April 6, 1926.

1,579,837

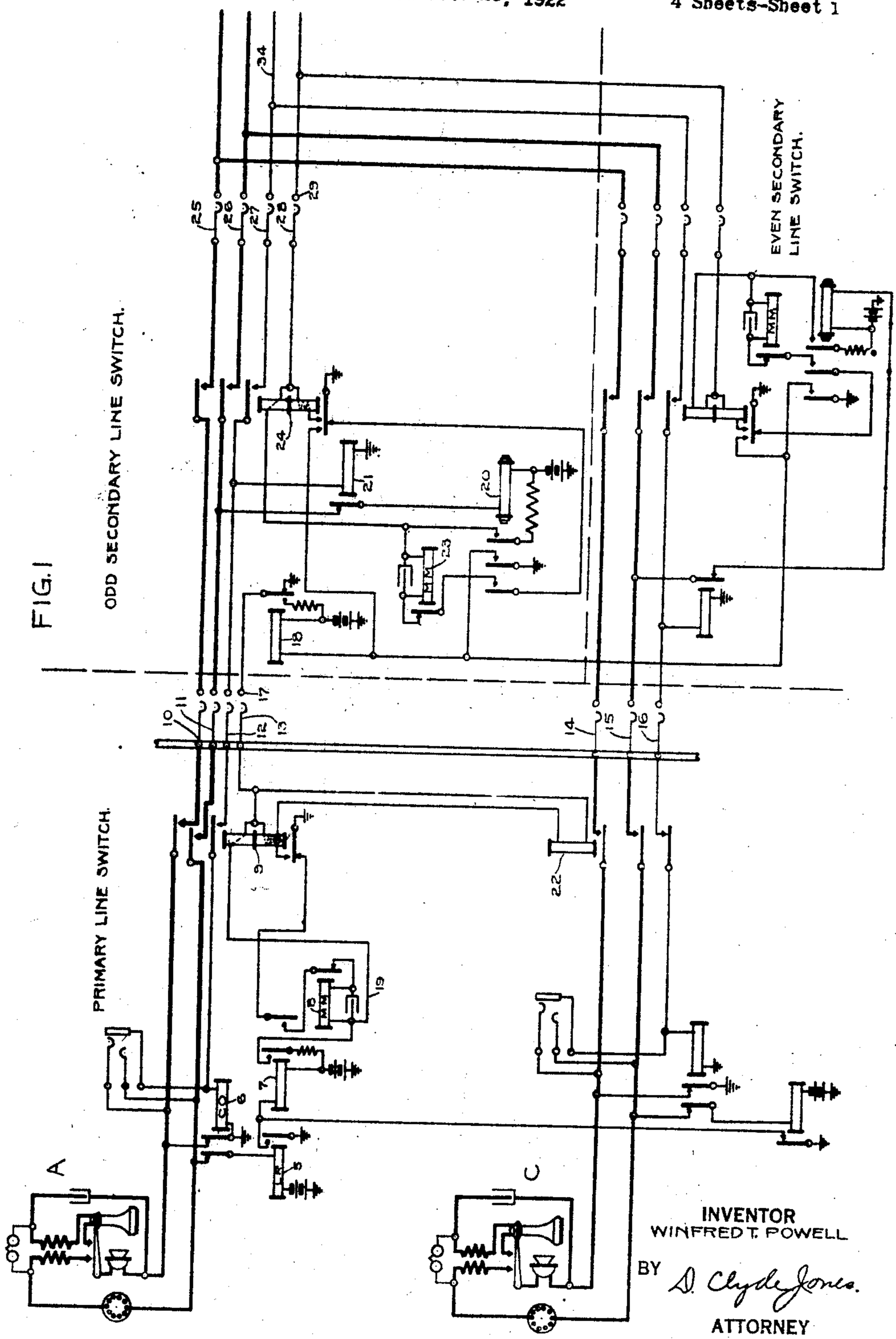
W. T. POWELL

AUTOMATIC TELEPHONE SYSTEM

Filed Oct. 23, 1922

