April 6, 1926.

1,579,838

W. T. POWELL

AUTOMATIC TELEPHONE SYSTEM

Filed March 6, 1923

4 Sheets-Sheet 1

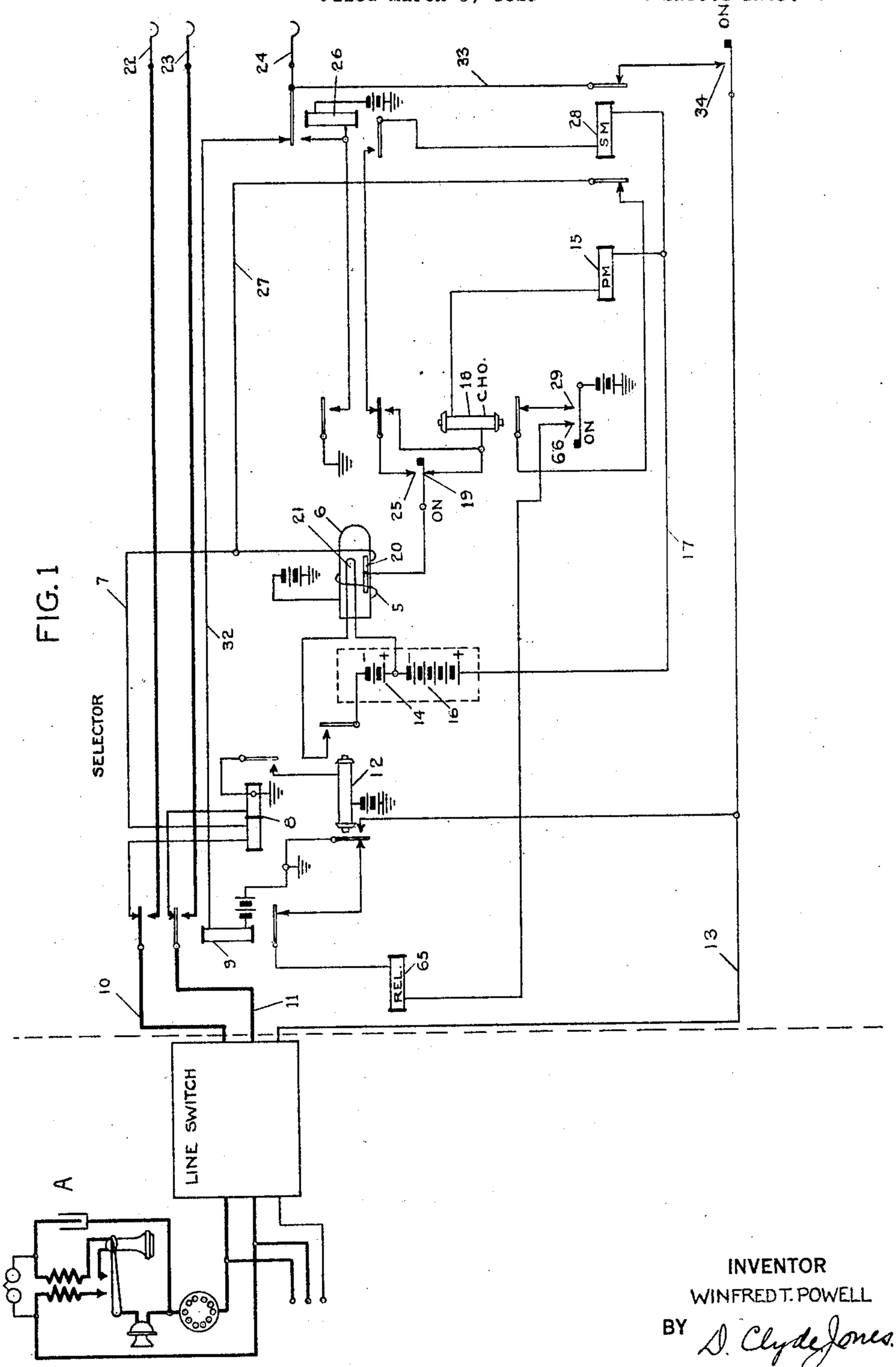

FIG. 1

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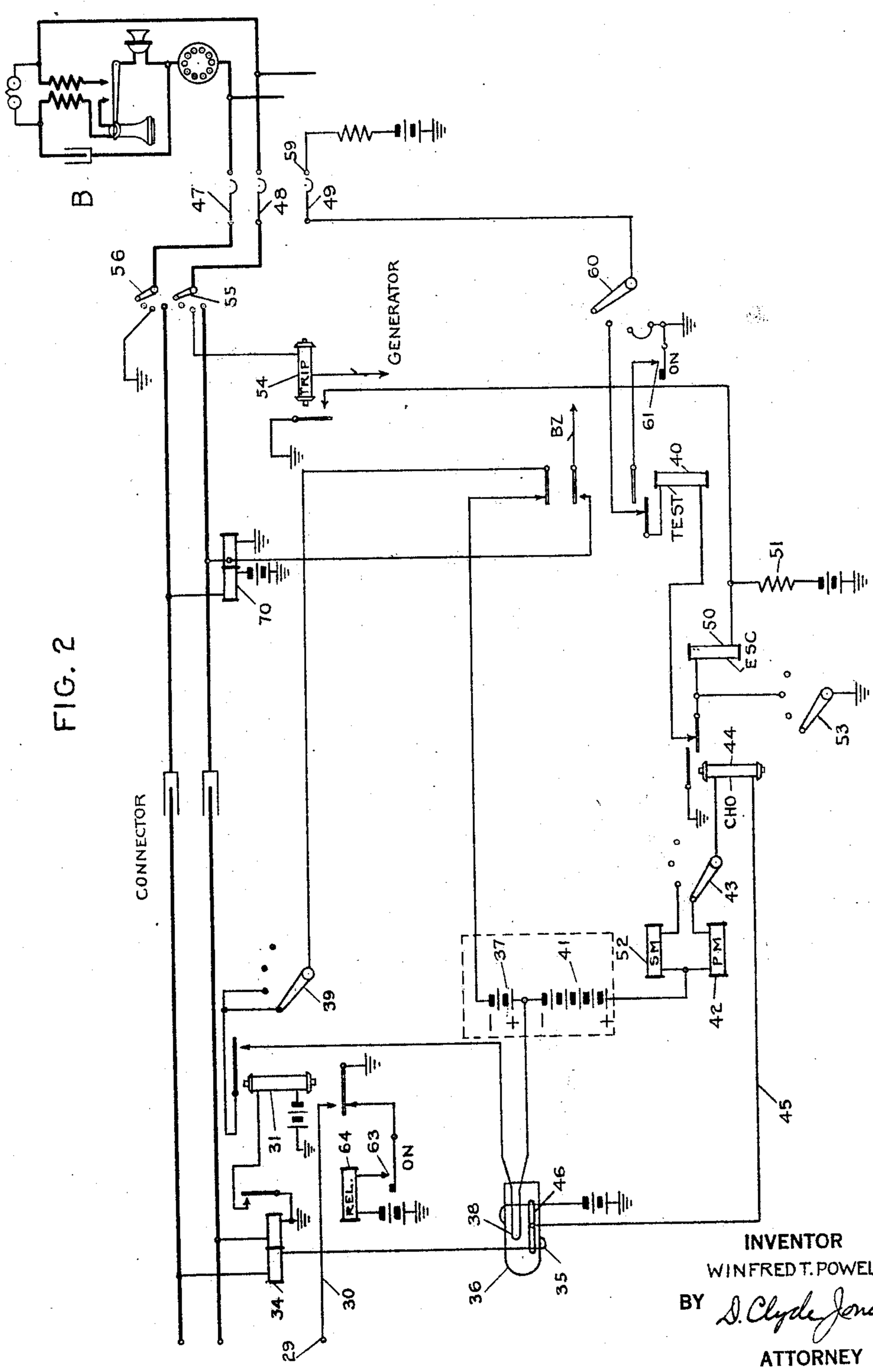
