F. R. McBERTY.

TELEPHONE EXCHANGE SYSTEM.

APPLICATION FILED NOV. 16, 1909.

1,126,047.

Patented Jan. 26, 1915.

3 SHEETS—SHEET 1.

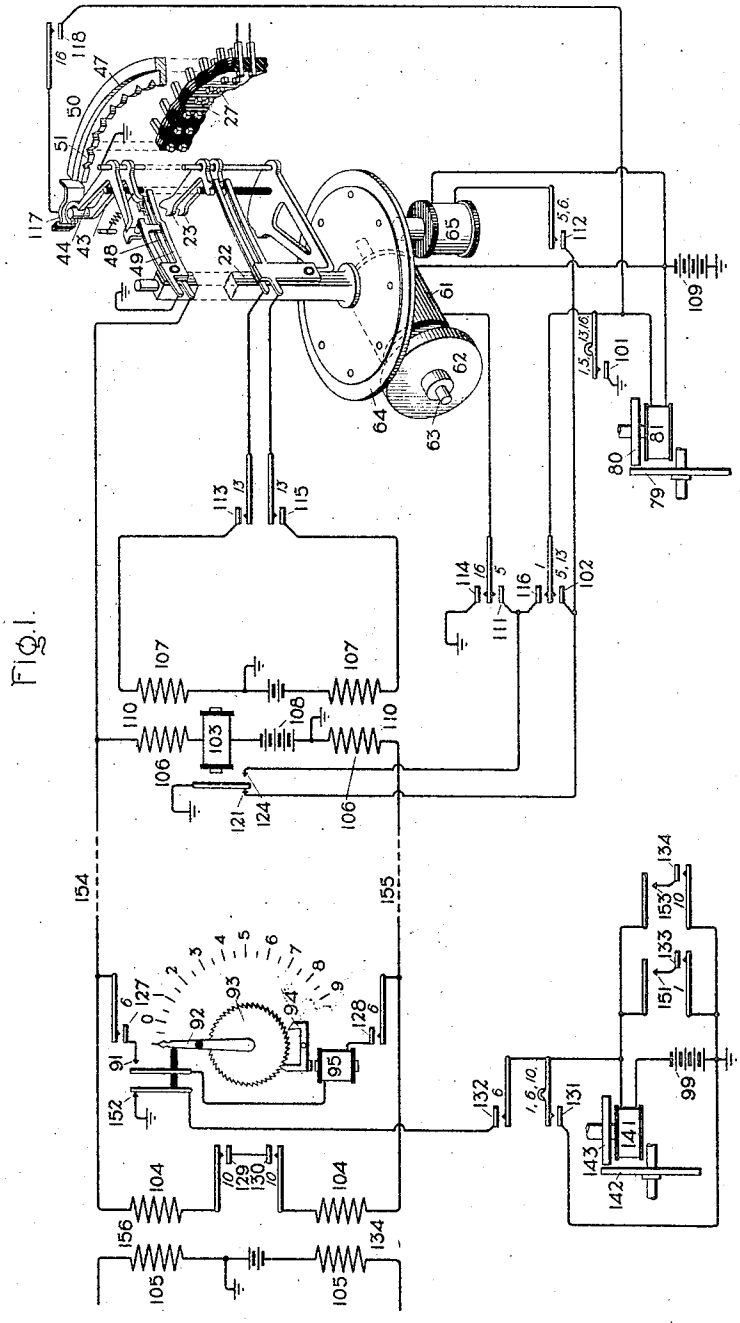

Fig. 1.

Witnesses:

H. H. Tilden

Fred V. Hollenbeck

Inventor:

Frank R. McBerty

by D. C. Banner, Atty.

F. R. McBERTY.

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3 SHEETS—SHEET 2.

Fig. 2.

