

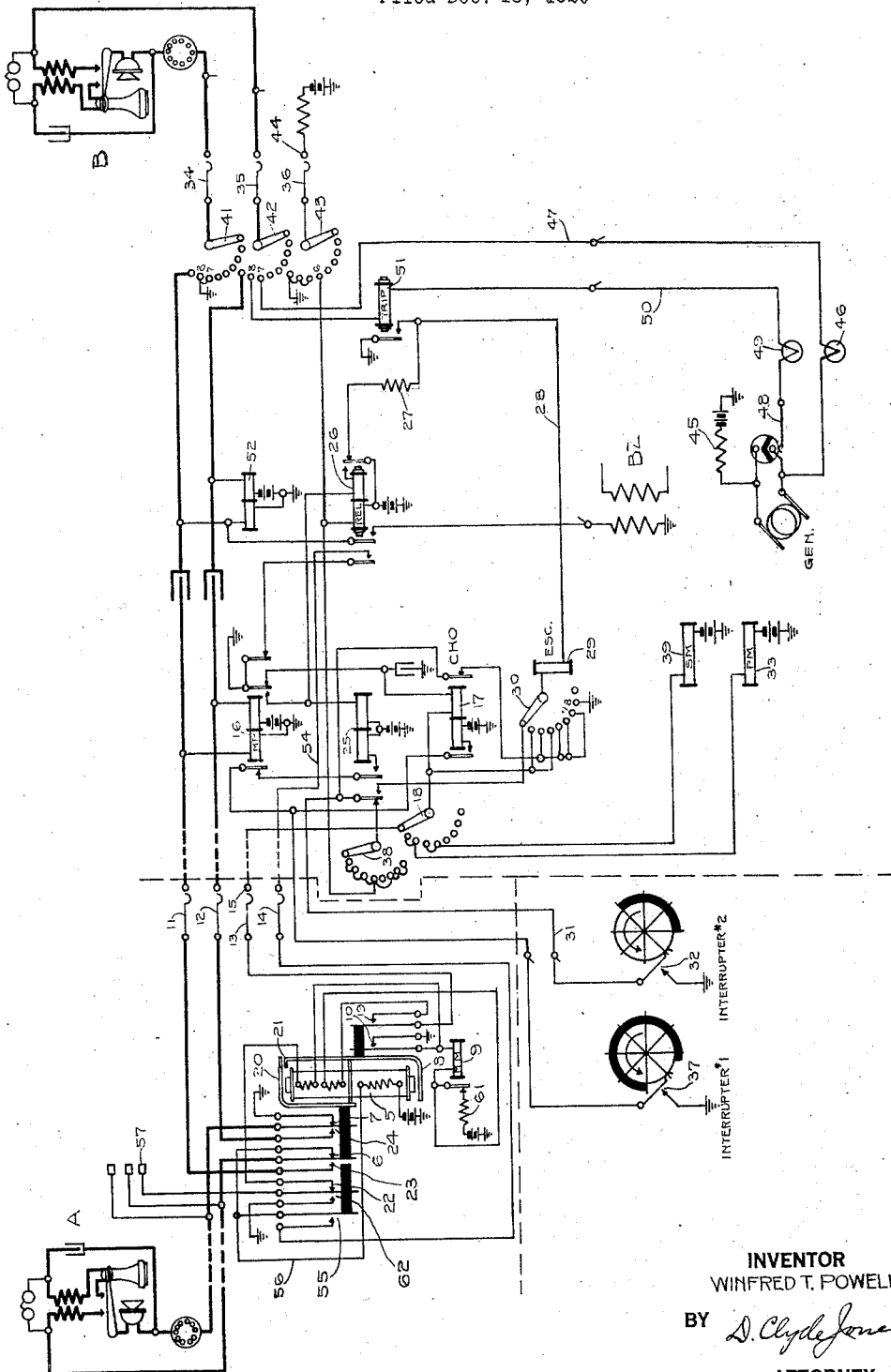
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W. T. POWELL

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AUTOMATIC TELEPHONE SYSTEM

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AUTOMATIC TELEPHONE SYSTEM.

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To all whom it may concern:

Be it known that I, WINFRED T. POWELL, a citizen of the United States, residing at Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to automatic telephone systems and more particularly to telephone systems employing automatic switches in establishing connections between calling and wanted subscribers.