AUTOMATIC TELEPHONE SYSTEM

Filed March 6, 1923 4 Sheets-Sheet 2

FIG. 2



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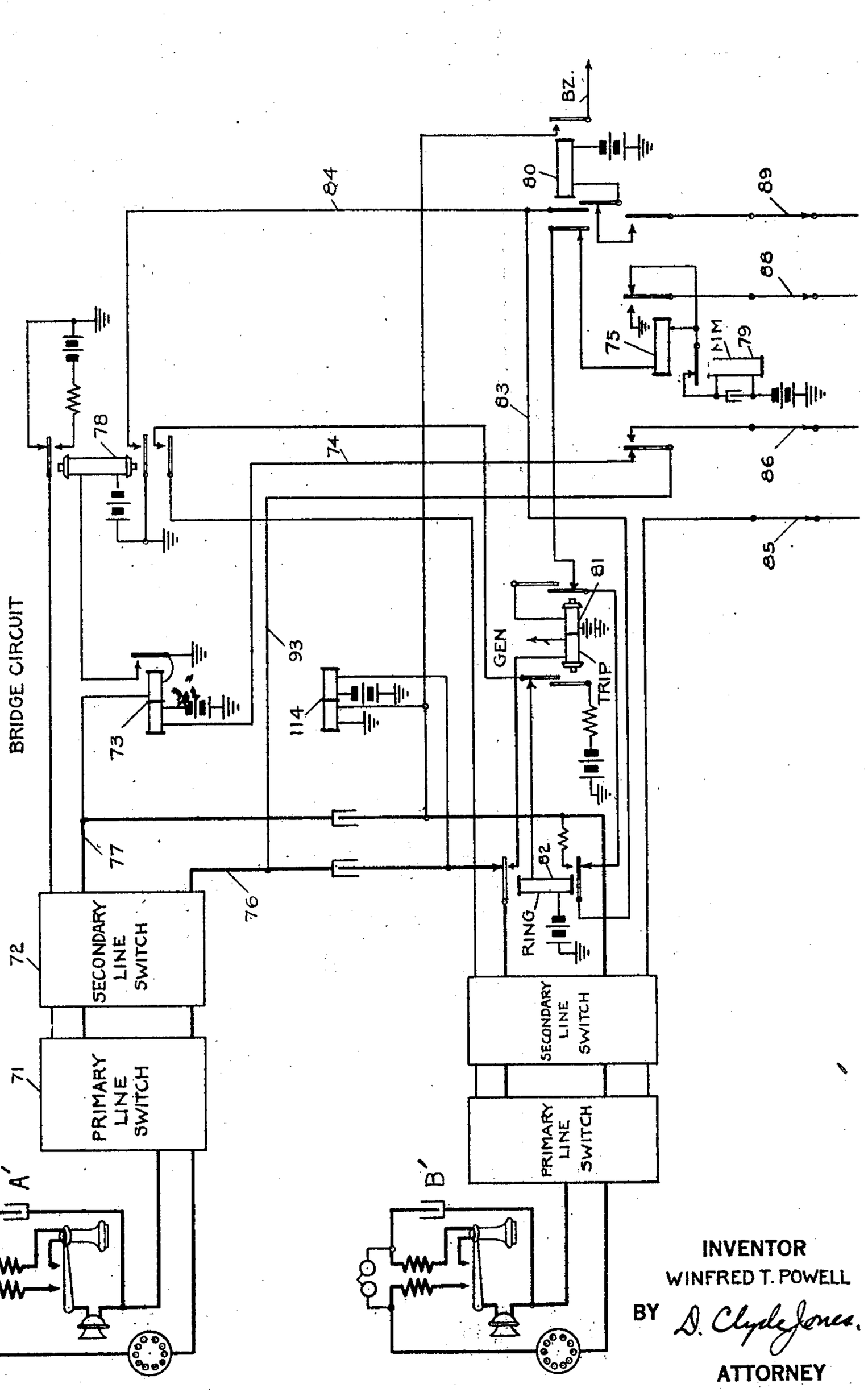
AUTOMATIC TELEPHONE SYSTEM

