

Feb. 9, 1926.

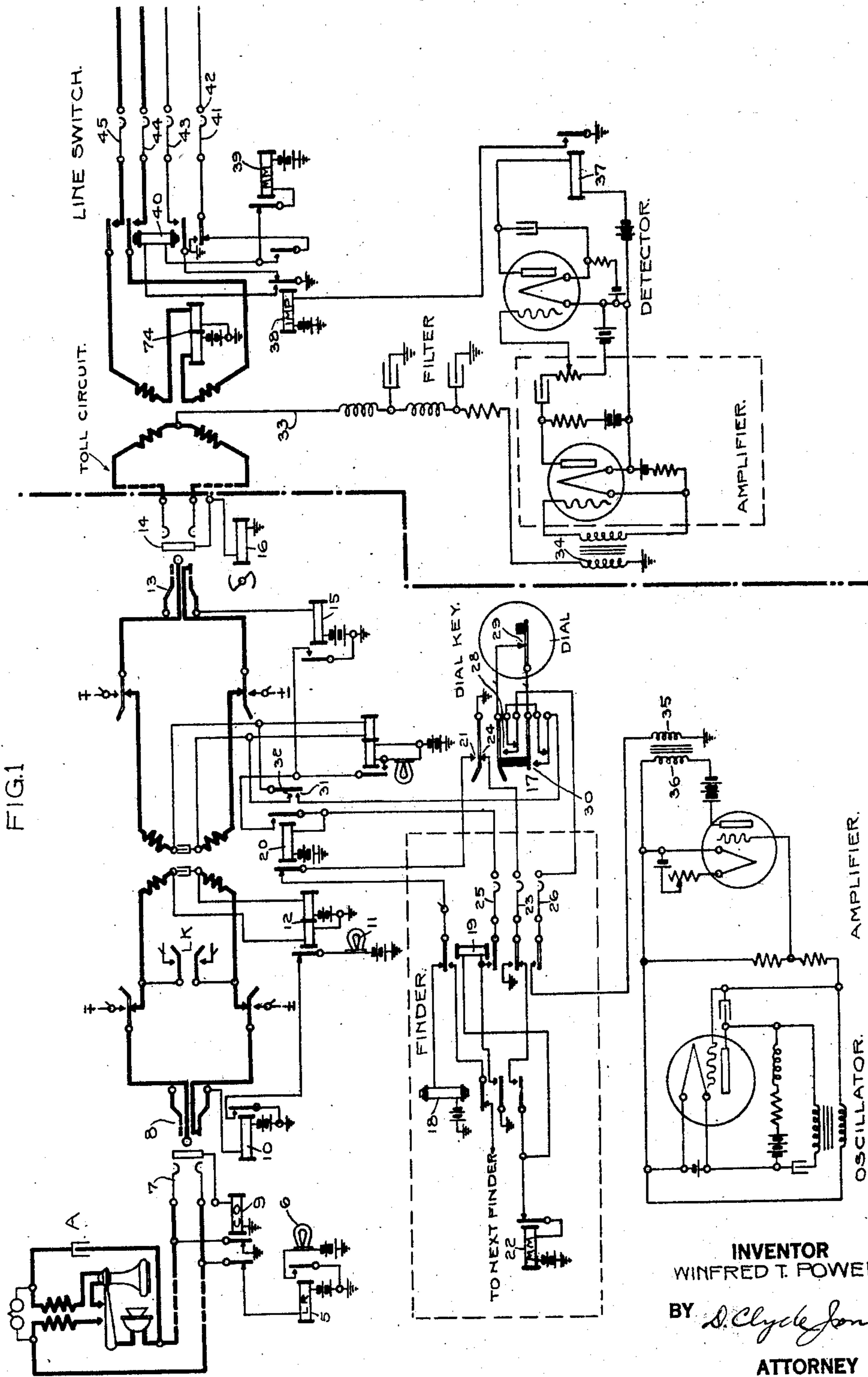
W. T. POWELL

1,572,224

LONG DISTANCE TELEPHONE SYSTEM

Filed April 2, 1921

2 Sheets-Sheet 1



Feb. 9, 1926.