In former telephone systems employing an individual non-numerical switch with separate operating means for each line it was customary to control the motor magnet by a plurality of controlling relays or electromagnets. It is one of the purposes of this invention to provide an individual non-numerical switch for each line in which the motor magnet is controlled by a single controlling relay.

Also in automatic telephone systems where automatic machine interrupted ringing current is provided, it frequently happens that the wanted line is seized during the silent interval of the interrupter so that an appreciable interval of time intervenes between the seizure and signalling of this wanted line. In accordance with one of the features of this invention, means are provided whereby a preliminary impulse of uninterrupted signalling current is applied to the called line when this line is seized during the silent interval of the ringing interrupter.

Referring to the drawing, the single figure represents a portion of a telephone system employing the present invention. That portion of the drawing appearing above and to the left of the dotted lines represents a calling subscriber's sub-station circuits and telephone line and the circuits of the individual non-numerical switch of this line. In the lower left-hand corner of the drawing there appears a device herein referred to as a double interrupter which is provided for the common use of all numerical switches employed in the exchange. At the right of the dotted line there is diagrammatically represented the operating circuits of a con-

necter switch. Although no selector switches have been represented, it will be understood that one or more of such switches may be interposed in the circuits in the broken lines connecting the circuits of the individual line switch and the connector switch, if the invention is used in large systems.

The individual line switch may be of the structure similar to that disclosed in the patent to Clement 1,107,153, August 11, 1914 and the circuits of this switch are so arranged that the switch, when not in use, retains its brushes in engagement with the trunk circuit last used. The connector switch may be similar in structure to that disclosed in the patent to Keith et al 815,176, March 13, 1906, when modified to operate in a so-called two-wire telephone system. The double interrupter is preferably of the form of a constantly rotating shaft provided with two interrupting devices so arranged that they close their circuits in predetermined time intervals as diagrammatically indicated in the drawing.

The single relay at the line switch is provided with a single core and three electromagnetic windings. The lower winding of the relay 5 is separated from the upper winding of this relay by a strip of conducting material which serves as a common portion for the electromagnetic circuit, including the upper armature of this relay and is also included in the electromagnetic circuit extending through the lower armature 8 of this relay. This relay is also provided with two armatures, the first of which 8 is pivoted at its middle point and is provided at one of its ends with a hook 21. This armature is controlled by the lower electromagnetic winding of relay 5 which winding has an electromagnetic circuit distinct from the upper two windings of this relay. The armature 20 of the relay 5 is arranged to be attracted by either of the upper windings of the relay 5, both of which have substantially the same electromagnetic circuit. When the armature 20 is actuated after the armature 8 has been operated, all of the contact springs, such as 23, 24 and 55, will be closed, while the contacts 6, 7 and 22 will be opened. Also if the armature 8 is retracted when the armature 20 is in its operated position, this last mentioned armature will be

mechanically locked operated until such time as the armature 8 is again attracted. If, however, the armature 20 is attracted when the armature 8 is in its normal position, then the hook 21 will prevent a complete movement of the armature 20 so that the sets of contacts 6, 7, 23, 24 and 55 will be open. If the relay 5 is used in a system supplied with current of 48 volts, the lower winding of relay 5 may have a resistance of 200 ohms, the middle winding 2 ohms and the upper winding 500 ohms, while the resistance designated 61 may have a value of 25 ohms and the motor magnet 9 a resistance of 23.6 ohms. It will, of course, be understood that these values are merely illustrative and can be materially varied without seriously effecting the operation of the system. It is believed that the invention will best be understood by describing the method of establishing a telephone connection between a calling subscriber's sub-station indicated at A, to a wanted subscriber's sub-station indicated at B. When the subscriber at A initiates a call by removing his receiver from its switch hook, a circuit is closed through the lower winding of relay 5, conductor 56, contact springs 6 of this relay, through the lower side of the calling line and the sub-station circuits in series, over the upper side of the calling line, spring contacts 7 of relay 5, to ground. The lower winding of the relay 5 is energized and causes this relay to attract its armature 8 to close the contact springs controlled by it. The upper armature of relay 5 remains inactive at this time. As soon as the armature 8 is attracted, a circuit is closed from grounded battery, resistance, back contact, armature and winding of the motor magnet 9, contact springs 10, to ground. Under the control of this circuit, the motor magnet 9 advances the brushes 11, 12, 13 and 14 of the line switch to hunt for an idle trunk line to the succeeding numerical switch. Busy trunks are characterized by the absence of potential on their test terminals, such as 15 so that as long as the test brush 13 is testing busy trunks, the motor magnet 9 continues to advance its brushes, but when this test brush engages an idle trunk, a circuit is closed from ground, at the armature and back contact of relay 16, right-hand winding of relay 17, side switch wiper 18 in its first position, test terminal 15, brush 13, contacts 19, middle winding of relay 5, armature and back contact of motor magnet 9, resistance, to grounded battery.