Filed March 6, 1923 4 Sheets-Sheet 3

FIG. 3



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AUTOMATIC TELEPHONE SYSTEM

Filed March 6, 1923 4 Sheets-Sheet 4

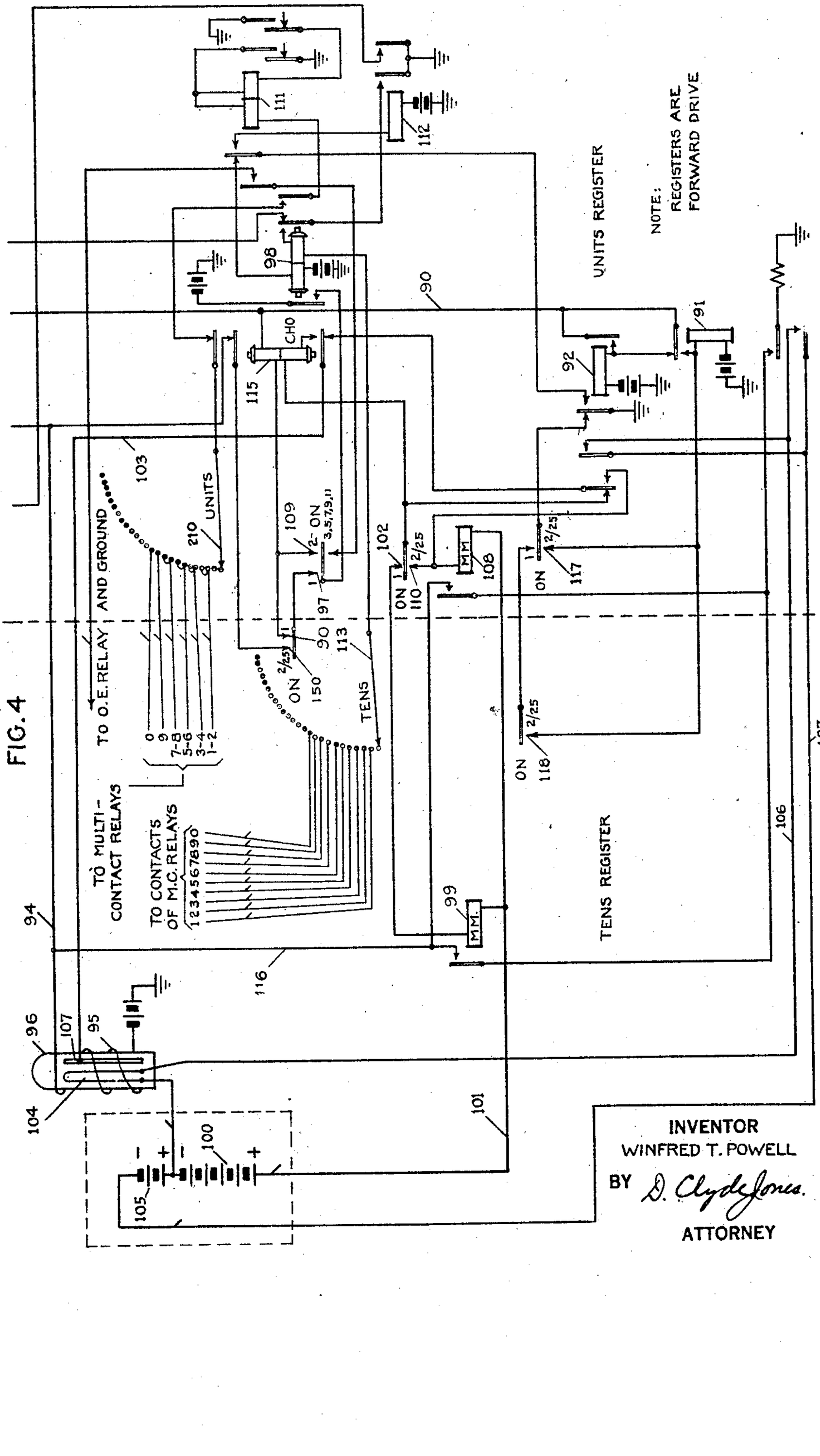

FIG. 4

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UNITED STATES PATENT OFFICE.

WINFRED T. POWELL, OF ROCHESTER, NEW YORK, ASSIGNOR TO THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

AUTOMATIC TELEPHONE SYSTEM.

Application filed March 6, 1923. Serial No. 623,362.

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 telephone systems and more particularly to telephone systems employing automatic switches in completing some portion of a telephone connection between calling and called subscribers.

The present invention has for its purpose the provision of means whereby a thermionic device directly controls the operation of one or more progressively movable automatic switches. Other features of the invention reside in the novel circuit arrangement for accomplishing this purpose.

The drawings with Figs. 1 and 2 arranged in the order named diagrammatically represent a portion of a telephone system employing the present invention. The portion of Fig. 1 at the left of the dotted line represents a calling subscriber's telephone line and a non-numerical switch or a line switch for extending this telephone line. At the right of the dotted line in Fig. 1 there are represented the operating circuits of a numerical or selector switch. In Fig. 2 there are shown the operating circuits of a connector switch, while at the upper right hand corner of this figure there is represented a called telephone line. Figs. 3 and 4 represent a modified form of the invention in which thermionically controlled circuits govern the variable setting of a register sender.