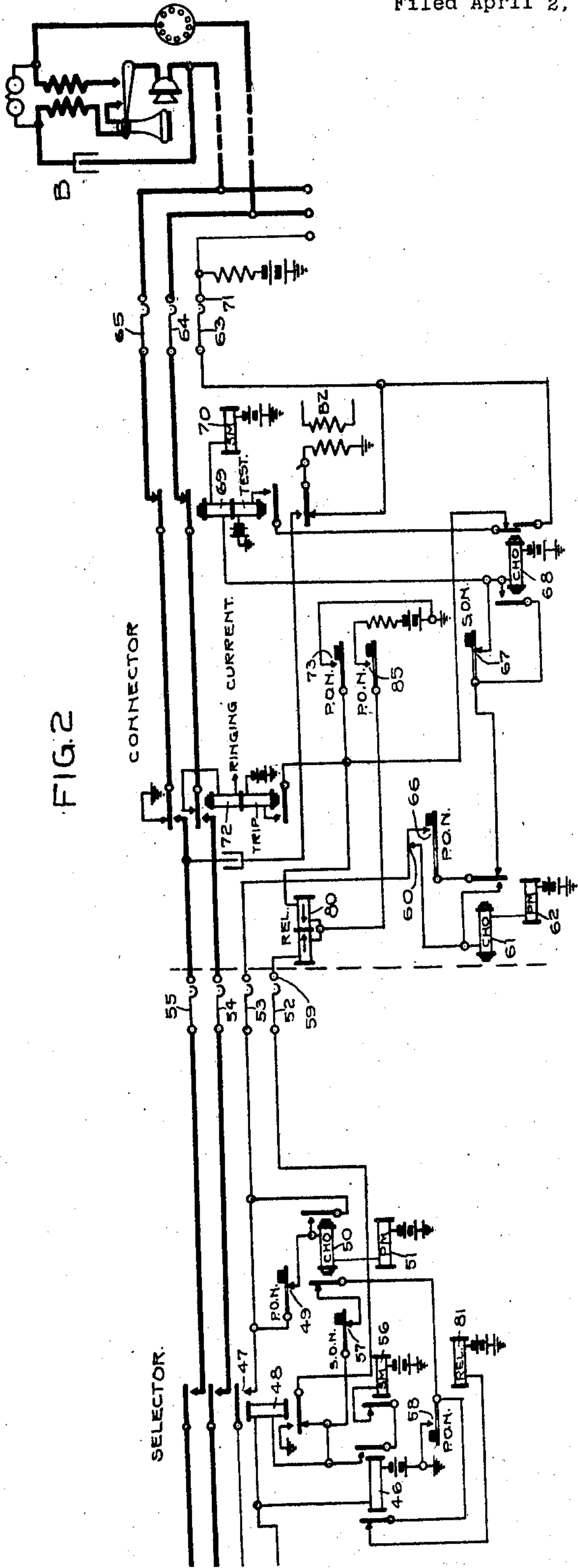
W. T. POWELL

LONG DISTANCE TELEPHONE SYSTEM

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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.

LONG-DISTANCE TELEPHONE SYSTEM.

Application filed April 2, 1921. Serial No. 457,860.

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 Long-Distance 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 for extending telephone calls between widely separated automatic exchanges which are connected by toll or long-distance lines.

The main features of this invention reside in the use of thermionic devices for controlling the setting of the automatic switches.

A further feature of this invention resides in the novel arrangement for establishing toll connections through the use of automatic switches.

Other features of the invention will appear from the detailed description and the appended claims.

The drawings with Fig. 2 placed at the right of Fig. 1 diagrammatically represent a portion of a telephone system including the present invention. The portion of Fig. 1 at the left of the heavy broken line represents the apparatus and circuits located at one office while a portion of the drawing at the right of Fig. 1 as well as all of the circuits of Fig. 2 represent a toll line and the automatic switches and controlling circuits for extending the same which are located at a distant office. At the upper left-hand corner of Fig. 1 there is represented a sub-station and telephone line terminating in the well-known answering jack at an operator's switchboard and associated therewith is a cord circuit terminating at each end in a well-known connecting plug. The toll line terminates in multiple jacks, one of which is shown just at the left of the heavy broken line. In the lower left-hand corner of Fig. 1 there is represented a thermionic device functioning as an oscillator and related therewith is a thermionic device functioning to amplify or magnify the oscillations generated by the oscillator. At the left-hand side of Fig. 1 and enclosed by dotted lines there is shown the operating circuits of a so-called finder switch which functions to