This last described circuit is effective to shunt the motor magnet 9 and to energize the middle winding of relay 5, causing it to attract the upper armature 20 of this relay. As soon as the armature 20 is fully operated, it opens the circuit through the lower winding of the relay 5, at contact springs 6

and 7, so that the lower armature 8 of this relay is retracted and the hook 21 engages the free end of the armature 20, thus locking this armature operated. Also when armature 20 is operated, it opens the contacts 22 and close contacts 62 to ground, whereby the seizure of the calling line by any connector switch is prevented. The operation of armature 20 likewise closes contacts 23 and 24 thereby connecting the calling line with its line brushes 11 and 12 to complete an energizing circuit extending from battery, through both windings of the impulse relay 16 in series. As long as relay 16 attracts its armatures, it closes a circuit from ground, its right-hand armature and front contact, right-hand winding of relay 25, to grounded battery. With relay 25 actuated, a circuit is closed from grounded battery, armature and back contact of release magnet 26, resistance 27, conductor 28, winding 29 of the escape magnet, side switch wiper 30 in its first position, outermost front contact and armature of relay 25, conductor 31, contacts 32, to ground, when these contacts are closed by the #2 interrupter, in its cycle of operation. When this last described circuit is opened, at contacts 32, by the continued rotation of interrupter #2, the escape magnet deenergizes and advances its side switch wipers into their second position.

The numerical switch is now in condition to receive directive impulses from the dial sender at the calling sub-station and, since it has been assumed in this disclosure that only connector switches are employed, the calling subscriber will operate his dial sender in accordance with the tens digit of the wanted number. In response to each of these impulses, the impulse relay 16 will vibrate its armatures thereby closing an operating circuit for the primary motor magnet 33 extending from grounded battery, winding of this magnet, side switch wiper 18, in its second position, winding of the change-over relay 17, back contact and armature of the impulse relay 16, to ground. In response to the first retraction of the armature of relay 16, the primary motor magnet 33 advances the brushes 34, 35 and 36 of the connector switch one step in the primary direction. Also the escape magnet 29 is energized in a circuit now traced from grounded battery, right-hand armature and back contact of magnet 26, resistance 27, conductor 28, winding of the escape magnet 29, side switch wiper 30 in its second position, right-hand winding of change-over relay 17, back contact and right-hand armature of relay 16, to ground. When the relay 16 attracts its armature after this first impulse, the escape magnet deenergizes and advances the side switch wiper into their third position, but the operating circuit of the primary magnet 33 is still

maintained closed in the third position of the side switch wiper 18 so that the remaining impulses of the tens series are repeated to the primary motor magnet causing it to advance the connector switch to select the group in which the wanted line terminates. It should be noted that during the transmission of these directive impulses that the release of the connector switch is prevented by the control of the so-called double interrupter device. During the transmission of these properly timed impulses the release relay 25 will be operated either by an energizing circuit extending through its right-hand winding and controlled at the impulse relay 16 or is locked operated in a circuit, through its left-hand winding and front contact and completed at the armature and back contact of impulse relay 16 and the contacts 37 of the #1 interrupter whenever a release circuit would otherwise be completed from grounded battery, through the left-hand winding of the release magnet 26, the side switch wiper 38, outer back contact and armature of relay 25, conductor 31, contacts 32 of the #2 interrupter to ground. It will thus be seen that the release of the connector switch is prevented during the transmission of directive impulses. It will subsequently be pointed out how the release of the connector switch is effected.