4 Sheets-Sheet 1

FIG. 1



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4 Sheets-Sheet 2

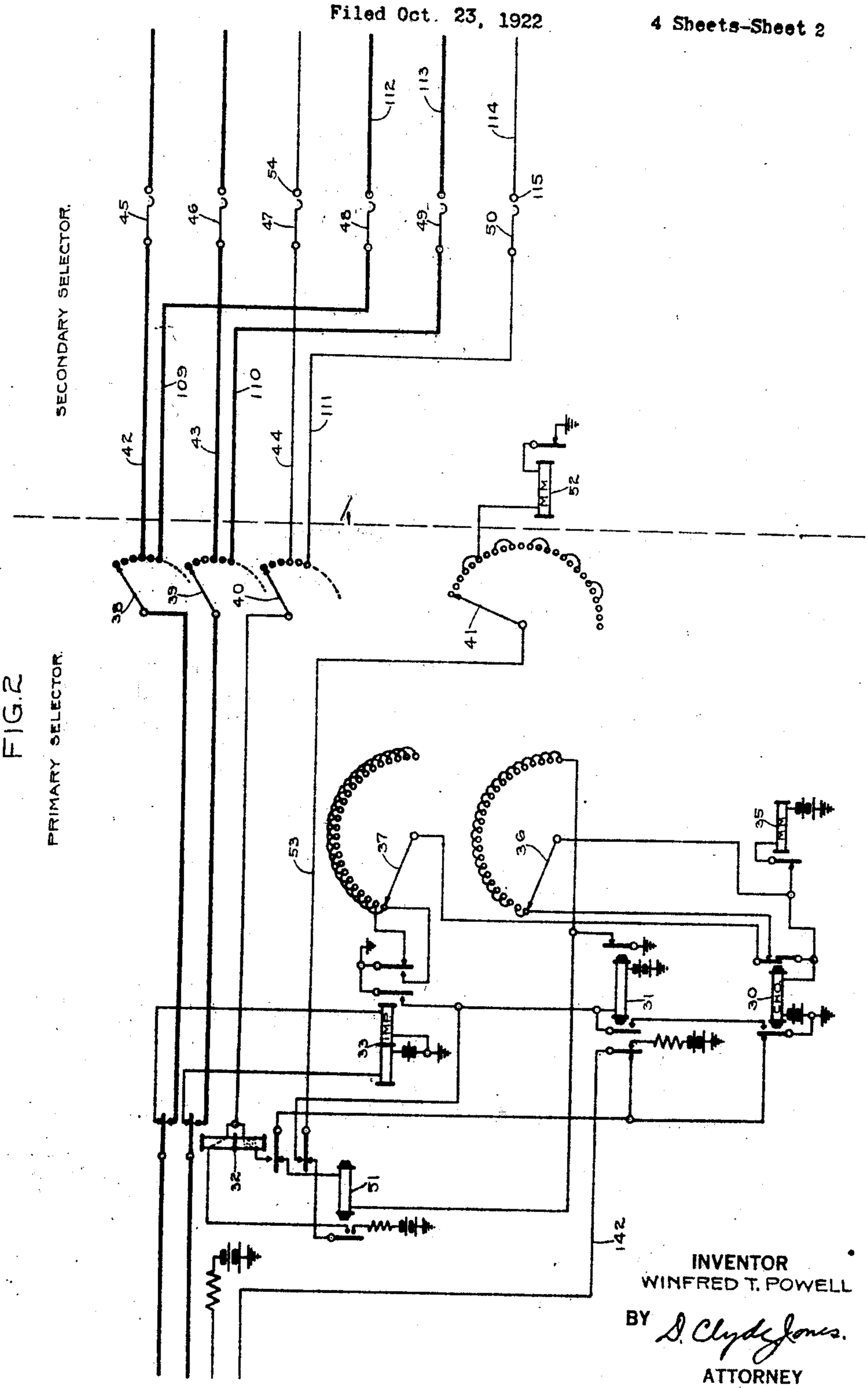