associate an idle oscillator and amplifier with a cord circuit that has been taken for use. At the right of the dotted line and represented by the broken lines of the talking conductors there is indicated a toll line. It will be understood, however, that the portion of these conductors shown as broken lines may be many miles in length. In the lower right-hand corner of Fig. 1 there is represented a thermionic device which functions to magnify or amplify incoming currents, and associated therewith is a second thermionic device referred to as a detector which serves to rectify the incoming current. At the upper right-hand corner of Fig. 1 there is shown a line switch which may be of any well-known type preferably of the rotary type. In Fig. 2 there is shown at the left of the dotted lines the operating circuits of a selector switch while at the right of this dotted line there is indicated the operating circuits of a connector switch and at the upper right hand corner of Fig. 2 there is represented a second telephone line terminating at the distant office.

The line switch may be similar in structure to that disclosed in the patent to Clement 1,107,153 patented August 11, 1914, while the selector switch may be similar in structure to that disclosed in the patent to Keith et al. 815,321 of March 13, 1906 and the connector switch may be similar to that disclosed in the patent to Keith et al. 815,176 patented March 13, 1906.

It is believed that the invention will best be understood by describing the method of establishing a connection from the calling sub-station indicated at "A" to a called sub-station indicated at "B." When the calling subscriber at "A" removes his receiver from its switch-hook, the line relay 5 is operated in the well-known manner to actuate a line lamp 6 associated with an answering jack 7 of the calling line. The operator on noting the lighting of lamp 6, inserts the plug 8 of an idle cord circuit at her position, into jack 7. This operation is effective to close an operating circuit from the cut-off relay 9 to ground, through the sleeves of the jack 7 and plug 8 through the winding of relay 10 to grounded battery. The cut-off relay 9 when operated disconnects the line relay 5 from the calling line and the line relay is

