circuit. When the last half of the last step is completed the sender arm 12^a opens off-normal contact 30, thus breaking the circuit through stop relay 33 and opening the circuit to selector line relay 103.

Although the operation of the low speed clutch is started by a circuit to ground 104 through contact 106 of relay 103, it is not continued in operation by said circuit but by another whose connection to ground is independent of relay 103. Therefore when relay 103 finally releases after the opening of the line circuit at contact 30, and opens the starting circuit, the operation of the clutch is continued uninterrupted in position 2 over the other circuit which is traced as follows: ground 117, selector sequence switch contact 118, wire 119, commutator plate 120, wire 148', selector sequence switch contact 139, wire 138, sequence switch contact 141, wire 145, clutch 146 to battery 147. When relay 103 released and closed its back contact 126 a circuit was completed from ground 104, contact 126, selector sequence switch contact 127, shift magnet 128, to battery 129. The operation of the shift magnet 128 twisted the selector rod 177 and caused its pin 178 to engage with the desired set of brushes 179 during the upward travel of the rod. The circuit which caused the sequence switch to be driven to position 2 was closed when relay 103 released and is traced from contact 126 of said relay through wire 130, sequence switch contact 131, wire 132, wire 109, selector sequence switch clutch 110 to battery 111. At position 2 the line relay 103 is again energized locally through the following circuit, the selector sequence switch contact 102 in the circuit to the sender being open: ground 117, sequence switch contact 118, wire 119, commutator plate 120, commutator brush 121, commutator brush 134, commutator plate 135, wire 136, selector sequence switch contact 133, wire 124, wire 125, relay 103, to battery 148. The result of the closure of this circuit is to close at front contact 106 of relay 103 a circuit to advance the sequence switch to position 3. The ground at 117 therefore not only completes a local energizing circuit for relay 103, but also serves to maintain the clutch magnet 146 energized during the entire brush selecting range of the commutator so that any desired brush may be seized without interrupting the movement of the brush rod. If no other ground for the circuit of the clutch magnet were provided than that under the control of relay 103, the clutch magnet would become deenergized as soon as the desired brush was selected and relay 103 deenergized by the opening of its circuit upon the return to normal of the hundreds register. At position 3, however, this ground 117 is removed by

the opening of sequence switch contact 118, ground for the remainder of the movement of the rod over the brush section 122 being supplied by the front contact of relay 103, wire 138, sequence switch contact 139, wire 148', commutator plate 120, brush 121, brush 134, commutator plate 135, wire 136, selector sequence switch contact 133, wire 124, wire 125, relay 103 to battery 148. This locking circuit insures that the first tooth 142 of the rack 181 will clear the holding pawl 180 at the end of the brush selecting movement or range and not allow the brush rod to fall down when the power is cut off, since the relay 103 will be held up until the brush 134 leaves commutator plate 135, the end of which corresponds with the location of the first tooth 142 on the rack 181. Returning to the controller Fig. 1, it will be seen that when stop relay 33 releases, contact 50 is closed completing the following circuit: battery 34, relay contact 50, sender sequence switch contact 51, wire 52 to sequence switch clutch 22 and ground 53. This advances the switch to position 3 for tens selection. The switch is stopped at position 3 by the operation of stop relay 33 as follows: battery 34, relay 33, wire 32, sender sequence switch contact 54, wire 29, off-normal contact 28 of the tens register, wire 27, wire 26, off-normal contact 25 of the units register to ground 24.

When the brush rod has reached the end of the brush range, relay 103 is released by the opening of the locking circuit referred to, and its back contact 126 moves the sequence switch to position 4. At position 4 the circuit to the register is again closed through contact 102 and relay 103 again operated. The closing of its front contact causes the sequence switch to move into position 5. Between positions 4 and 5 sequence switch contact 140 is momentarily operated to send a preliminary step to the tens controller. While this is taking place the selector sequence switch continues its movement to position 6 where tens selection takes place. In case the 0 tens key has been depressed (i. e. no tens steps are to be taken by the selector) the preliminary step by contact 140 satisfies the tens register, that is to say, a circuit is closed and opened from ground 36, through sender sequence switch contact 42 to the step magnet 43' of the tens register, which restores said register to normal, since the zero key has been depressed and the arm 46' thereof rested on the first contact 10'. The apparatus then proceeds to units selection. In case the one impulse did not satisfy the tens register, however, at position 6 of the selector sequence switch, relay 103 will be held up with the result that current is supplied to the high speed clutch 150 through sequence switch contact 112, wire 113 to battery 115 and the high speed com-

mutator brush 134 in passing over the tens commutator contact plates 152 intermittently short circuits relay 37 and causes the tens register to be stepped back to its normal position.