At the close of the tens series of impulses, the impulse relay 16 maintains its armature attracted for a relatively long interval so that the energizing circuit through the right-hand winding of change-over relay 17 is opened. In the event that the contacts 37 of the #1 interrupter are closed, the relay 17 will be maintained energized through its left-hand winding, front contact and armature. In the course of the operation of the double interrupter, however, contacts 37 will be opened and when contacts 32 of the interrupter #2 are subsequently closed, a circuit is completed from ground through these contacts, conductor 31, armature and back contact of change over relay 17, side switch wiper 30 in its third position, escape magnet 29, conductor 28, resistance 27, back contact and armature of relay 26, to grounded battery. As the double interrupter device continues to rotate, contacts 32 will be opened and the escape magnet 29 will advance the side switch wipers into their fourth position.

The connector switch is now in condition to receive the directive impulses corresponding to the units digit of the wanted number. In response to these impulses the impulse relay 16 vibrates its armatures and at its right-hand armature and back contact closes a circuit from ground, through the right-hand winding of change-over relay 17, side switch wiper 18 in its fourth position, winding of the secondary motor magnet 39, to

grounded battery. The escape magnet 29 is energized in multiple with this last described circuit and, when the impulse relay 16 attracts its armatures at the close of the first units impulse, the escape magnet 29 deenergizes and advances its wipers into their fifth position, but the operating circuit of the secondary motor magnet 39 is still extended through side switch wiper 18 in its fifth position so that in response to the units impulses the connector switch brushes are directive operated to select the wanted line in the previously selected group.

At the close of the units series of impulses, the impulse relay 16 maintains its armature attracted so that the right-hand winding of the change-over relay 17 is deenergized and subsequently, after an interval determined by the double interrupter device, the circuit through the left-hand winding of relay 17 is opened permitting this relay to retract its armatures to close a circuit from grounded battery, armature and back contact of release magnet 26, resistance 27, conductor 28, escape magnet 29, side switch wiper 30 in its fifth position, back contact and armature of change-over relay 17, conductor 31, contacts 32, to ground. As soon as the contacts 32 are opened, the escape magnet deenergizes and moves the side switch wipers into their sixth position.

The connector switch brushes are now in engagement with the terminals of the wanted line so that, when the side switch wipers are moved into position 6, the testing of the wanted line is accomplished. Let it first be assumed that the wanted line is idle under which assumption a full battery potential will be present on its test terminal 44, so that when the connector test brush 36 engages this test terminal, the release magnet 26 will not be operated, but, after an interval measured by the double interrupter device, the escape magnet is energized in the circuit previously described as extending through side switch wiper 30 and conductor 31. When contacts 32 of interrupter #2 are opened, the escape magnet moves its side switch wipers into their seventh position.

It now becomes necessary to signal the wanted subscriber and in accordance with one feature of the present invention a preliminary impulse of uninterrupter current is applied to the wanted line before the interrupted machine ringing current is connected to this line. This uninterrupted alternating current is applied to the called line in a circuit traceable from grounded battery, through the resistance 45 and ringing generator GEN, lamp 46, conductor 47, side switch wiper 42, in its seventh position, connector brush 35, through the lower side of

the wanted subscriber's line, through the ringer at this station over the upper side of this line, connector brush 34, side switch wiper 41 in its seventh position, to ground. This uninterrupted ringing current will be applied over the circuit just described until the side switch wipers are advanced into their eighth position. This is accomplished when the contacts 32 of the interrupter are again closed to complete a circuit from ground, over conductor 31, armature and back contact of change-over relay 17, side switch wiper 30 in its seventh position, escape magnet 29, conductor 28, resistance 27, back contact and armature of release magnet 26, to grounded battery. The escape magnet 29 is energized in this circuit and, when contacts 32 are opened, the side switch is advanced into position 8 in which position the escape magnet is energized in a circuit traceable from ground, side switch wiper 30, escape magnet 29, conductor 28, resistance 27, back contact and armature of release magnet 26, to grounded battery. In position 8 interrupted ringing current is applied over a circuit extending from grounded battery, resistance 45, ringing generator GEN, ringing interrupter brush 48, lamp 49, conductor 50, winding of the trip relay 51, side switch wiper 42 in its eighth position, through the sub-station circuits, as previously described, side switch wiper 41, in its eighth position, to ground. The trip magnet 51 is not energized in this circuit but, when the called party responds, the trip relay 51 is actuated and at its armature and front contact short-circuits the escape magnet 29 causing it to release and advance the side switch wipers into the ninth or talking position.