thus deenergized to extinguish the lamp 6. The relay 10 is also energized in the mentioned circuit and at its armature and front contact closes a break-point in the circuit of the answering supervisory lamp 11, but the lamp 11 is not lighted at this time, since the battery feed relay 12 is energized through both sides of the cord circuit and calling line in series. The operator after inserting the plug 8 into the jack 7 depresses her listening key LK to associate her telephone set (not shown) with the calling line and thereby inquires the designation of the wanted line. On receiving this information the operator inserts the calling plug 13 into a multiple jack of a toll circuit over which the called party may be reached. With the sleeve contacts of plug 13 and jack 14 in engagement a circuit is closed for operating the relay 15 and visual signal 16 which indicates that the toll circuit disclosed has been taken for use. The operator then depresses the dial key, generally designated 17. As a result of the depression of this dial key an idle finder switch such as that appearing at the left of Fig. 1 is set into operation by reason of the closure of a circuit from grounded battery, winding of the slow-releasing relay 18, upper back contact and armature of relay 19, left hand contact and armature of relay 20, contact 21 of the dial key to ground. It should be noted at this point that in the system in which applicant's invention is used, several toll operators' positions are provided and each position is equipped with a certain number of cord circuits which may be ten or more in number. In such a layout, only a portion of all the cord circuits of the operators' positions are simultaneously in use so that it results in a saving of equipment to make all of the oscillators and their associated amplifiers common to all the cord circuits. Finder switches are then employed to associate an idle oscillator and its amplifier with a cord circuit taken for use. In this way it is only necessary to provide enough oscillators for the maximum number of simultaneous calls rather than to provide an oscillator for each cord circuit. With relay 18 operated, a circuit is closed for the motor magnet 22 of the finder switch from grounded battery, winding of this magnet, its armature and back contact, lowermost armature and front contact of relay 18, middle armature and back contact of relay 19, finder brush 23 and contacts similar to 24 of other dial keys that are in their normal position, to ground. Under the control of this last described circuit, the motor magnet 22 advances the brushes 23, 25 and 26 of the finder switch until its test brush 23 engages the test terminal connected to the key contact 24 which is now open. The motor magnet 22 therefore stops advancing the finder switch and at this time the relay 19 which has been short-circuited is actuated by an operating circuit from grounded battery, winding of the motor magnet 22, its armature and back contact, winding of relay 19, middle armature and front contact of relay 18 to ground. As soon as relay 19 is operated the relay 20 is actuated in a circuit traceable from grounded battery, winding of the relay 20, holding brush 25, inner armature and front contact of relay 19, middle armature and front contact of relay 18 to ground. Relay 19 when operated closes a locking circuit for itself from grounded battery at the motor magnet 22, winding of relay 19, its innermost front contact and armature holding brush 25, inner armature and front contact of relay 20, front contact and armature of relay 15 to ground. Relay 20 when operated closes a locking circuit for itself and for relay 19 through its inner armature and front contact to ground at the front contact and armature of relay 15. Relay 20 at its outer right hand armature and front contacts short-circuits the condenser appearing between the right-hand windings of the repeating coil and also closes a break-point in the simplex circuit which will presently be described. It will be understood that the dial key 17 is of that type which when once actuated will remain depressed until released. With the dial key depressed and the relays 19 and 20 actuated, a simplex circuit is closed from ground through the winding 35 of the transformer, lowermost front contact and armature of relay 19, finder brush 26, contacts 28 of the dial key, impulse contacts 29 of the dial, contacts 30 of the dial key to the contact 31 of relay 20, and since the contact 32 and outer armature of relay 20 merely short-circuits the condenser on the right-hand side of the operator's cord circuit, it will thus be seen that the secondary winding of the transformer is connected to the mid-point of the balanced circuit including both sides of the calling end of the cord circuit and the two sides of the toll circuit in series. At the distant office a conductor 33 is likewise connected to the mid-point of this balanced circuit and through the filter to the primary winding 34 of a transformer. It will be understood that the filter may be of any well-known type and serves to eliminate certain foreign currents.

The secondary winding 35 of the transformer at the originating office is connected through the primary winding 36 of this transformer to an amplifier interposed between the mentioned primary winding and an oscillator or alternating current-generating device. In this disclosure the current-generating device referred to is an oscillator and may consist of any well-known type of thermionic device with its controlling circuits. Similarly the amplifier is also of

the thermionic type and is arranged to operate in well-known amplifying circuits. It will thus be seen that a source of alternating current of the proper frequency and of desired magnitude is delivered to the simplex circuit connecting the two offices and that the filtering device eliminates certain foreign sources of current, so that alternating current from the oscillator is delivered to the amplifier at the distant office. This amplifier is likewise of the thermionic type and the circuits for controlling the same are now well known in the art. The detector associated with the amplifier at the distant office is also of the thermionic type and its controlling circuits are such as to rectify or translate the incoming alternating current so that it is effective to actuate a direct current receiving relay.

As a result of the operations previously described, the oscillator and its associated amplifying device is connected to the toll circuit and delivers alternating current to the detector at the distant office, and this device thereupon causes the actuation of relay 37 associated therewith. Relay 37 on operation closes a circuit for the impulse relay 38 and this relay is operated to close at its outer armature and front contact an operating circuit for the motor magnet 39 of the line switch individual to this toll circuit. This operating circuit may be traced from grounded battery, winding of the motor magnet 39, its armature and back contact, outer front contact and armature of relay 38, lowermost back contact and armature of relay 40, test brush 41 of the line switch to a multiple test terminal similar to 42 of busy trunks, to a test brush similar to 41 at the line switch that has seized this trunk and through the lower armature and front contact of a relay similar to 40 at this line switch to ground. Under the control of this circuit the motor magnet 39 advances its brushes 41, 43, 44 and 45 until its test brush 41 engages a test terminal such as 42, which is characterized by the absence of potential. The motor magnet 39 will then cease to operate and the switching relay 40 will be energized in a circuit completed from grounded battery, winding of the motor magnet 39, its armature and back contact, winding of the relay 40, innermost front contact and armature of relay 38 to ground. Relay 40 is operated in this circuit, but the motor magnet 39 is inactive. At the lowermost armature and front contact of relay 40 busy or ground potential is applied through the test brush 41 to the test terminal 42 of the selected trunk and a circuit is completed for energizing relays 46 and 48. At the upper armatures and front contacts of relay 40 the toll circuit is connected to the brushes 44 and 45 of the line switch and