The non-numerical switch or line switch and registers referred to may be substantially similar in structure to that disclosed in the patent to Clement 1,107,153, granted August 11, 1914, while the operating circuits of the line switch of Fig. 1 may be substantially similar to those shown in Fig. 49 on page 52 of "Automatic Telephony" by Smith & Campbell, second edition. The selector and connector switches may be similar to those disclosed in the patents to Keith, Erickson & Erickson, #815,176 and #815,321, granted March 13, 1906, when modified to operate in a so-called two-wire system.

A thermionic device or vacuum tube suitable for operation in the present disclosure may be similar to that disclosed in the patent to Allcutt #1,440,432 granted January 2, 1923, in which a filament electrode and a plate electrode are enclosed in an evacuated space and a third control element in the form of an electromagnetic control winding is placed without the evacuated space but with its field surrounding the first two mentioned electrodes.

In this disclosure several battery symbols are indicated, but it will be understood that these symbols merely represent one large battery at the exchange with the exception of the batteries which are indicated within the dotted rectangles of Figs. 1, 2 and 4 which are employed to control the thermionic device. In the course of the description, these last mentioned controlling batteries are referred to as high and low potential batteries, but it will be understood that a single high voltage battery may be employed instead of these two batteries and that the terminals of the filaments are connected to the proper number of cells of the battery to obtain the proper amount of potential.

It is believed that the present invention will best be understood by describing the method of establishing a telephone connection from the calling telephone line such as A of Fig. 1 to a called telephone line such as B of Fig. 2. When the subscriber at A removes his receiver from its switch hook the two sides of the telephone line are automatically extended through the line switch in the well-known manner to an idle trunk leading to a selector switch such as that shown in Fig. 1. As soon as the selector switch is seized, a circuit is closed from grounded battery, through winding 5 of the control element of the thermionic device or vacuum tube 6, conductor 7, left hand winding of relay 8, uppermost, back contact and armature of the relay 9, over conductor 10 of the selector trunk, through the line switch, over the upper side of the calling line and through its substation circuits in series, over the lower side of this line and through the line switch to conductor 11 of the selector trunk, right hand winding of relay 8 to ground. The relay 8 is thus operated and at its front contact and arma-

ture closes a circuit for actuating the slow releasing relay 12, which relay at its left hand armature and front contact applies a ground potential to the holding conductor 13 which maintains the line switch operated. At the right hand armature and front contact of relay 12, a circuit is closed from the low voltage battery 14 for lighting the filament of the thermionic device 6. It should be noted that the control element 5 of this device acts at this time to "block" it so that it is ineffective. The selector switch is now in condition to receive impulses corresponding to the hundreds digit of the wanted number, and the calling subscriber thereupon operates his dial sender to send this series of impulses. In response to each of these impulses, the circuit of the control element 5 of the thermionic device 6 is opened so that this control element is ineffective to control the thermionic device with the result that an operating circuit is closed for the primary motor magnet 15 of the selector switch from the positive side of the high voltage battery 16, conductor 17, winding of the primary motor magnet, winding of the change-over relay 18, off-normal contacts 19, plate 20 and filament 21 of the thermionic device to the negative side of the battery 16.

The magnet 15 and the change-over relay 18 are energized in this circuit, but when the dial sender again closes the two sides of the calling line, the control element 5 of the thermionic device is energized so that magnet 15 deenergizes, but the change-over relay 18 is slow to release its armatures and is thus held operated during impulses. In response to each impulse, the primary magnet 15 of the selector advances the brushes 22, 23 and 24 one step in their primary direction. In response to the succeeding impulses of the hundreds series the primary motor magnet 15 is energized in a circuit similar to that previously described except that it now extends through the inner front contact and armature of the change-over relay 18 and the off-normal contacts 25. As soon as the change-over relay 18 is operated, it closes an actuating circuit for relay 26 from grounded battery, winding of this relay, uppermost front contact and armature of relay 18 to ground.

At the close of the hundreds series of impulses the control element 5 of the thermionic device is short circuited in a circuit closed from grounded battery, control element 5, conductor 27, armature and back contact of secondary motor magnet 28, lower armature and back contact of relay 18, off-normal contacts 29 to grounded battery.

The control element 5 is thus ineffective to "block" the thermionic device 6, with the result that the secondary motor magnet 28 is energized from the positive side of the battery 16, winding of the secondary motor magnet 28, lower armature and front contact of relay 26, inner back contact and armature of relay 18, off-normal contacts 25, plate 20 and filament 21 to the negative side of battery 16. The secondary motor magnet 28 is thus energized and at its armature and back contact opens the short circuit around control element 5, so that it is now effective to block the thermionic device, which effects the deenergization of the secondary motor magnet 28. In response to each energization of the motor magnet 28 the brushes 22, 23 and 24 of the selector switch are advanced one step in their secondary movement. The energization and deenergization of the secondary motor magnet 28 continues as long as test brush 24 encounters test terminals having a guarding ground potential such as may be applied over a conductor similar to 30 from ground at the lower armature and front contact of slow releasing relay 31. When, however, the ungrounded test terminal 29 is reached, the switching relay 9 is actuated from grounded battery, winding of this relay, conductor 32, back contact and armature of relay 26, conductor 33, right hand armature and back contact of motor magnet 28, off-normal contacts 34, left hand front contact and armature of relay 12 to ground. The switching relay 9 on actuation extends the calling line and the conductors 10 and 11 of the selected trunk through the selector brushes 22 and 23 to the windings of relay 34; the right hand winding of this relay is extended to ground, while the left hand winding of this relay is extended to grounded battery through the control element 35 of the thermionic device 36. Relay 34 is actuated in this circuit, and at its armatures and front contact, effects the operation of the slow releasing relay 31. This last named relay in turn operates to apply a guarding potential over conductor 30 and to close a circuit from the low voltage battery 37, through the filament 38, front contact and armature of relay 31, side switch wiper 39 in its first position, uppermost armature and back contact of test relay 40 to the opposite side of the battery 37. The control element 35 is effective at this time to "block" the thermionic device 36.