FIG.2

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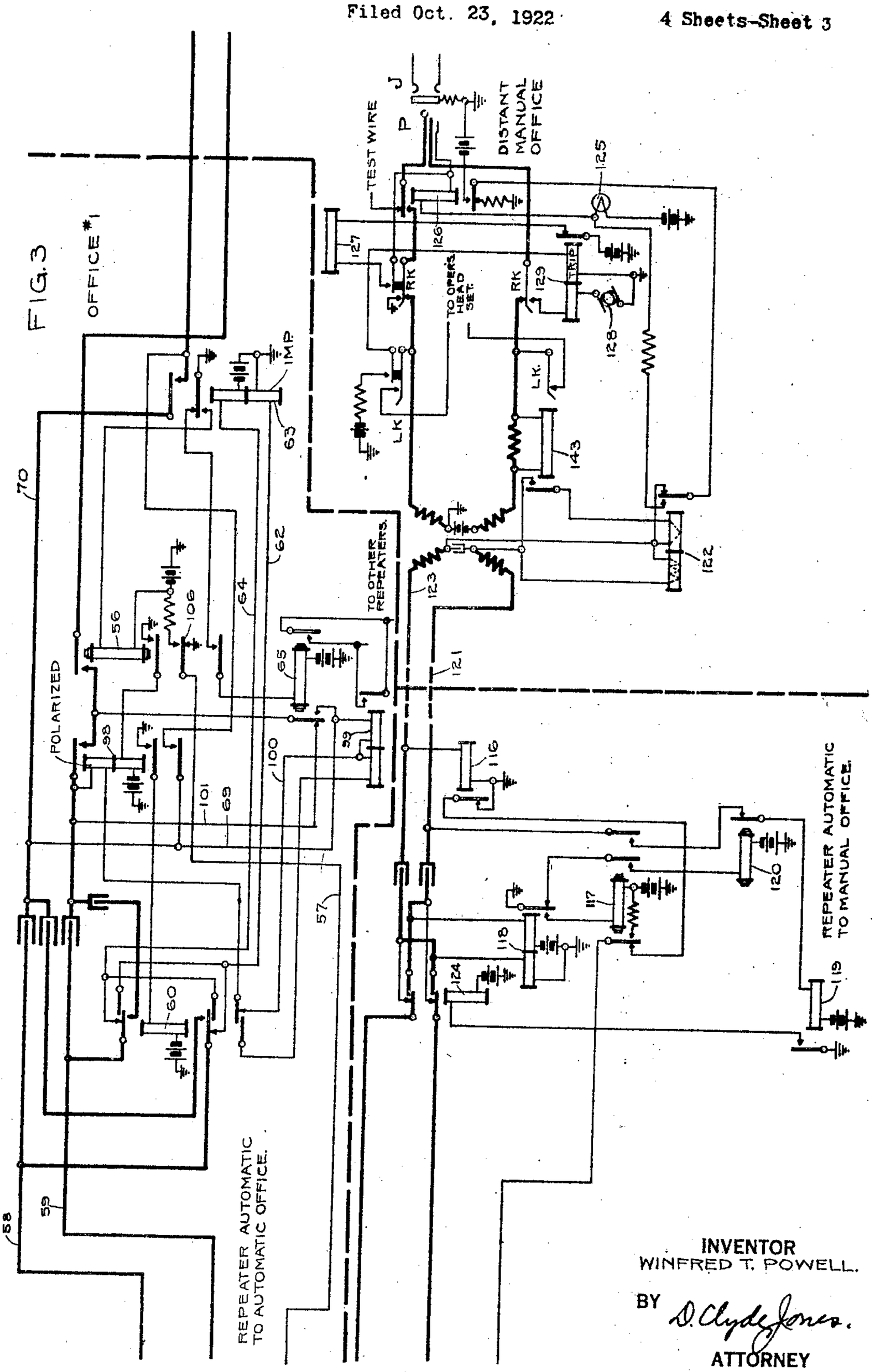
4 Sheets-Sheet 3