Talking current for the calling subscriber is supplied through the windings of the impulse relay 16 while talking battery for the called subscriber is supplied through the windings of the relay 52.

Let it be assumed that the wanted line was engaged at the time it was tested with side switch wiper 43 in position 6. Under this assumption the release magnet 26 is operated in a circuit completed from grounded battery, its left-hand winding, side switch wiper 43 in its sixth position, test brush 36, test terminal 44 and through a multiple test terminal such as 44 and the test brush such as 36 of the connector switch which has previously seized the wanted line through a side switch wiper similar to 43 in position 9, to ground. The release magnet is energized and closes a locking circuit for itself from grounded battery, through its right hand armature, front contact and winding, front contact and armature of impulse relay 16, to ground. At the inner left-hand armature and front contact of relay 26 a busy tone is applied from a source of busy tone

current BZ to the calling subscriber's line to inform him that the wanted line is busy. The calling subscriber then replaces his receiver on its switch hook to effect the release of the established connection. The manner of effecting the release operation is the same irrespective of whether the call is abandoned or whether the call has been terminated.

On the restoration of the calling receiver to its switch hook, the impulse relay 16 retracts its armature and, at its inner right-hand armature and front contact interrupts the locking circuit of the release magnet 26. This magnet, however, is slow in releasing its armatures and a circuit is thereby completed from ground, outer right-hand armature and back contact of relay 16, outer left-hand armature and front contact of release magnet 26, conductor 54, release brush 14 of the line switch, contacts 55 of relay 5, conductor 56, lower winding of relay 5, to grounded battery. The energization of the lower winding of relay 5 causes it to retract its armature 8 which causes the hook 21 to disengage the free end of the armature 20 and, since the calling party has terminated the call, the armature 20 is retracted. It will be recalled that the line switch is of that type in which the line switch brushes remain in engagement with the trunk circuit last used, but these brushes are disconnected from the subscriber's line.

On the opening of the locking circuit of release magnet 26 it deenergizes and restores the connector switch as well as the side switch into normal position. The apparatus is now in condition for use on a succeeding call.

In the event that the subscriber at A is the wanted party, whenever a connector switch engages the test terminals 57 of this line, a circuit is closed from grounded battery, back contact and armature of motor magnet 9, upper winding of relay 5, contact springs 22, contact 57, through a side switch wiper similar to 43 (shown at the extreme right of the sheet) in its ninth position, to ground. This operates armature 20, but the hook 21 prevents the full attraction of this armature so that, while the lower winding of the relay 5 is disconnected from its line, the line switch brushes 11 and 12 are not connected to the called station.

It will thus be seen that a non-numerical switch circuit of the "stay-put" type with only one controlling relay has been provided. Likewise, novel means have been provided for signalling a wanted subscriber's line.

What is claimed is:

1. In a telephone system, an incoming circuit, a plurality of outgoing circuits, a non-numerical switch for inter-connecting said incoming circuit with any of said outgoing circuits, operating circuits for said

switch whereby said switch may occupy any one of a plurality of normal positions when not in use, a motor magnet for operating said switch, and a single electromagnetic device at said switch co-operating with said

5 circuits for controlling said motor magnet, said electromagnetic device having a single core and a plurality of interacting armatures.

10 2. In a telephone system, an incoming circuit, a plurality of outgoing circuits, a non-numerical switch for interconnecting said incoming circuit with any of said outgoing circuits, operating circuits for said switch arranged so that it may occupy any one of a plurality of normal positions when not in use, a motor magnet for operating said switch, and a single electromagnetic device at said switch for controlling said

20 motor magnet, said electromagnetic device having a single core and a plurality of windings.

3. In a telephone system, an incoming circuit, a plurality of outgoing circuits, a non-numerical switch for interconnecting said incoming circuit with any one of said outgoing circuits, a motor magnet for operating said switch, and a single electromagnetic device at said switch for controlling said motor magnet, said electromagnet having a single core and a plurality of windings, one of said windings being energized over both sides of said incoming circuit in series to effect the operation of the motor magnet and a second winding for disconnecting said electromagnet from said incoming circuit and to stop the operation of said motor magnet.