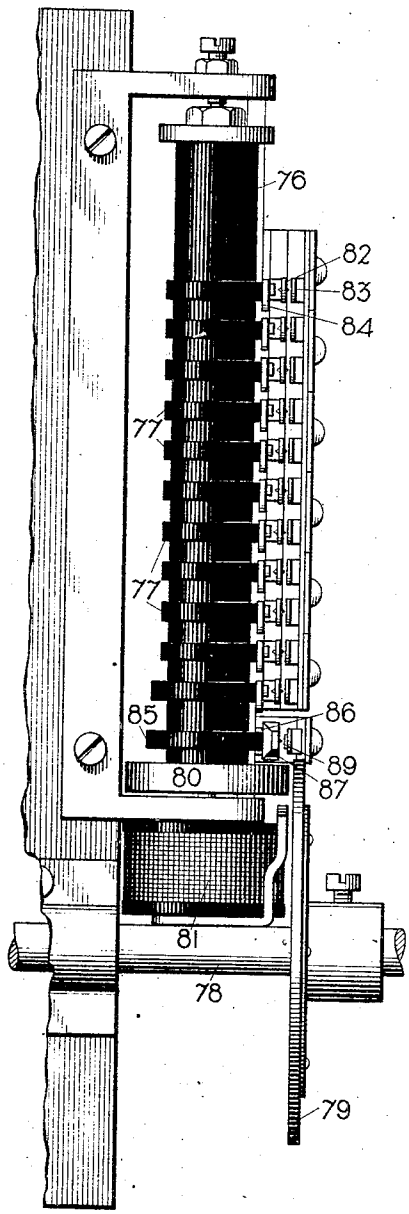
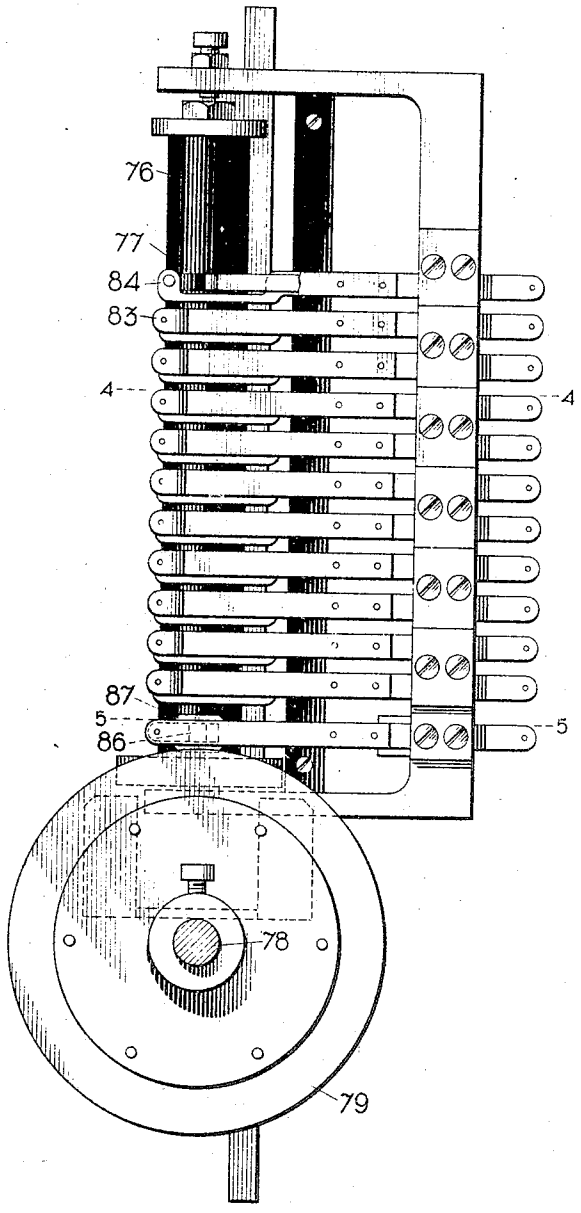


Fig. 3.



Witnesses:

H. H. Tilden

Fred V. Hollenbeck

Inventor:

Frank R. McBerty

by D. C. Dawes.

Atty.

F. R. McBERTY.

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3 SHEETS—SHEET 3.

Fig. 4.