through these brushes to the trunk circuit to which they are now connected. The apparatus at the distant office is now in condition to be directionally operated, and the operator at the originating office actuates the dial sender to operate the contacts 29 to transmit series of impulses corresponding to the designation of the wanted number. Each of these series of impulses is generated by the opening of contacts 29 in the simplex circuit a number of times corresponding to the digit transmitted. In response to the opening of contacts 29 a series of impulses of alternating current is transmitted over the simplex circuit to the distant office and there amplified and rectified into a series of impulses to actuate the direct current relay 37. In the arrangement shown, the first series of impulses corresponds to the hundreds digit and in response to each impulse of the series transmitted, the relay 37 is operated and actuates the impulse relay 38 associated with the line switch. In response to the first impulse of this series, the impulse relay 38 retracts its armatures and thereby closes a circuit from ground, its inner armature and back contact, inner lower armature and front contact of relay 40, brush 43 of the line switch, armature and contact 47 of relay 48, primary off-normal contact 49, winding of the change-over relay 50, winding of the primary motor magnet 51 to grounded battery. In response to this first impulse the primary motor magnet advances the brushes 52 to 55 inclusive of the selector switch in the primary direction and this operation is also effective to operate the primary off-normal contacts 49. The remaining impulses of this series are now transmitted to the primary motor magnet over a circuit now traceable from ground, armature and back contact of impulse relay 38, innermost lower armature and front contact of relay 40, line switch brush 43, armature and contact 47 of relay 48, right-hand armature, front contact and winding of the change-over relay 50, winding of the primary motor magnet 51 to grounded battery. In response to each of the impulses received over this circuit, the primary motor magnet continues to advance the brushes of the selector switch in its primary direction. It will be noted that the change-over relay 50 is energized during the remaining impulses of the series to hold open at its left-hand armature and back contact the operating circuit of the secondary motor magnet. At the close of this series of impulses, however, change-over relay 50 retracts its armatures and at its right-hand armature and front contact opens the operating circuit of the primary motor magnet and at its left-hand armature and back contact closes an initial operating circuit for the secondary motor magnet 56. This circuit extends from

grounded battery, winding, back contact and armature of the motor magnet 56 right-hand armature and front contact of relay 46, secondary off-normal contacts 57, back contact and armature of the relay 50, primary off-normal contacts 58 to ground. This circuit is effective to short-circuit relay 48 and to advance the brushes of the selector switch one step in its secondary direction and thereby open the secondary off-normal contacts 57. The brushes of the selector are now in engagement with the first trunk of the selected group. Let it be assumed that this first trunk is engaged, which condition will be indicated by the presence of ground potential on its test terminal such as 59. The secondary motor magnet will then be operated in a circuit extending from grounded battery, its winding, back contact and armature, armature and front contact of relay 46, lower back contact and armature of relay 48, selector test brush 52, test terminal 59 and to a multiple terminal thereof, through a test brush similar to 52 at the selector which has seized this trunk and an armature and front contact of a relay similar to 48 associated therewith to ground. Under the control of circuits similar to this, the relay 48 is short-circuited and the secondary motor magnet continues to advance the brushes of the selector until an idle trunk to a connector switch is located. Let it be assumed that the first idle trunk reached is that shown in Fig. 2. This idle condition will be characterized by the absence of potential on the test terminal 59, so that the switching relay 48 will no longer be short-circuited, but will immediately attract its armatures. The operating circuit of the secondary motor magnet will of course be open at the test terminal 59 so that this magnet will no longer advance the selector switch brushes.