When the tens register reaches normal position it opens the off-normal contact 28, releasing relay 33, which in turn releases relay 103 at contact 35. Relay 103 in releasing also releases the high speed clutch, and by means of its back contact 126, moves the sequence switch to position 7 which is preparatory to units selection. At the sender when relay 33 releases at the end of tens selection the sequence switch is moved to position 4 for units selection by the following circuit: battery 34, contact 50, sequence switch contact 51, wire 52, clutch 22 to ground 53. The switch is stopped at position 4 when relay 33 operates through the following circuit: battery 34, relay 33, wire 32, selector sequence switch contact 55, wire 56, wire 26, off-normal contact 25 of the units register to ground 24. At selector switch position 7 the circuit of relay 103 is again closed at the sender contact 35, which advances the switch to position 8 for units selection, in which position the circuit of the low speed clutch 146 is closed through contact 106 of relay 103, and selector sequence switch contact 141, and the brush rod 177 is again driven upward at low speed. During this operation the commutator contact brush 116 and units commutator plate 184 intermittently short circuit relay 37, as described before and the units register is allowed to step back to its normal position. It will be remembered that at the third position of the selector sequence switch the control of the shunt circuit about the sender-operating magnet 37 was transferred to front contact 106 of the line relay 103 and that the energizing circuit for the clutch 146 also is controlled at the same contact. We will now examine the various relative positions of the commutator brush 116, the units commutator segment 184, the line brushes *b* and their coöperating fixed terminals *t* during the process of a selection. The commutator brushes are normally out of contact with the segments in order to enable the sender operating relay 37 to be initially energized to cause the hundreds register to take the first half step, since the relay 37 would not pull up upon the energization of the relay 33 if this shunt were closed at this time. There must be of course a definite relation between the commutator segments, the teeth of the rack, the fixed line terminals and the fixed holding pawl, there being necessarily a correspondence in number between the units commutator segments 184 and the fixed line terminals. The commutator plate 135, which enables a circuit to be closed to keep the brush moving throughout

the brush range, is arranged in such relation to the fixed pawl and the teeth in the rack that when the brush 134 clears its end, or in other words passes out of the brush-selecting range, the first or top tooth upon the rack 142 will have passed the fixed pawl 180, and since the line circuit by which the relay 103 was initially energized was opened when the arm 12 of the hundreds register had opened the off-normal contact 30 upon its final movement, the shunt circuit controlling the circuit of the elevating clutch 146 is opened the instant the brush 134 leaves the segment 135. The rod 177 then settles back until the pawl 180 reaches the bottom of the notch between teeth 142 and 143, in which position the set of brushes selected is one step below the first set of fixed terminals *t*. The low-speed clutch alone, or the high and low-speed clutches alternately may then be applied to continue the upward travel of the rod with its selected set of brushes *b*, the relation between the units segments 184 of the commutator and the teeth of the rack 181 being such that when the commutator brush 116 clears the segment corresponding to the line terminals *t* predetermined by the setting of the sender, its corresponding tooth on the rack 181 has cleared the pawl 180 and is held thereby, with the selected set of brushes *b* in contact with the desired fixed terminals *t*. For various reasons, among which may be mentioned mechanical imperfections and the necessarily slight separation of the commutator segments 184,—when the brush rod settles back the commutator brush 116 would in practice occasionally again contact with the corresponding units segment 184 which when it left caused the opening of the shunt circuit and the consequent deenergization of the line relay which through its front contact closed the circuit of the power applying magnet 147, and therefore since this front contact opens when such deenergization occurs, this power-applying shunt circuit cannot again become closed when said brush falls back and comes into contact with the segment it left, or if having enough inertia with the one above. Another advantage of this arrangement is that the selected set of brushes may be driven upward at as low a speed as desired without danger of under-selecting, that is, of selecting the set of line terminals below the one desired, this being due to the holding up of the line relay 103 by the shunt circuit after the alternative circuit to the sender has been opened. When relay 103 released, its back contact 126 completed the circuit to the sequence switch clutch, which advanced the sequence switch to position 9 for talking. At the same time relay 33 releasing moves the controller sequence switch to position 5 where it remains until restoration takes place upon the release of listening key 14.