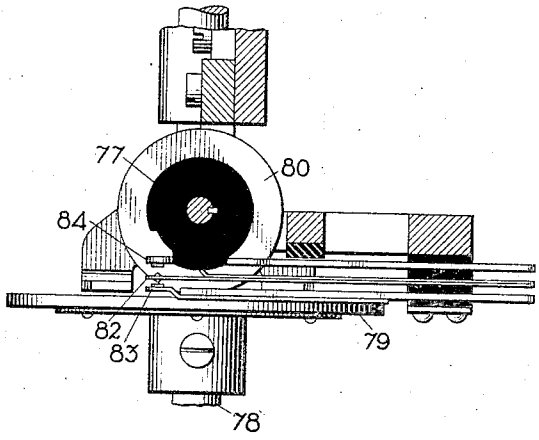
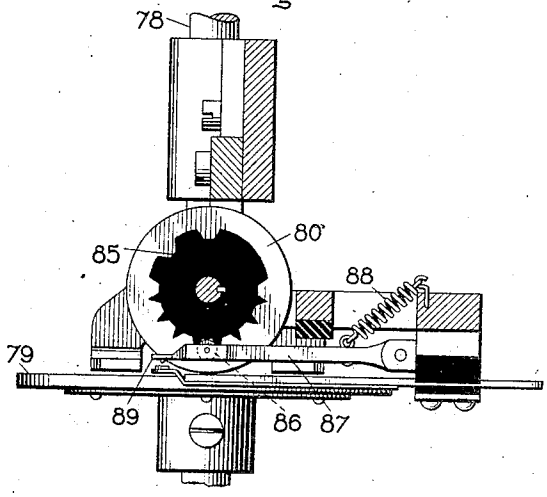


Fig. 5.



Witnesses:

H. H. Tilden.

Fred V. Hollenbeck

Inventor:

Frank R. McBerty.

by D. C. Hannes.

Atty.

UNITED STATES PATENT OFFICE.

FRANK R. McBERTY, OF NEW ROCHELLE, NEW YORK, ASSIGNOR TO WESTERN ELECTRIC COMPANY, OF NEW YORK, N. Y., A CORPORATION OF ILLINOIS.

TELEPHONE-EXCHANGE SYSTEM.

1,126,047. Specification of Letters Patent. Patented Jan. 26, 1915.

Application filed November 16, 1909. Serial No. 528,293.

To all whom it may concern:

Be it known that I, FRANK R. McBERTY, citizen of the United States, residing at New Rochelle, in the county of Westchester and State of New York, have invented a certain new and useful Improvement in Telephone-Exchange Systems, of which the following is in full, clear, concise, and exact description.

This invention relates to the control of automatic selectors and it contemplates a system of electrical control by revertive impulses which is useful wherever it is desirable to effect particular selective operations from a more or less distant point over electrical circuits.

The object of the invention is to provide means for such revertive impulse control which shall be extremely simple and effective.

More especially this invention is applicable to and has special utility in the control of a telephone exchange system where large numbers of subscribers' lines are to be interconnected for the purpose of telephonic communication. It has been found desirable in adapting the invention to such systems to employ the conductors which form parts of the telephone or trunk lines as the main conductors of the selector controlling circuits, the controlling mechanism or "sender" being located at one end of the line and the selector at the other.

There is shown in the drawings accompanying this application a simplified or skeleton diagram of the circuits and apparatus which enter directly into, or are closely associated with the means for controlling a single selector switch mechanism. In a large automatic or semi-automatic exchange system, the circuits and apparatus would be much more extensive and complex than those shown herein in order to take care of the great variety of requirements which enter into the operation of such systems. The diagram shown in this application is intended to illustrate an organization which takes care of only a few of such requirements, but it fully illustrates an organization which represents a complete embodiment of the peculiar system of control of this invention.

According to this invention, the operating device or electromagnet for the controller and that for the selector are included in the main controlling circuit, preferably in series, the former being responsive to electrical impulses which are directed over the circuit by means actuated in unison with the selector and operating intermittently to shunt or short-circuit the controller operating device or electromagnet.

Preferably the means for causing the reverse impulses to be directed over the circuit to the controller forms a part of the selector mechanism, so that as the selector advances to perform the desired selecting operation, the impulses will be sent in exact accordance with the movement thereof and the controller will by its operation accurately measure the extent of movement of the selector.