4. In a telephone system, an incoming circuit, a plurality of outgoing circuits, a non-numerical switch for interconnecting said incoming circuit with any of said outgoing circuits, a motor magnet for advancing said switch, said switch having brushes, and a single relay with a single core for controlling said motor magnet, said relay having one winding energized over both sides of said incoming circuit in series to start the operation of said motor magnet and a second winding for disconnecting said relay from said incoming circuit and for connecting said incoming circuit to said switch brushes.

5. In a telephone system, an incoming circuit, a plurality of outgoing circuits, a switch for interconnecting said incoming circuit with any one of said outgoing circuits, a motor magnet for advancing said switch, and a single relay at said switch for controlling the operation of the motor magnet, said relay being provided with two armatures the first of these armatures being effective to mechanically lock the second armature in operated position when once actuated, said first armature operating to

start said motor magnet and the second armature being effective to prevent operation of said motor magnet, and means for operating said relay to actuate said armatures.

6. In a telephone system, an incoming circuit, a plurality of outgoing circuits, a switch having brushes normally disconnected from said incoming circuit for connecting said incoming circuit to any one of said outgoing circuits, a motor magnet for advancing said switch, and a single relay at said switch for controlling the operation of the motor magnet, said relay being provided with three windings, the first winding being energized over said incoming circuit to start the operation of the motor magnet, said second winding being energized to connect said incoming circuit to said switch brushes and said third winding being effective to prevent the operation of the motor magnet without connecting said incoming circuit to its brushes.

7. In a telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch having brushes normally disconnected from said incoming circuit but effective to connect said incoming circuit with any of said outgoing circuits, a motor magnet for advancing said switch, and a single electromagnet at said switch for controlling the operation of the motor magnet, said electromagnet being provided with a single core and a plurality of armatures, the first armature controlling said motor magnet and the second armature controlling the connection of said incoming line to the brushes of said automatic switch.

8. In a telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch having brushes normally disconnected from said incoming circuit but operating to connect said incoming circuit with a selectable outgoing circuit, means for characterizing outgoing circuits by a non-selectable condition, a motor magnet for advancing said switch, a test circuit for determining the selectable condition of an outgoing circuit, operating to control the motor magnet, and a single electromagnet at said switch for controlling the operation of the motor magnet, said electromagnet being provided with a single core and a plurality of armatures, one of said armatures controlling the motor magnet and said test circuit and the second armature operating to connect said incoming circuit to the brushes of said automatic switch.

9. In a telephone system, a plurality of telephone lines, switches for interconnecting said lines, directly controlled means including a uni-directional rotating timing device controlled over one of said telephone lines for selectively operating a numerical switch to select a wanted telephone line, sources of signalling current of two different

characters, and means controlled by said timing device for connecting said sources of current to a wanted telephone line.

10. In a telephone system, an incoming line, a plurality of outgoing telephone lines, means including a numerical switch for interconnecting said incoming line with a wanted outgoing line, means controlled over said incoming line for variably operating said numerical switch, and a unidirectional rotating timing device co-operating with said means in the control of said automatic switch, sources of interrupted and non-interrupted signalling current and means under the control of said timing device for connecting said sources of current in sequence to the selected telephone line.

11. In a telephone system, an incoming circuit, a plurality of outgoing circuits, a non-numerical switch for interconnecting said incoming circuit with any of said outgoing circuits, said switch having at least four brushes, a motor magnet for advancing the brushes of said switch, a single relay with a single core controlling said motor magnet, said relay having one winding energized over both sides of said incoming

circuit in series to cause the operation of said motor magnet, said relay having a second winding for disconnecting said relay from said incoming circuit and for connecting said incoming circuit to certain of said switch brushes, said relay having a third winding for restoring said switch to its normal condition and circuits for said last two relay windings completed through the certain others of said switch brushes.

12. In a telephone system, an incoming circuit, a plurality of outgoing circuits, a switch for interconnecting said incoming circuit with any of said outgoing circuits, a motor magnet for advancing said switch, and a single relay at said switch for controlling the operation of the motor magnet, said relay being provided with two armatures to control the operation and restoration of said automatic switch, magnetic circuits in said relay for controlling said armatures, and a common conducting portion for said magnetic circuits.

In witness whereof, I hereunto subscribe my name this 4th day of December A. D. 1920.

WINFRED T. POWELL.