After this seizure of an idle trunk to a desired connector switch has been effected, the operator now transmits a series of impulses corresponding to the tens digit of the wanted number. In response to each of these impulses the relay 37 will retract its armature and this in turn will cause the impulse relay 38 to retract its armatures to close an impulse circuit to the connector switch extending from ground, inner armature and back contact of relay 38, lower inner armature and front contact of relay 40, line switch brush 43, armature and contact 47 of relay 48, brush 53 of the selector switch, contact 60 controlled by the primary off-normal switch, winding of the change-over relay 61 and winding of the primary motor magnet 62 of the connector switch in series to grounded battery. The change-over relay 61 and the primary motor magnet 62 are energized in this circuit. The primary motor magnet advances the brushes 63,

64 and 65 of the connector switch one step in their primary direction. This movement of the selector is also effective to close the primary off-normal switches thereby opening contact 60 and closing contacts 66 so that the remaining impulses of the tens series are received at the change-over relay 61 and the primary motor magnet 62 through the off-normal contacts 66 and armature and front contact of the change-over relay 61. In response to each of the remaining impulses of this series, the primary motor magnet advances the brushes of the connector switch one step and at the close of this series of impulses the change-over relay 61 retracts its armature to open the operating circuit of the primary motor magnet 62 and to extend an impulse circuit through the armature and back contact of the change-over relay 61, secondary off-normal contacts 67, upper winding of the test relay 69, winding of the secondary motor magnet 70 to grounded battery. The test relay is operated in this circuit to remove potential from the connector brushes 64 and 65 to prevent them from disturbing conversations being held on other lines over which the brushes of the connector switch pass. The secondary motor magnet 70 is operated to advance the brushes of the connector switch one step in their secondary direction. It will be noted that the secondary change-over relay is energized in a circuit in multiple of that just described. However, when the secondary off-normal switch is operated, contact 67 will be opened so that the impulse circuit through the secondary motor magnet will now extend through the left-hand armature and front contact of the secondary change-over relay 68. In response to the remaining impulse of the units series, the secondary motor magnet 70 advances the brushes of the connector switch one step.

It will be noted that on the closure of the primary off-normal contacts 73 and 85 after the first primary step of the connector switch, a circuit is closed from grounded battery and resistance through both windings of the release magnet 80, the right-hand winding being connected to ground through contacts 73 and the left-hand winding being connected to ground at the lower front contact and armature of relay 48. This release magnet is differentially wound and when both windings are thus energized it will not operate.

At the close of this series of impulses, if the wanted line is idle this condition will be indicated by the absence of ground potential on its test terminal 71, so that the circuit extending from grounded battery, lower winding of the test relay 69, its front contact and armature and through the armature and continuity spring of the change-over relay 68, and test brush 63, is shunted at the mul-

multiple terminal 71. The test relay 69 will thereupon deenergize to complete a circuit for signalling the wanted party. Ringing current is then applied to the wanted line through the upper winding of the trip relay 72, its inner back contact and armature, inner armature and back contact of relay 69, brush 64 of the connector over the lower side of the wanted line and through the signal at station "B" over the upper side of the wanted line, connector brush 65, back contact and armature of relay 69, armature and back contact of relay 72 to ground. Ringing current is applied over this circuit until the called party responds, at which time the trip relay 72 receives sufficient current to energize. It then attracts its armatures to disconnect ringing current from the wanted line and to close break-points in the talking circuit. The trip relay when actuated is also locked in this condition through a circuit completed from grounded battery, its lower winding, front contact and armature, and primary off-normal contacts 73 to ground.

Talking battery is supplied to the calling party through the windings of the relay 12, and the left-hand windings of the repeating coil of the operator's cord circuit, while talking battery is supplied to the wanted party through the windings of relay 74, and the right-hand windings of the repeating coil shown in the upper right-hand corner of Figure 1. The circuit between the two offices for voice currents is over the two sides of the toll line in series, these currents being induced in the local windings of the repeating coils.