The controller may comprise any suitable mechanism which upon being set for operation will automatically respond to current impulses and effect some definite change in the controlling circuit after a predetermined number of impulses are received. Preferably the controller operates to open the circuit when the selector has advanced to the position desired, whereupon the device or electromagnet for effecting the operation of the selector is deënergized or otherwise made responsive to cause the selector to stop at that position.

The selector device may be made responsive to steady flow of current, the intermittent shunting of the controller device in the circuit causing impulses which do not interrupt the steady flow of current in the selector device. This arrangement permits the continuous application of the motive power to the selector until the controller has taken a predetermined number of steps whereupon the circuit is opened and the selector is caused to stop. The selector controlling device may accordingly be included in an undivided portion of a divided circuit, one of the divided portions thereof being the shunt path referred to, this path being preferably arranged to be closed at the moment the other path is opened by the controller. The control of the calling device over the selector switch moving mechanism is thus neutralized momentarily at each closure of the shunt path, the object being to prevent the movable terminals or brushes from stopping between the stationary terminals. A moment after the one path is opened at the controller the chunt path be-

comes opened at the selector, whereupon the selector device responds and the selector is caused to stop with the brushes centrally located in contact with the terminals of the desired line.

In adapting this invention to an automatic or semi-automatic telephone exchange system, a highly sensitive relay included in the controlling circuit may be employed as the operating device for the selector. Such a relay will respond quickly to the very weak currents in the circuit, but may be made to control comparatively powerful electromagnets in local circuits adapted for the immediate control of the selector.

Where the selectors are constructed to actuate the switch mechanisms directly to make the desired connections between the subscribers' lines or trunk lines, the reverse impulses may be transmitted in step with the contacts successively made by the movable terminals or brushes as they trail over the stationary terminals, so that these current impulses and the movement of the controller caused thereby may be said to "count" the stationary terminals successively reached in the advance of the selector.

My invention will be more readily understood by reference to the accompanying drawings in which—

Figure 1 shows diagrammatically the apparatus and circuits for the control of a selector switch of a semi-automatic telephone exchange system, and Figs. 2, 3, 4 and 5 show in detail a structure of a sequence switch by which the circuits at the selector and also at the sender are partly controlled. Figs. 2 and 3 are front and side elevations, respectively, of the sequence switch, while Fig. 4 is a view in cross-section on line 4—4 of Fig. 3 and Fig. 5 a view in cross-section on line 5—5 of Fig. 3. The same reference characters are used to indicate the same or like parts in the several drawings.

Some of the circuits at the selector and some at the controller are governed by the sequence switches. There is preferably one such sequence switch for each selector and one for the controller. In general, the function of the sequence switch is to establish in a definite order at successive stages of the operation the various circuits required to bring into service various devices or parts in proper sequence. The sequence switch consists in its elements of a movable switch operating member, a number of circuit changers actuated in sequence as said member is moved from one position to another, an electromagnet, and motor mechanism operated or controlled by said magnet for advancing said movable member. In each position to which a movable member of the sequence switch is advanced, a circuit or set of circuits is established by which a given operation of the device under control is made possible, and at the same time another circuit is partly closed whereby the motor magnet of the sequence switch may subsequently be actuated and the sequence switch then automatically advanced to the next position, wherein a new set of circuits is established, bringing about a new operation or electrical condition of the device or devices under control, and so on.

In the form of sequence switch shown in Figs. 2 to 5 inclusive, the movable member is a vertical rotary shaft 76 carrying a number of switch operating cams 77, said shaft being arranged to be driven by power applied through the agency of an electromagnetic clutch. The constantly driven power shaft 78 carries a friction driving disk 79 which is adapted to be drawn into engagement with a friction roller 80, carried upon the shaft 76, by the action of a clutch magnet 81. The roller 80 and the disk 79 are of iron, and the motor magnet 81 is adapted when excited to magnetize said roller 80, which serves as a rotary pole piece for said magnet, whereby the driving disk 79 is attracted into engagement with said roller, the rotation of the shaft 76 thus continuing as long as the motor magnet 81 remains excited.