FIG. 3



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AUTOMATIC TELEPHONE SYSTEM

Filed Oct. 23, 1922 4 Sheets-Sheet 4

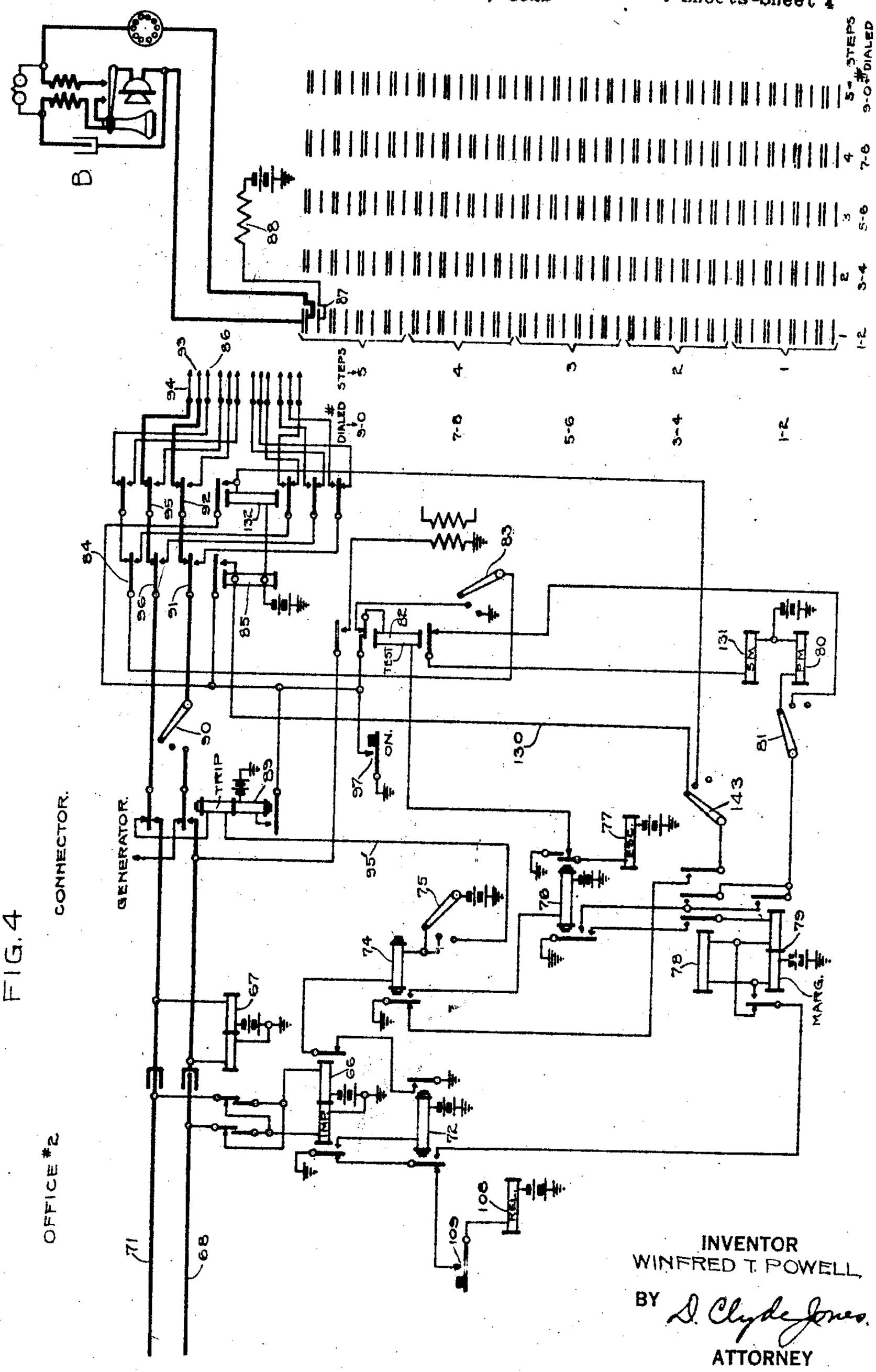

FIG. 4

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Patented Apr. 6, 1926. 1,579,837

UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

Application filed October 23, 1922. Serial No. 596,280.