The connector switch is now in condition to receive the tens impulses from the subscriber's dial sender. In response to each of the interruptions of the extended calling line, the control element 35 is rendered ineffective so that a circuit is closed from the positive side of the battery 41, winding of the primary motor magnet 42, side switch wiper 43, winding of the change-over relay 44, conductor 45, plate 46, filament 38, to the negative side of battery 41. When the

dial sender again closes the extended calling line the control element 35 is effective to "block" the thermionic device 36, so that the primary motor magnet 42 deenergizes. In response to each energization and deenergization of the primary motor magnet 42 the brushes 47, 48 and 49 of the connector switch are advanced one step in their primary movement. The succeeding impulses of the tens series are effective to energize and deenergize the primary motor magnet 42 in the manner just described. On the first energization of the change-over relay 44, a circuit is closed from ground, its armature and continuity spring, winding of the escape magnet 50, resistance 51, to grounded battery. This circuit holds the escape magnet operated until the close of the tens series of impulses when the change-over relay 44 deenergizes to effect the release of the escape magnet 50, which moves the side switch wipers into their second position.

The connector switch is in condition to receive the units series of impulses and the calling subscriber now operates his dial sender to effect the last stage in the operation of the connector switch. In response to each interruption of the extended calling line by the dial sender, the control element 35 is rendered ineffective so that an actuating circuit is closed for the secondary motor magnet 52 from the positive side of battery 41, winding of this magnet, side switch wiper 43 in its second postion, winding of the change-over relay 44, conductor 45, plate 46 and filament 38 to the negative side of battery 41. The secondary motor magnet 52 and the change-over relay 44 are energized in this circuit; the change-over relay at its upper armature and continuity spring again causes the energization of the escape magnet 50. When the calling line is again closed in the course of the operation of the dial sender the control element 35 is effective to cause the deenergization of the secondary motor magnet 52, but the slow releasing change-over relay 44 remains operated. In response to each cycle of energization and deenergization of the secondary motor magnet 52, the brushes of the connector switch are advanced one step in their secondary movement. At the close of the units series of impulses the control element 35 blocks the thermionic device 36 for a relatively long interval so that the change-over relay 44 deenergizes and effects the deenergization of the escape magnet 50. This magnet thereupon moves the side switch wipers into their third position, provided the called line is idle. The escape magnet 50 is then actuated from grounded battery resistance 51, its winding, side switch wiper 53 to ground. Ringing current is now applied to the called line from the ringing generator, winding of the trip relay 54, side switch wiper 55 in its third position, connector brush 48, over the lower side of the called line, through the substation circuits in series, upper side of the called line, connector brush 47, side switch wiper 56 in its third position to ground. Ringing current is applied over this circuit until the called partly responds at which time the trip relay 54 is operated and at its armature and front contact short-circuits the escape magnet 50. This last named magnet thereupon deenergizes and moves the side switch wipers into their fourth or talking position. Guarding potential is applied to the multiple test terminals such as 59 of the called line through test brush 49, side switch wiper 60 in its third and fourth positions to ground. Talking battery is supplied to the calling party through the windings of relay 34, while talking battery is supplied to the called party through the windings of relay 70.

Let is be assumed that the called line is busy at the close of the units series of impulses, so that when the change-over relay 44 deenergizes, a circuit is closed from grounded batter, resistance 51, winding of the escape magnet 50, continuity spring and back contact of relay 44, winding of the test relay 40, its continuity spring and back contact, side switch wiper 60 in its second position, test brush 49 and through a multiple test terminal such as 59, through the test brush such as 49 of the connector that has previously seized the called line, to ground through a side switch wiper such as 60 in its third or fourth position. The escape magnet is held operated in this circuit and the test relay 40 is operated to close a locking circuit for itself through its continuity spring and innermost armature, off-normal contacts 61 to ground. The escape magnet 50 and the test relay 40 are thus held operated until the calling party releases. A source of busy tone B Z is then applied to the calling line through the middle armature and front contact of the test relay 40.

At the close of the conversation when the calling subscriber replaces his receiver on its switch hook, the relay 34 deenergizes and shortly afterwards, the slow releasing relay 31 retracts its armatures. This closes a circuit from ground at the armature and back contact of relay 31, off-normal contacts 63, winding of the release magnet 64 to grounded battery. The release magnet 64 when thus energized effects the release of the connector switch in the well known manner.

The deenergization of relay 31 also removes the holding ground from the conductor 30 so that the switching relay 9 retracts its armatures. On the restoration of relay 9 the release magnet 65 is energized

from grounded battery, off-normal contacts 66, winding of the release magnet 65, lower armature and back contact of relay 9, back contact and armature of relay 12 to ground. The release magnet 65 on energization releases the selector switch to its normal position, also when holding ground is removed from conductor 30, the holding conductor 13 of the line switch is opened to effect the release of that switch. The apparatus referred to is now in condition to extend a succeeding call.

In the modification of the invention shown in Figs. 3 and 4 the invention is shown applied to a so-called register sender of the type disclosed in my Patent No. 1,531,219, issued March 24, 1925. It will be understood, however, that this type of register sender may be used in any system wherein the designation of the called line is recorded on one or more of a plurality of number storing devices located at the central office. The disclosure of the system of Figs. 3 and 4 has been greatly abbreviated for simplicity in description, but it will be understood that Fig. 4 of this disclosure may be substituted for Fig. 4 of my copending application. If such a substitution is made, relay 106 (Fig. 3) and the conductors leading thereto will be omitted.