Now let it be assumed that the wanted party is busy at the time when the test brush 63 of the connector switch engages the test terminal 71 of this line. A circuit is then completed from grounded battery, lower winding, front contact and armature of the test relay 69, continuity spring and armature of the secondary change-over relay 68, test brush 63 of the connector, terminal 71 of the wanted line and through a multiple terminal thereof to ground over a test brush similar to 63 and armature and back contact of a relay similar to 69 of the connector switch which has previously seized the wanted line. As a result of the closure of this circuit the test relay 69 will be held operated and when the secondary change-over relay deenergizes at the close of the series of impulses, the test relay will then be locked operated in a circuit completed from grounded battery, its winding, front contact and armature, continuity spring and back contact of relay 68, and primary off-normal contact 73 to ground. With the test relay at 69 locked operated, the ringing circuit is open at the armatures and back contacts of relay 69 so that the wanted party will not be

rung at this time. Through the lowermost armature and front contact of relay 69, a source of busy tone is applied from the source BZ to the calling line to indicate that the wanted line is busy.

The circuit for holding the connection is over the two sides of the toll line in parallel, the current in this circuit being generated and amplified by the oscillator and amplifier at the originating office. When the calling party terminates the call, relay 12 deenergizes and lights the answering supervisory lamp 11 to indicate to the operator that the connection may be disestablished. The operator thereupon removes the answering plug 8 from the jack 7 of the calling line and also removes the calling plug 13 from the jack of the toll circuit. The removal of the calling plug disconnects the holding current from the toll circuit which permits the relays 37, 38, 40, 46 and 48 to release. The release of the relay 48 removes ground from the left-hand winding of the differential release magnet 80, thereby energizing this magnet to effect the release of the connector switch. The deenergization of the relay 46 closes an operating circuit for the release magnet 81 of the selector switch traceable from grounded battery, winding of this magnet, back contact and armature of relay 46, and primary off-normal contacts 58 to ground. Under the control of this circuit the release magnet 81 restores the selector switch to its normal position. The line switch is of that type which remains in engagement with the terminals of the trunk last used, and to effect its release it is only necessary to disconnect its brushes 44 and 45 from the toll circuit and this is effected by the mentioned deenergization of the relay 40. The apparatus is now in position for use on a succeeding call.

It will thus be seen that an arrangement is provided whereby thermionic devices may be employed to control automatic switches as well as other arrangements which function to establish automatic toll connections under the control of thermionic devices.

I claim:

1. In a telephone system in combination with a conversational circuit having two conductors, means for transmitting impulses over said conductors in parallel, an electron discharge device having an input and an output circuit, said input circuit being connected electrically to said conductors to receive impulses thereover, and electromagnetic mechanism operated under control of said output circuit.

2. In a telephone system in combination with a circuit having two sides, means for transmitting impulses over two sides of said circuit in parallel, an electron discharge device having an input circuit and an output circuit provided with a source of energy,

said input circuit being electrically connected to said first mentioned circuit and functioning to cause energy variations in said output circuit in accordance with impulses received from said first mentioned circuit, an electromagnetic mechanism operating under the control of energy variations in said output circuit, and releasing means for said mechanism also controlled by said output circuit.

3. In automatic connecting circuits and apparatus for a telephone system, the combination with a plurality of electromagnetically controlled connecting means responding to relatively short current changes and electromagnetic control or shifting means for the circuit of the connecting means responding to relatively long current changes, of an electron discharge device provided with an input circuit having a control element and provided with an output circuit including a source of energy variably controlled by said control element, means for transmitting long and short impulses to said controlling element for producing and applying long and short energy variations to said connecting means and to said magnetic control or shifting means.

4. In an automatic telephone system, an incoming circuit, a plurality of telephone lines, means including link circuits and automatic switches for extending said incoming circuit to a wanted telephone line, operating means including an electron discharge device controlled over said incoming circuit for operating said automatic switches to complete such connection, releasing mechanism for each of said automatic switches, a release circuit having branches for controlling the release of each of the said automatic switches, said electron discharge device being provided with an input circuit and an output circuit, means including said incoming circuit and link circuits for causing said input circuit to govern said output circuit, and means including said output circuit for governing said release circuit.

5. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, a progressively movable switching mechanism for interconnecting said incoming circuit with any of said outgoing circuits, said switching mechanism including a normally inoperative motor magnet and a circuit therefor, an electron discharge device including an electron emitter, an output electrode and a control electrode, an input circuit including said control electrode, an output circuit including said electron emitter and said output electrode, a source of controlling impulses at a distant point connectable to said input circuit for varying the effect of said control electrode, said control electrode functioning to vary the energy in said output circuit in response to said im-

pulses, two relays having different time constants which control said motor magnet circuit, the slow relay acting to place said circuit in condition to receive energy variations and the more rapidly acting relay operating to repeat energy variations in said output circuit to the circuit of said motor magnet.