To restore the selector to its normal position key 14 is released, which opens the circuit through relay 17. The back contact 61 of this relay restores the controller sequence switch to its normal position, and contact 62 completes a circuit from ground 18, wire 63, wire 188, selector sequence switch contact 143 to clutch 110 causing it to move to position 10, in which a circuit is closed from battery 129 through release magnet 182, selector sequence switch contact 185 to ground, which causes said magnet through the lever 186 and rack 181 to twist the rod 177 and cause the engaged tooth to slide off the pawl 180 and the pin 178 to be disengaged from the brush 179 and they both drop back to normal, the descent being periodically checked by an intermittent circuit through the low-speed clutch 146 from battery 147, the magnet of said clutch, selector sequence switch contact 189, vibrator 190 to earth. When the brush 134 reaches the commutator segment, with which it is shown in contact, a circuit is closed from battery 111 of the selector sequence switch motor magnet 110, sequence switch contact 187, the said commutator segment, brush 134, brush 121, segment 120, conductor 119, sequence switch contact 118 to ground 117, and the sequence switch moves on to normal position. The mechanism is now free to establish another connection.

While the invention is particularly useful in selecting telephone line terminals in automatic or semi-automatic telephone exchanges, it may of course be employed wherever it is desired to select one of a number of grouped circuit terminals.

I claim:

1. The combination with a selector, a motor-magnet therefor, a relay for controlling the circuit of said magnet, a line circuit, a sender, an operating magnet therefor in said line circuit, a contact in said line circuit controlled by said sender, a commutator and arm associated with said selector for closing a shunt path about said sender operating magnet to intermittently actuate the sender, and a contact in said shunt path controlled by said relay.

2. The combination with a line circuit, a sender, its operating relay, said sender being adapted to close the line circuit through

said relay, a selector, a line relay at said selector energized by the closure of said line circuit, a motor-magnet for said selector energized by said line relay upon the closure of said line circuit, a commutator and its arm, and a shunt circuit about said sender controlled at a front contact of said line relay, said shunt being intermittently closed by said commutator and arm to actuate said sender operating relay.

3. The combination with a line circuit, a sender adapted to close the same when displaced, a panel selector and its brush, a relay energized by the closure of said line circuit, a motor-magnet for driving said brush, a circuit for said motor-magnet and a shunt circuit about said sender both controlled at a front contact of said relay, and a commutator and arm for intermittently closing said shunt when said relay is energized and said brush moved, permitting the restoration of said sender to open said line circuit.

4. The combination with a line circuit, a sender adapted to close the same when displaced, a selector, a relay energized by the closure of said circuit, a motor-magnet for said selector, a circuit therefor closed at a front contact of said relay upon the closure of said line circuit, and a shunt circuit about said sender including said relay and its front contact, and a commutator and arm adapted to intermittently open said shunt circuit to permit the restoration of said sender which thereupon opens said line circuit, whereby the next opening of the shunt circuit by the commutator and arm deenergizes said relay.

5. The combination with a selector provided with an interrupter, of a controlling circuit, and an operating circuit for the selector, and a relay for controlling said operating circuit having a contact and armature included in said controlling circuit in series with said interrupter whereby said relay effects a change in one of said circuits simultaneously with a change in the other of said circuits.

In witness whereof, I hereunto subscribe my name this seventh day of July A. D., 1911.

JOHN NEWBERRY REYNOLDS.

Witnesses:

IRVING MAC DONALD,

FRANK A. FLEISCHMAN.