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.

In manual telephone systems, it becomes desirable, either from commercial or operating reasons to replace certain portions of the manual equipment by automatic switches while still retaining certain of the offices of the system on a manual basis of operation. Even those offices in which automatic switches are installed, it is somtimes desirable to retain the manual line equipment such as the line and cut-off relays, to cooperate with the relays of the automatic switches.

One of the features of the present invention is the novel arrangement by which automatic offices and manual offices of a telephone exchange are arranged to cooperate.

Another feature of the invention is the novel arrangement by which the numerically directed switches of the system may be selectively operated.

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

The drawings with Figs. 1, 2, 3, and 4 arranged in the order named diagrammatically represent a portion of a telephone system including the above mentioned features. At the left of the dotted line in Fig. 1 there are represented substations and lines of two subscribers which lines terminate in the brushes of a non-numerical line switch. It will be seen that the line and cut-off relays as well as the calling jacks of the lines of sub-station A and C is equipment which has been retained from the time when these lines were used in a manual office. At the right of the dotted line of Fig. 1 there is represented an odd secondary line switch and an even secondary line switch. At the left of Fig. 2 there is represented the operating circuits of a primary numerical selector switch, while at the right of the dotted line of Fig. 2 there is shown a secondary selector switch which is entirely non-numerical in operation. Above the dotted line of Fig. 3 there is diagrammatically shown a so-called repeater arrangement for repeating impulses from a dial sender, such as that at substation A to a distant automatic office such as shown in Fig. 4. In the lower left hand corner of Fig. 3 there is shown a so-called repeater arrangement, which cooperates in extending a telephone connection from an automatic telephone line such as that leading from substation A to a telephone line terminating at a distant manual office, such as that represented in the lower right hand corner of Fig. 3. Fig. 4 diagrammatically discloses the operating circuits of a so-called connector switch as well as one of the lines and its sub-station B which terminates in this switch.

The line switches of this disclosure as well as the primary and secondary selector switches may be of the type substantially similar to that disclosed in the patent to Clement No. 1,107,153, granted August 11, 1914. The connector switch may be of the type somewhat similar to that disclosed in the patent to Keith, Erickson & Erickson No. 815,176, granted March 13, 1906. The present connector switch differs from that disclosed in the mentioned patent by being arranged to operate in a so-called two-wire system, also the terminals of the connector bank instead of being arranged in ten levels with ten sets of contacts in each level are modified by being arranged in twenty levels with five sets of contacts in each level. Also the switch, instead of being provided with a single set of three brushes, is provided with four sets of brushes with three brushes in each set.

It is believed that the invention will best be understood by describing the method of establishing a telephone connection from a substation such as A to a wanted subscriber at a distant automatic office and by describing subsequently a connection to a subscriber at a distant manual office.

When the subscriber at A removes his receiver from its switch hook a circuit is completed for the line relay 5 from grounded battery, winding of this relay, armature and back contact of the cut-off relay 6, over the lower side of the calling