It is believed that the present invention will best be understood by describing the method of establishing a telephone connection from a calling substation such as A′ to a called substation such as B′, reference being had to my mentioned patent for a complete disclosure of the details of the system. When the subscriber at A′ removes his receiver from its switch hook primary and secondary line switches such as those indicated at 71 and 72 function to extend the calling line to an idle bridge circuit. The extension of the calling line effects the energization of the relay 73 over a circuit closed from grounded battery, left hand winding of this relay, conductor 74, back contact and armature of relay 75, conductors 93 and 76 of the selected bridge circuit through the secondary and primary line switches, over the lower side of the calling line and through the calling substation circuits in series, over the upper side of the calling line, through the mentioned primary and secondary line switches, conductor 77, right hand winding of relay 73 to ground. The energization of relay 73 causes the operation of the slow releasing relay 78. The actuation of relay 78 effects the operation of relay 75 over a circuit closed from grounded battery, winding of motor magnet 79, its back contact and armature, winding of the relay 75, outer back contact and armature of relay 80, back contact and continuity spring of trip relay 81, lower back contact and armature of relay 82, conductors 83 and 84, inner front contact and armature of relay 78 to ground. It need only be mentioned that the sender selector switch is normally standing with its brushes 85, 86, 88 and 89 in engagement with the terminals of an idle register sender. For this reason the operation of relay 75 closes a circuit from ground, innner front contact and armature of this relay, selector brush 88, conductor 90, armature and back contact of relay 91, winding of relay 92 to grounded battery. The relay 92 is operated and serves to hold the register sender in its busy or operated condition until the release after an extension of a call or when the calling subscriber abandons a call. The relay 92 on operation closes a locking circuit for itself through its right hand front contact and armature, which locking circuit is independent of the relay 91. Also the operation of the relay 75 extends the calling line through conductors 76 and 93, left hand armature and front contact of relay 75, selector brush 86, conductor 94, control element 95 of the thermionic device 96 to grounded battery. The control element 95 is effective to block the operation of the device 96 at this time. Simultaneously with the operation of relay 92, the change over relay 115 is operated in a circuit traceable from ground, inner front contact and armature of relay 75, selector brush 88, upper winding of relay 115, off-normal contacts 90 and 97, left hand front contact and armature of relay 98 to grounded battery. The relay 92 of Fig. 4 closes a circuit for lighting the filament 104 from the positive side of low voltage battery 105 to the filament 104, conductor 106, middle front contact and armature of relay 92, conductor 107 to the negative side of battery 105.

It will thus be seen that the filament is maintained lighted as long as the register is in use and is maintained in this condition by the relay 92 or by the relay 91. The register sender is now in condition to receive impulses from the calling line over the impulse circuit which has previously been described as including the control element 95. The operation of the dial sender at the calling substation is effective to interrupt this mentioned impulse circuit so that the control element 95 is ineffective to block the operation of the thermionic device with the result that the motor magnet 99 is operated in a circuit traceable from the positive side of battery 100, conductor 101, winding of motor magnet 99, off-normal contacts 102, lower winding, front contact and armature of relay 115, conductor 103, plate 107, filament 104 to the negative side of battery 100. The motor magnet is energized in this circuit and since the registers are of that type which are advanced on the energization of the motor magnet instead of on the deener-

gization of this magnet, the brushes of the tens register are therefore advanced into their second position.

It is well understood that the dial sender in its operation intermittently opens and closes the impulse circuit so that in response to the closure of the impulse circuit succeeding the first mentioned interruption thereof, the control element 95 blocks the operation of the thermionic device with the result that the motor magnet 99 deenergizes. In response to the continued interruptions and closures of the calling line, the control element 95 renders the thermionic device effective and ineffective to intermittently energize and deenergize the motor magnet 99. As a result of the energization and deenergization of this motor magnet, the brushes of the tens register are advanced step-by-step in accordance with the tens designation of the wanted number. At the close of this series of impulses, the impulse circuit is closed for a relatively long period so that the circuit including the lower winding of the slow releasing relay 115 is open for a relatively long period to permit the deenergization of this relay.

The release of relay 115 closes a circuit for short circuiting the control element 95 of the thermionic device 96, traceable from grounded battery, left hand armature and make contact of relay 98, units register off normal contact 97, tens register off normal contact 150, inner upper armature and back contact of relay 115, conductor 94 and control element 95. The control element 95 is thus short circuited which renders it ineffective to block the operation of the thermionic device so that a circuit is closed to advance the units register from position 1 to position 2. This circuit is traceable from the positive side of battery 100, conductor 101, winding of motor magnet 108, outer left hand armature and front contact of relay 92, lower armature and back contact of relay 115, conductor 103, plate 107, filament 104 to the negative side of battery 100.

With the units register in position 2 a circuit is closed for operating relay 115 traceable from grounded battery, left hand armature and front contact of relay 98, units register off-normal contact 109, upper winding of relay 115, brush 88, inner right hand armature and contact of relay 75 to ground. The short circuit is removed from control element 95 by the opening of contact 97 when the units register leaves position 1, so that the control element is again rendered effective.

The circuits are now in condition to receive the units series of impulses. In response to the first of these impulses the control element 95 is rendered ineffective so that a circuit is closed from the positive side of battery 100, conductor 101, winding of the motor magnet 108, off normal contact 110, lower winding, front contact and armature of relay 115, plate 107, filament 104 to the negative side of battery 100. The motor magnet 108 is thus energized and advances the brushes of the units register one step. In response to the succeeding impulses of the series, the motor magnet 108 is operated in a circuit traceable from the positive side of battery 100, conductor 101, winding of this motor magnet, off normal contacts 110, lower winding, front contact and armature of change-over relay 115, conductor 103, plate 107, filament 104 to the negative side of battery 100.