The cams 77 carried by the rotary shaft 76 are arranged to operate switch springs 82, forcing said springs into engagement with outer contacts 83, or allowing them to engage their alternate inner contacts 84, according to the positions of said cams. As many cams and switches may be provided as the particular apparatus to be controlled may require. Certain of the switch contacts operated in the successive positions of the movable switch element may control circuits for the motor magnet 81. A special switch, such as shown in Fig. 5, is also preferably provided to control a local circuit for said motor magnet, whereby after the initial energizing circuit is broken by one or the other of the switches the motor magnet may still be excited by current in the local circuit until the next intended stopping position of the rotary element is fully reached. As shown in Fig. 5, the cam 85 for operating the "local" switch is adapted to be engaged by a cam roller 86 carried by a pivoted switch lever 87. A spring 88 is arranged to act upon said pivoted lever 87 so as to press the cam roller 86 against the edge of the cam 85. When the roller 86 rides upon a tooth or high part of the cam 85, said lever 87 closes a contact 89 which controls the local circuit for the motor magnet. The teeth of the cam 85 have inclined edges, so that the cam roller 86, after riding over the point of a tooth, is forced down the opposite slope by the action of the spring 88, and this tends to push against the cam to continue the rotation

thereof until the roller 86 reaches the bottom of the following notch. The rotary element is thus brought to rest accurately in each of the positions where it is intended to stop. In the operation of the device, the circuit will first be closed for the motor magnet through one of the springs 82 and one or the other of the contact anvils 83 or 84 of such spring. Then as the motor magnet is excited and the shaft of the sequence switch begins to rotate, the contact through which the motor magnet was initially excited may be broken, but the local circuit will be maintained for the motor magnet through the contact 89 closed by the cam 85, and the rotary element will thus continue to advance until the cam roller 86 reaches the bottom of the next notch of the cam 85.

In Fig. 1 the switch springs of the sequence switch are not shown in their actual arrangement, but are so located as to give a clear arrangement of the circuits; and the operating cams are not shown. The positions of the rotary elements of each sequence switch in which any of the contacts (except the special contacts 101 and 131) are closed, are indicated by numbers placed adjacent to such contacts; each contact being open in all positions except those indicated by reference numbers. For example, contact 102 is closed in the 5th and 13th positions as indicated by the numbers 5 and 13 placed adjacent thereto. In the case of the special contacts 101 or 131, the numbers are placed on the opposite side of the switch lever from its contact anvil and indicate positions in which the contact is opened, such contact being closed continuously while the rotary element of the sequence switch is in transit between the positions indicated. It will, therefore, be understood that the special contact 101 of the selector sequence switch is closed continuously between positions 1 and 5, 5 and 13, 13 and 16, and 16 and 1, but open while resting in positions 1, 5, 13 and 16. In the same manner, the special contact 131 of the controller sequence switch is closed continuously between positions 1 and 6, 6 and 10, and 10 and 1, but open while resting in each of the positions 1, 6 and 10. There may be, say eighteen positions in all of each sequence switch and the cams thereof will be caused to make one complete revolution in passing from normal through the eighteen positions and back to normal again. It will be readily understood that other contacts of these sequence switches than those indicated in the drawing may be arranged to be closed and opened in various positions to control other devices, or to cause the apparatus to perform other functions that may be desired in the operation of the telephone exchange system.

A suitable controller or calling mechanism for governing and determining the advance movement of the selector is shown in Fig. 1. It may comprise a switch contact 91 normally held open by an arm 92, which is adapted to be manually placed in any one of a plurality of numbered positions away from normal. The return movement of the arm after being set in any position is controlled by a ratchet wheel 93 secured to the arm and an escapement device 94 adapted to be rocked back and forth under the control of an electromagnet 95 responsive to impulses of current. The numbered positions to which the arm 92 may be placed are indicated by short radial lines and the numerals 0 to 9. A contact 152 of the controller may be arranged to be closed when the selecting operation is completed, this contact entering into the operation of the sequence switch, as will presently be explained. Other suitable arrangements of controlling apparatus to secure the same general mode of operation of the selector mechanism may be substituted for that which is shown, the essential requirement of such a controlling mechanism being that it may be manipulated to predetermine the number of impulses of current that may be received over the controlling circuit before the controlling mechanism operates its own switch in the circuit.