line and substation circuits in series, over the upper side of the calling line, inner back contact and armature of relay 6 to ground. The line relay 5 is energized in this circuit and completes an operating circuit for the relay 7 from grounded battery, winding of this relay, contact and armature of relay 5, to ground. The relay 7 on operation closes an actuating circuit for the motor magnet 8 traceable from grounded battery, resistance, inner armature and front contact of relay 7, winding, back contact and armature of motor magnet 8, outer front contact and armature of relay 7, lower back contact and armature of switching relay 9 to ground. Under the control of this circuit the motor magnet of the primary line switch advances its brushes 10, 11, 12, 13, 14, 15, and 16 until a pair of idle primary trunks is located, which condition is indicated by the presence of ground potential on a test terminal such as 17 individual to such pair of trunks. When such an idle test terminal is located, a circuit is closed from ground at the armature and back contact of relay 18, test terminal 17, test brush 13, low resistance winding of relay 9, conductor 19, inner front contact and armature of relay 7, resistance, to grounded battery. It will be noted that the motor magnet 8 is short circuited by the completion of this circuit while the relay 9 is operated to extend the calling line through its upper armatures and front contacts and the brushes 10 and 11 of the primary line switch to the selected primary trunk. The slow releasing relay 20 of the odd secondary line switch thus has a circuit closed from grounded battery, winding of this relay armature and back contact of relay 21, over the lower side of the selected trunk, brush 11, over the lower side of the calling line and substation circuits in series, over the upper side of the calling line to ground at the inner back contact and armature of relay 6. Relay 20 when thus energized completes an operating circuit for the motor magnet 23 of the odd secondary line switch, traceable from grounded battery, resistance, innermost armature and front contact of relay 20, winding, back contact and armature of motor magnet 23, outermost front contact and armature of relay 20, lower back contact and armature of relay 24 to ground. Under the control of this circuit, the motor magnet 23 advances the brushes 25, 26, 27, and 28 of the odd secondary line switch until the test terminal of an idle secondary trunk is located, which condition is indicated by the presence of ground potential thereon.

Let it be assumed that the first idle secondary trunk tested is that appearing in Figs. 1 and 2. Under this assumption a circuit is closed from ground at the armature and back contact of relay 30, outer back contact and armature of relay 31, conductor 142, test terminal 29, test brush 28, low resistance winding of relay 24, inner front contact and the armature of relay 20 to grounded battery. This short circuits the motor magnet 23 to stop the brushes 25 to 28 inclusive of the odd secondary line switch in engagement with the terminals of the idle trunk. This circuit also effects the energization of the switching relay 24, which relay at its upper armatures and front contacts extends the calling line to the brushes 25 and 26 of the secondary line switch and through the upper armatures and back contacts of relay 32 Fig. 2 to grounded battery and ground respectively through the windings of impulse relay 33. Relay 33 thereupon operates and closes a circuit from ground at its inner armature and front contact for actuating slow releasing relay 31, and this last mentioned relay at its outer armature and front contact closes a holding circuit from grounded battery, resistance, conductor 142, test terminal 29, test brush 28, high-resistance winding, front contact and armature of relay 24 to ground. The seizure of the odd secondary trunk as well as the energizing of the switching relay 24 completes an operating circuit for the relay 21 from ground, winding of this relay, inner upper armature and front contact of relay 24, brush 27, conductor 34, resistance to grounded battery. At this time the cut-off relay 6 is also energized in multiple with this last described circuit through the inner upper armature and front contact of relay 9 and primary line switch brush 12.

Let it be assumed that the wanted line, designated "#102" terminates at a distant automatic office, under which assumption the calling subscriber operates his dial sender to transmit impulses by which the primary selector is advanced to select an outgoing trunk over which the wanted automatic line may be reached. When the impulse relay 33 is thus energized on the seizure of its trunk circuit, the motor magnet 35 of the primary selector is operated from grounded battery, winding, armature and back contact of this magnet, brush 36 of the primary selector in its first position, back contact and continuity spring of relay 30, primary selector brush 37, outer front contact and armature of impulse relay 33 to ground. The motor magnet 35 on energization interrupts its own circuit and advances the brushes 36, 37, 38, 39, 40, and 41 of the primary selector one step. The primary selector is now in readiness to receive the first series of directive impulses from the dial sender at sub-station A. In response to each of these dial interruptions the impulse relay 33 retracts and attracts its armatures. On the first retraction of its armature a circuit is closed from ground, outer armature