At the close of this series of impulses, the impulse circuit is again completed and the control element 95 interrupts for a relatively long interval, the circuit including the motor magnet 108 and the change-over relay 115. This relay thereupon deenergizes so that this register sender is no longer under the control of the dial sender. Upon the deenergization of the relay 115, a circuit is closed for operating one of the multi-contact relays (not shown) through the units brush 210, uppermost armature and back contact of relay 115, outer front contact and armature of relay 98, through both windings in series of relay 111 to ground through the armature of the relays similar to 111 at other register senders. The relay 111 is thus operated and at its inner left hand front contact and armature closes a circuit for operating the relay 112, which circuit is completed at the innermost front contact and armature of relay 92. Relay 112 when thus actuated, closes at its inner armature and front contact a circuit from ground, through inner right hand armature, front contact and winding of relay 98, tens register brush 113 and the contacts of the operated multi-contact relay (not shown) to the test circuit of the called line. The completion of this circuit starts the primary and secondary line switches of Fig. 3 to extend the called line to the terminating end of the bridge circuit to which the calling line is already connected. The extension of the called line B′ to the selected bridge completes a signaling circuit from the ringing generator, through the left hand winding of the slow operating trip relay 81, upper front contact and armature of relay 82 (now operated) over the upper side of the extended circuits to the signal at the substation B′, over the lower side of the extended connection, left hand winding of the impedance coil 114 to ground.

When the called party responds, the trip relay 81 is operated to open the circuit of the ringing relay 82 and to complete a locking circuit for itself through its right hand armature and continuity spring, lower back contact and armature of relay 82, conductors 83 and 84, inner front contact and armature

of relay 78 to ground. The operation of the relay 81 also opens the energizing circuit of the relay 75, whereupon this relay deenergizes and at its inner front contact and armature, the circuit of relay 92 is opened causing it to retract its armatures. This last mentioned operation results in the restoration of the tens and units registers to their normal positions. The deenergization of relay 75 has opened the circuit of the control element 95 so that the release of relay 92 closes a circuit from the positive side of the battery 100, winding of magnet 108, off normal contacts 110, outer back contact and armature of relay 92, lower back contact and armature of relay 115, plate 107 and filament 104. Magnet 108 is energized in this circuit and advances the units register one step towards its normal position, however, the energization of the motor magnet 108 also closes a circuit for energizing the control element 95, which circuit is traceable from grounded battery, winding of the control element, conductor 116, front contact and armature of magnet 108, inner front contact and armature of relay 91, resistance to ground. The completion of this circuit is effective to block the operation of the thermionic device so that the motor magnet 108 deenergizes and opens the circuit of the control element, thereupon the operating circuit of the motor magnet 108 is again completed to advance the brushes of the units register an additional step toward their normal position. The energization of magnet 108 also closes again the circuit for the control element. This cycle of operations is repeated until the units register reaches its normal position at which time the off normal contacts 110 are opened and the off-normal contacts 102 are closed. The motor magnet 99 of the tens register is now energized in a circuit traceable from the positive side of the battery 100, conductor 101, winding of the motor magnet 99, off-normal contacts 102, back contact and armature of relay 92, back contact and armature of relay 115, plate 107, filament 104 to the negative side of battery. The motor magnet 99 is energized in this circuit and advances the brushes of the tens register one step towards their normal position. The energization of the motor magnet 99 also closes an energizing circuit for the control element 95 in a manner similar to that already described. The cycle of operations described for the units register is now repeated in the tens register to cause the operation of the motor magnet 99, until the tens register reaches its normal position at which time the off-normal contacts 118 are opened to permit the release of relay 91 and the consequent interruption of the circuit of filament 104.

While the operation of this register sender has been described in connection with an automatic telephone system such as that disclosed in my mentioned patent, it will be understood that this invention is suitable for any telephone system wherein registers are controlled from a remote point to store the designation of a wanted telephone line and thereafter control the setting of automatic switches to extend a calling line to a called line. The present invention is also particularly adapted for use in a telephone system such as that disclosed in the patent to Lundell #1,168,319 granted January 18, 1916.

What I consider to be novel in the system of Figures 3 and 4 is the use of a remotely controlled thermionic device to variably set a series of number storing devices in succession and thereafter cause these registers to control the setting of one or more automatic switches to extend a calling line to a called line.

What is claimed is:—

1. In an automatic telephone system, an incoming circuit, outgoing circuits, automatic switching means for extending said incoming circuit to any of said outgoing circuits, a source of direct current, and means including an electron discharge device provided with a control element, an impulse circuit including said control element extending over two sides of said incoming circuit in series, said control element being governed over said impulse circuit by current from said source for directively controlling said automatic switching means.

2. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, a progressively movable automatic switch for interconnecting said incoming circuit with any of said outgoing circuits, a source of direct current, and means including a thermionic device provided with a control element, an impulse circuit including said control element extending over the two sides of said incoming line in series, said control element being governed over said impulse circuit by current from said source for directively controlling the operation of said automatic switch.

3. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic step-by-step switch for interconnecting said incoming circuit with any of said outgoing circuits, a source of direct current, and means including a thermionic device provided with a control element, an impulse circuit including said control element extending over the two sides of said incoming line in series, said control element being governed over said impulse circuit by current from said source for directively governing the operation of said automatic switch.

4. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, automatic switching means for inter-

connecting said incoming circuit with any of said outgoing circuits, a motor magnet for controlling the operation of said automatic switch, a surce of direct current, a multi-electrode thermionic device directively controlled by current from said source over said incoming circuit, and a circuit for said motor magnet including electrodes of said thermionic device.

5. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch for extending said incoming circuit to a wanted outgoing circuit, a motor magnet for advancing said automatic switch, a thermionic device having a plurality of electrodes enclosed within an evacuated space, a third control electrode for said thermionic device, said third electrode being remotely and directively controlled from a distant point, and a circuit of said motor magnet extending across the space between the electrodes within the evacuated space of said thermionic device.

6. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, automatic switching means for extending said incoming circuit to any of said outgoing circuits, a plurality of motor magnets operating in succession, operating circuits for said motor magnets, a thermionic device having a plurality of electrodes within an evacuated space, a control element for said thermionic device arranged to be directively controlled from a remote point, and a relay for closing the circuits of said motor magnets in succession, the operating circuit for one of said motor magnets serially including the winding of said relay and the space between said electrodes.

7. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, automatic switching means for extending said incoming circuit to any of said outgong crcuits, a source of direct current, a thermionic device having two elements enclosed within an evacuated space, means for causing a space current between said electrodes, an additional element for said thermionic device, an impulse circuit in which said element is connected including two sides in series of said incoming circuit, said element being remotely controlled from said source of current, over said impulse circuit to vary said space current, and means including said space current for controlling the operation of said automatic switching means.

8. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, means including switches and a link circuit for extending said incoming circuit to a wanted outgoing circuit, a thermionic device having a filament, a plate and a control electrode for directively controlling the operation of one of said automatic switches, and means controlled by the seizure of said link circuit for automatically lighting said filament.

9. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, means including switches and a link circuit for extending said incoming circuit to a wanted outgoing circuit, a thermionic device having a filament, a plate and a control electrode for directively controlling the operation of one of said automatic switches, means controlled by the seizure of said link circuit for automatically lighting said filament, and means for extinguishing said filament when the link circuit has been extended to the wanted outgoing circuit.

10. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, automatic switching means for extending said incoming circuit to a wanted outgoing circuit, a plurality of motor magnets for said automatic switching means, a source of direct current, a thermionic device having an input circuit including said source and the two sides of said incoming circuit in series for directively controlling in succession said motor magnets.

11. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, a plurality of link circuits, each provided with an automatic switch, a thermionic device at each link circuit for governing the operation of its automatic switch, means including a series of said link circuits and automatic switches for progressively extending said incoming circuit to a wanted outgoing circuit, and means at a remote point for controlling the thermionic device of a selected link circuit and for disabling the thermionic device of the preceeding link circuit in the series.

12. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, two groups of link circuits, each of said link circuits being provided with an automatic switch, thermionic devices associated with certain of said link circuits of each group for controlling said automatic switches, means controlled over the two sides in series of said incoming circuit to actuate a thermionic device whereby a link circuit and its switch in each group cooperate to extend said incoming circuit in a connection to a wanted outgoing circuit, and means controlled over said connection from the last link circuit thereof for releasing said connection.

13. In an automatic telephone system, a telephone line, a plurality of outgoing circuits, a connecting circuit provided with automatic means for extending said connecting circuit to a wanted outgoing circuit over a metallic connection, a thermionic device remotely controlled over two sides of said telephone line in series for directively governing

said connection, and means including a non-numerical switch for extending said telephone line to said connecting circuit.

14. In an automatic telephone system, a series of automatic switches each provided with a thermionic device for governing the same, a control circuit common to said thermionic devices, and means for transferring said control circuit to said thermionic devices in succession.

15. In an automatic telephone system, a calling telephone line, a plurality of other telephone lines each provided with terminals, a source of direct current, automatic switching means including a thermionic device directively controlled over the two sides of said calling telephone line in series from said source for causing said switching means to connect said calling telephone line over a metallic connection to terminals of a wanted telephone line, and means effective subsequent to the operation of said thermionic device for signaling said called telephone line.

16. In a telephone system, an incoming line, a plurality of outgoing lines, an automatic switch for interconnecting said incoming line with any of said outgoing lines, a source of direct current and an impulse sender associated with said incoming line, an electron discharge device provided with an input circuit and an output circuit, means including said source of current and said impulse sender for transmitting impulses of direct current to said input circuit, and means in the output circuit controlled by current impulses in said input circuit for directively operating said automatic switch.

17. In a telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch for interconnecting said incoming circuit with any of said outgoing circuits, an impulse sender associated with said incoming circuit, an electron discharge device including two electrodes enclosed within an evacuated space, a control electrode external to said evacuated space, an output circuit including said first mentioned electrodes, means including said incoming circuit and said control electrode for producing energy variations in said output circuit, and means responsive to said energy variations for directively operating said automatic switch to extend said incoming circuit to an outgoing circuit.

18. In a telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch for extending said incoming circuit to any of said outgoing circuits, an electron discharge device including two electrodes enclosed within an evacuated space and a coil external to said space for controlling the electrical condition between said electrodes, means including said incoming circuit and said coil in series for producing energy variations in said output circuit, and means responsive to said energy variations for directively operating said automatic switch.

19. In a telephone system, a telephone line, a plurality of link circuits each provided with an automatic switch, said link circuits and automatic switches being arranged for connection in tandem to extend said telephone line to any outgoing line, an electron discharge device associated with each link circuit, each electron discharge device being provided with two electrodes included within an evacuated space and a coil surrounding said evacuated space to control the electrical condition between said electrodes, means including said telephone line and the electron discharge device of one of said link circuits for extending said telephone line and said link circuit to a second link circuit, and means including a part of said first mentioned means and the electron discharge device of said last mentioned link circuit for causing the automatic switch of said last mentioned link circuit to extend this last mentioned link circuit to an outgoing telephone line.

20. In a telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch for extending said incoming circuit to any outgoing circuit, an electron discharge device for controlling said automatic switch, said electron discharge device being provided with a pair of electrodes and a controlling electrode, an output circuit including said pair of electrodes, an impulse circuit including said control electrode in series with a control relay and said incoming line, means for generating directive impulses in said impulse circuit for causing energy variations in said output circuit, means responsive to said energy variations for directively operating said switch, a releasing mechanism for said switch, and a slow releasing relay controlled by said control relay for governing the release of said automatic switch.

In witness whereof, I hereunto subscribe my name this 2nd day of March, A. D., 1923.

WINFRED T. POWELL.