An automatic switch or selector, which is suitable for the method of control of this invention is also shown in diagrammatic form in Fig. 1. As there illustrated, it comprises a pair of brushes 23 mounted so as to move about a shaft 22, and two rows of stationary terminals 27 adapted to be traversed by the brushes. The rotation of the shaft is controlled by motor mechanism which comprises an electromagnet 61, a driving roller 62 mounted upon a continuously revolving shaft 63 and a disk 64 secured to the lower end of the spindle. Energization of the electromagnet 61 will cause the disk 64, which is flexibly secured to the spindle, to be attracted to the periphery of the roller 62, whereupon power communicated through the shaft 63 and roller 62 will cause rotation of the disk 64 and the spindle 22. An electromagnet 65 having its pole piece extending upwardly and in proximity to the underneath surface of the disk 64 is adapted when energized to stop the movement of the selector quickly by causing the disk 64 to engage the pole piece of the magnet.

Secured to the upper part of the spindle 22 is an interrupter device comprising the springs 48 and 49 and operating arms therefor 43 and 44. These arms and the springs are adapted to be carried with the shaft in its rotation, the free end of the arm 43 engaging the teeth and notches of the plate or cam 50, and the free end of the arm 44

engaging the smooth edge 47 of the same plate, while the brushes 23 are passing over the terminals 27. The brushes 23, the fixed terminals 27, the arms 43 and 44 and the plate 50 are so arranged that when the free end of the arm 43 engages the first tooth 51 of the plate, the brushes 23 are approaching and about to make contact with the first set of stationary terminals 27, and as the free end of the arm 43 drops into the notch following the first tooth 51, the brushes 23 are centrally located on the first set of terminals. The interrupter springs 48 and 49 are thus caused intermittently to make contact with each other, while the brushes 23 are traversing the spaces between adjacent sets of stationary terminals, the contact being opened while the brushes are touching each set in passing.

Those parts of the sequence switch mechanism associated with the selector, which are shown in Fig. 1, are the motor magnet 81, the driving disk 79, the roller 80 and the following switch contacts operated thereby: 101, 102, 111 to 116 inclusive, and 118. A battery 109 supplies current for the energization of a motor magnet 81, and the various local circuits at the selector. The sequence switch associated with the controller or calling mechanism comprises similarly a motor magnet 141, a driving disk 142, a roller 143 and contacts 127 to 134 inclusive. Battery 99 supplies current for the energization of the motor magnet 141.

The main controlling circuit for the selector extends by way of conductors 154 and 155, to the controller. These conductors may also form the main circuit conductors of a trunk line of an automatic or semi-automatic telephone exchange system. The trunk line circuit includes a battery 108, a line relay 103, the windings 106 of a repeating coil 110 at the selector end and windings 104 of a repeating coil 156 at the controller end. The coöperating windings 105 of the repeating coil 156 may be connected through suitable mechanism or conductors not shown in the drawing to the line of a calling subscriber, while the windings 107 of the repeating coil 110 may likewise be connected to the brushes 23 of the selector switch. Contacts 129 and 130 of the controller sequence switch are interposed in the trunk circuit and contacts 113 and 115 are interposed in the circuit leading from the repeating coil windings 107 to the brushes 23. The functions of these contacts and other contacts and devices represented in Fig. 1 will appear from the following description of the operation of the system.