and back contact of impulse relay 33, selector brush 37 in its second position, continuity spring and back contact of change-over relay 30, selector brush 36, back contact, armature and winding of motor magnet 35 to grounded battery. The motor magnet is thus operated to advance the brushes of the primary selector into their third position. The change-over relay 30 energizes in multiple with the last-described circuit and on the attraction of its armatures closes a locking circuit for itself through its armature and continuity spring, selector brush 37, back contact and armature of relay 33 to ground. With the selector in its third position, a circuit is closed from ground, outer armature and front contact of impulse relay 33, brush 37, continuity spring and armature of relay 30, back contact, armature and winding of motor magnet 35 to grounded battery. The motor magnet 35 is thus again energized and advances the primary selector brushes into their fourth position where it is in readiness to be operated in response to the next interruption of this series. It will be noted that in response to each dial interruption the primary selector advances its brushes two steps.

Let it be assumed that the primary selector brushes 38, 39 and 40 have been advanced to the terminals of conductors 42, 43, and 44 of a trunk leading to the brushes 45, 46, and 47 of the secondary selector of Fig. 2.

At the close of the first series of interruptions, impulse relay 33 holds its armatures attracted for a long enough period to permit the change-over relay 30 to deenergize, whereupon the relay 51 is actuated in a circuit closed from ground at the armature and back contact of relay 30, inner lower armature and back contact of relay 32, winding of relay 51, primary selector brush 36, back contact, armature and winding of the motor magnet 35 to grounded battery. This motor magnet is marginal and will not operate in series with relay 51, but this last named relay is energized to complete a circuit from grounded battery, resistance, front contact and armature of relay 51, lowermost back contact and armature of relay 32, conductor 53, primary selector brush 41, winding armature, and back contact of the motor magnet 52 to ground. Under the control of this circuit the motor magnet 52 of the secondary selector advances its brushes 45 to 50 inclusive to locate an idle trunk in the group selected by the primary selector. The motor magnet 52 continues to operate until the test brush 47 encounters an idle test terminal such as 54 which is characterized by the presence of ground potential to indicate its idle condition.

Let it be assumed that the first idle trunk located is that shown in the upper right hand corner of Fig. 2 and in the upper portion of Fig. 3. When this trunk is tested, a circuit is closed from ground, back contact and armature 106 of relay 56, conductor 57, test terminal 54, test brush 47, conductor 44, test brush 40, low resistance winding of relay 32, front contacts and armature of relay 51, resistance to grounded battery. This circuit is effective to short circuit the motor magnet 52, to stop the operation of the secondary selector, and it is also effective to actuate the relay 32 whereupon the calling line is extended through the primary selector brushes 38 and 39 and the secondary selector brushes 45 and 46 to the conductors 58 and 59. Conductor 58 is then extended through the inner continuity spring and back contact of relay 60, conductor 62, lower winding of the impulse relay 63 to ground. Conductor 59 is extended through the upper continuity spring and back contact of relay 60, conductor 64, upper winding of the impulse relay 63 to grounded battery. The impulse relay is thus energized to attract its armatures and at its inner armature and front contact extends a circuit from ground, through the winding of slow releasing relay 56 to grounded battery. The relay 56 is thus operated and closes a holding circuit for relay 32 from grounded battery, resistance, front contact and armature 106, conductor 57, test terminal 54, test brush 47, conductor 44, primary selector test brush 40, high resistance winding, front contact and armature of the switching relay 32, back contact and armature of change-over relay 30 to ground.

The subscriber at A thereupon transmits a second series of dial interruptions corresponding to the second digit of the wanted number. The repeater circuit shown in the upper portion of Fig. 3 located in the first office, operates to repeat this series of interruptions to the numerical switches located at a second office. For purposes of this description, a single numerical switch which is a connector, has been shown, but it will be understood that one or more of the so-called selectors of the well-known type may be interposed between the repeater and the connector switch of Fig. 4. It will also be understood that other types of connector switches instead of that of Fig. 4 will cooperate with the remainder of the system.