6. In a telephone system in combination with an incoming circuit, an automatic switch connected thereto, said automatic switch being provided with contacts divided into groups and a cooperating moving contact, a primary magnet and associated means for stepping said moving contact to a desired group of contacts, a secondary magnet and associated means for moving said contact to a desired contact in that group, quick and sluggish relays for controlling said magnets, an electron discharge device having an input circuit and an output circuit, a source of directive impulses connectible to said input circuit through said incoming circuit for causing energy variations in said output circuit, and means for energizing and deenergizing said relays in response to variations of energy in the output circuit of said electron discharge device to operate said primary and secondary magnets and thereby effect desired movements of said moving contact.

7. In a telephone exchange system, an incoming circuit, an automatic switch associated therewith, said automatic switch having waiting contacts divided into groups and a cooperating movable contact, means outside of said switch for rendering some of said waiting contacts busy, an electron discharge device provided with an output circuit having a source of energy therein and provided with an input circuit having a controlling element for causing energy variations in said output circuit, means for advancing said movable contact to a desired group of waiting contacts in response to energy variations in said output circuit, means for starting said movable contact in search of an idle contact in that group, and means for continuing the movement of said movable contact in such search and stopping it when an idle contact is reached.

8. In an automatic telephone system, an incoming circuit, an automatic switch associated therewith, said automatic switch being provided with waiting contacts divided into groups and a cooperating movable contact, a primary magnet and associated means for stepping said movable contact to a desired group of said contacts, a secondary magnet and associated means for stepping said movable contact to a desired contact in that group, a sluggish relay for controlling the operating circuit of said secondary magnet, a quick acting relay for controlling said primary magnet and said

sluggish relay, an electron discharge device provided with an input circuit having a control element and provided with an output circuit having a source of energy variably controlled by said control element, a source of impulses at a distant point, and means for transmitting said impulses to said input circuit to govern said control electrode, the energy variations in said output circuit serving to energize and deenergize said quick acting relay to operate said primary magnet and to energize and maintain said sluggish relay energized during said operation and then to deenergize said sluggish relay and operate said secondary magnet.

9. In a telephone system, an originating office, a terminating office, terminating lines at each of said offices, a toll circuit connecting said offices, means to connect a calling line to the toll circuit, a plurality of sources of oscillating current at the originating office arranged to be connected individually to said toll circuit, an automatic switch for extending said toll circuit to a wanted telephone line, and means including a thermionic receiving device responsive to said oscillating current for controlling the setting of said automatic switch.

10. 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, a plurality of electron discharge devices for generating oscillating current, automatic means for associating an idle electron discharge device with said incoming circuit when it is taken for use, and means for varying the current from said device in accordance with a predetermined code to selectively actuate said automatic switch and

thereby cause it to seize a desired outgoing circuit.

11. In a telephone system, an incoming circuit, a plurality of outgoing circuits, means including an automatic switch for interconnecting said incoming circuit with a desired outgoing circuit, means including electron discharge devices for generating oscillating current, means including a non-numerical switch for connecting an idle electron discharge device to said incoming circuit to introduce oscillating current therein, means for varying the oscillating current in said incoming circuit in accordance with a predetermined code, and mechanism including a receiving electron discharge device located at a distant point for receiving said current variations to control directly the setting of said automatic switch and thereby effect the interconnection of said incoming circuit with a desired outgoing circuit.

12. In a telephone system comprising subscribers' lines, means including automatic switches for extending said lines for conversation, an electron discharge device for controlling the operation of said automatic switches, said electron discharge device including a control electrode for governing its operation, a plurality of operators' positions, and means including an impulse sending device at each position whereby the operator at any one of a plurality of positions may individually and variably control the operation of said control electrode.

In witness whereof, I hereunto subscribe my name this 30th day of March A. D. 1921.

WINFRED T. POWELL.