The operator first sets the controller arm 92 to a position on the dial which indicates the number of the line desired. It may be assumed, for example, that this line is No. 6, the terminals of which on the selector are the seventh set in the line of travel of the brushes 23. The operator may then cause switch 151 to be closed to start the operation of the sequence switch at the controller, the motor magnet 141 receiving current in a local circuit including battery 99, sequence switch contact 133 and the switch 151 referred to. The sequence switch thereupon advances from the first to the sixth position. In this position the controlling circuit including the line relay 103 and trunk line conductors 154 and 155 is completed by way of the controller sequence switch contacts 127, 128 and the controller contact 91. Contact 132 is also closed in this position, but the circuit of the motor magnet 141 is open at the controller contact 152. The energization of line relay 103 causes a circuit to be closed by way of front contact 124 of the relay and contact 116 of the selector sequence switch for the motor magnet 81 of the sequence switch associated with the selector, whereupon this sequence switch advances from the 1st to the 5th position. In the 5th position a circuit is closed for the motor magnet 62 of the selector by way of the front contact 124 of the line relay and contact 111 of the sequence switch. The selector thereupon advances carrying the brushes 23 and arms 42, 43 over the terminals 27 and plate 50, respectively. As the brushes 23 are approaching the first terminal and the arm 43 is rocked by engagement with the first tooth 51 of the plate 50, the interrupter contacts 48 and 49 are closed, causing a short circuit to be established about the magnet 95 of the controller. Before, however, this short circuit had occurred, the electromagnet 95, by rocking the escapement arm 94, had allowed the arm 92 to be moved backward one-half step. The short circuit causes the magnet 95 to be deenergized and thus allows the escapement arm 94 to be rocked again and the arm 92 to be moved back another half step, making one complete step in its return movement. Thus at each closure of the interrupter contact springs 48 and 49, the controller arm 92 has been moved back another full step. Finally, after it has taken seven full steps, the normal position is reached, contact 91 is opened and contact 152 closed.

The opening of contact 91 permits relay 103 to be deënergized. It should be stated, however, that the circuit for relay 103 will be closed through the interrupter springs 48, 49, during the last step until the arm 43 drops into the 7th notch on the plate 50, at which time the brushes 23 will be resting on the 7th terminal's line (No. 6). The deenergization of relay 103 causes the opening of the circuit of the motor magnet 61 of the selector and the closing of the cir-

cuit for the holding magnet 65 by way of the back contact 121 of the line relay and contact 112 of the sequence switch. The engagement of the disk 64 and the pole piece of the holding magnet 65 causes the selector to be stopped instantly and to be held in that position for a moment, thus preventing the inertia of the moving parts of the brush carriage from carrying the brushes beyond the selected terminal.

When the relay 103 is deënergized after selection, not only is the local circuit for the holding magnet 65 closed through the back contact 121 of the line relay, but also a local circuit for the sequence switch motor magnet 81 is closed by way of the sequence switch contact 102. The sequence switch, therefore, advances from the 5th to the 13th position. In this latter position the talking circuit from the repeating coil 110 to the selector brushes 23 is closed at sequence switch contacts 113 and 115. It may be mentioned that the circuit of the holding magnet 65 was opened as the sequence switch passed out of the 6th position.

During the travel of the sequence switch associated with the selector, from the 5th to the 13th position the sequence switch associated with the sender, was being advanced from the 6th to the 10th position. The closing of contact 152 at the end of the selecting operation had closed a circuit by way of contact 132 to the motor magnet 141. In passing out of the 6th position contacts 127, 128 and 132 were opened, thus disconnecting the controller from the trunk circuit and preventing further control of the sequence switch by contact 152. In the 10th position the circuit of the trunk line becomes closed at contacts 129 and 130 and the line relay 103 is again energized. This operation is completed for the controller sequence switch before the selector sequence switch reaches the 13th or "talking" position. At any time, therefore, when it shall be desired to return the selector to normal position, the operator may cause switch contact 153 to be closed, whereupon the sequence switch at the controller advances from the 10th position to normal, opening the trunk line circuit at contacts 129 and 130. This opening of the trunk line circuit at contacts 129 and 130 causes the line relay 103 to be deënergized, whereupon a circuit is closed for the motor magnet 81 of the selector sequence switch by way of sequence switch contact 102 and the back contact 121 of the line relay. The sequence switch thereupon advances to the 16th position in which a circuit is closed for the motor magnet 62 of the selector by way of contact 114. The disk 64 of the selector and the brushes 23 and arms 43 and 44 carried thereby are thereupon caused to move around until the normal position is reached. In this position the arms 43 and 44 which may be connected to ground through the frame of the selector, engage a normal stop plate 117 whereupon a circuit is completed for the motor magnet 81 of the sequence switch by way of the selector sequence switch contact 118 and the sequence switch advances to normal position. As the sequence switch passes the 16th position, the circuit for the motor magnet 61 of the selector is opened and the selector comes to rest.

I claim:

1. The combination with a selector having stationary and movable terminals and a controller therefor, of a circuit including means for operating the selector and means for operating the controller, said means for operating the selector being responsive to steady current and said means for operating the controller being responsive to intermittent current, and means operating in unison with the selector for intermittently shunting the means for operating the controller during the entire time required for the movable terminal to pass over the space between adjacent stationary terminals.

2. The combination with a selector having stationary and movable terminals and a controller therefor, of a circuit including a single source of current, means for operating said selector and means for operating said controller, said means for operating the controller being responsive to intermittent current and said means for operating the selector being responsive to steady current, a contact device actuated in unison with the selector during the time required for the movable terminal of the latter to pass between adjacent stationary terminals and adapted to intermittently shunt the means for operating the controller, and a contact device associated with the controller adapted to open said circuit only while a movable terminal engages a stationary terminal to determine the extent of movement of the selector.

3. The combination with a selector having stationary and movable terminals and a controller therefor, of a divided circuit including in the undivided portion thereof means for controlling the operation of the selector, switching mechanism actuated in unison with the selector for intermittently closing one of the divided portions of said circuit whenever said movable terminal is passing between adjacent stationary terminals and the other divided portion whenever said movable terminal rests upon a stationary terminal, and means for operating the controller included in the last mentioned divided portion of said circuit.

4. The combination with a selector having stationary and movable terminals and a controller therefor, of a circuit including a

source of current, electromagnets for the selector and controller, said selector electromagnet being adapted in response to steady current to cause the operation of said selector and said controller electromagnet being adapted in response to intermittent current to cause the operation of the controller, a contact device operated in the movement of the selector to intermittently shunt the controller electromagnet in said circuit whenever the movable terminal is passing between adjacent terminals, and a contact device actuated in the movement of the controller adapted to open said circuit only when a movable terminal engages a stationary terminal to accurately determine the extent of movement of the selector.

5. The combination with an electromagnetically operated selector having stationary and movable terminals and an electromagnetically operated controller, of a contact device intermittently operated in the movement of the selector, a circuit having two parallel paths, one of said paths including the magnet of the controller rendered effective to stop the movement of the selector only when a movable terminal is in contact with a stationary terminal and the other of said paths including said contact device which maintains said path closed when the movable terminal passes over the space between adjacent stationary terminals, and an undivided portion of said circuit including a controlling magnet of the selector.

6. In a telephone system, the combination with an electromagnetically controlled selector having stationary and movable terminals, of an electromagnetically controlled calling mechanism adapted to be operated by pulsations of current, a divided circuit including a controlling magnet of said selector in its undivided portion, a source of current arranged to cause flow of current in the circuit, a contact device in one of the branches of said divided circuit adapted to interrupt the flow of current in the circuit when a movable terminal rests upon a stationary terminal and a contact device in the other branch of said divided circuit operated in the movement of said selector to intermittently close said other branch whenever a movable terminal is passing between adjacent stationary terminals, and thereby to short circuit the magnet of the calling mechanism in the first mentioned branch and also to prevent the movable terminal from being stopped between adjacent stationary terminals.

7. In a telephone system the combination with a line terminating in an automatic switch having a movable terminal and a plurality of stationary terminals to which other lines are connected, of a calling device adapted to be associated with said line, means for registering a call thereon, means for restoring said registering device to normal, an intermittently acting switch operating in the movement of said movable terminal over said stationary terminals for measuring the displacement of said movable terminal and actuating said register restoring means, actuating means for said movable terminal, controlling means therefor maintained active over a divided circuit, and means for placing one branch of said circuit under the control of the calling device as soon as a movable terminal engages a stationary terminal and the other branch under the control of the intermittently acting switch of the movable terminal when, and only when, the latter is traversing space between adjacent stationary terminals, whereby said movable terminal is prevented from stopping between stationary terminals, but will be stopped by said calling device upon the return of the latter to normal.

In witness whereof, I hereunto subscribe my name this 13th day of November A. D. 1909.

FRANK R. McBERTY.

Witnesses:
IRVING MACDONALD,
EDGAR F. BEAUBIEN.