In response to each of the interruptions of the second series transmitted from the dial sender at substation A, the impulse relay 63 vibrates its armatures and on the first retraction of its armature a circuit is closed from ground, its inner armature and back contact, lowermost front contact and armature of relay 56, winding of relay 65 to grounded battery, which causes the relay 65 to attract its armatures. With the relay 65 energized and when impulse relay 63 attracts its armatures in response to

each impulse, the impulse relay 66 of Fig. 4 is energized in a circuit traceable from grounded battery, right hand winding of relay 66, outer back contact and continuity spring of relay 67, conductor 68, armature and front contact of relay 56, left hand armature and front contact of relay 65, conductors 69 and 70, uppermost armature and front contact of relay 63, conductor 71, innermost continuity spring and back contact of relay 67, left hand winding of relay 66 to ground. On the first energization of relay 66, slow releasing relay 72 is operated in a circuit closed at the left hand front contact and armature of the relay 66.

In response to the first interruption of the tens series, relay 66 retracts its armatures, whereupon a circuit is completed from ground at the armature and front contact of relay 72, right hand back contact and armature of relay 66, winding of relay 74, side switch wiper 75 to grounded battery. The relay 74 is thus actuated and effects the operation of slow releasing relays 76, and this relay in turn operates the escape magnet 77. At the left hand armature and back contact of relay 66, a circuit is closed from ground through the left hand armature and front contact of relay 72, left hand armature and back contact of relay 79, winding of relay 78, left hand winding of marginal relay 79 to grounded battery. The relay 78 is operated in this circuit but marginal relay 79 is not operated at this time. As soon as relay 78 attracts its armatures it completes an energizing circuit for the primary motor magnet 80 from grounded battery, winding of this magnet, side switch wiper 81, in its first position, middle armature and front contact of relay 78, front contact and armature of relay 76 to ground.

The energization of relay 78 also closes a second circuit from grounded battery, left hand winding of relay 79, winding of relay 78, right hand winding of relay 79, innermost armature and front contact of relay 78, front contact and armature of relay 76 to ground. The right hand winding of relay 79 is short circuited by ground at the left hand armature and back contact of relay 66, until this relay is energized. At the close of this line interruption when impulse relay 66 removes this short circuit, relay 78 is held operated and the relay 79 is operated in the circuit last described. If this series of interruptions consists of only one interruption, the impulse relay 66 is now held operated for a relatively long interval to effect the deenergization of relays 74 and 76. In the interval, however, between the deenergization of relays 74 and 76 the relay 85 is operated from grounded battery, its winding, conductor 130, side switch wiper 143, outermost armature and front contact of relay 78, back contact and armature of relay 74 to ground. Relay 85 on operation closes a locking circuit for itself through its innermost front contact and armature to ground at the off-normal contacts 97. The release of relay 76 causes the escape magnet 77 to move the side-switch wipers into their second position, whereupon the units series of dial interruptions is transmitted to operate the secondary motor magnet 131.

If, however, the tens series of interruptions contains two interruptions, at the close of the first interruption of the series, the relays 78 and 79 are both energized. In response to the second interruption of this series a circuit is closed from ground at the left hand armature and back contact of relay 66, armature and front contact of relay 72, left hand armature, front contact and winding of relay 79 to grounded battery. The relay 79 is held operated in this circuit, but the relay 78 is short circuited and releases its armatures. It will be noted, however, that the operating circuit of the primary motor magnet 80 is at this time closed through the right hand armature and front contact of relay 79. At the close of the second interruption of this series, the impulse relay 66 is again operated, and opens the locking circuit just described for the relay 79. If these are the only two interruptions in the series, relays 74 and 76 deenergize as a result of the repeated operation of relay 66 in the manner already described. In this instance, however, no operating circuit is completed for the relay 85, due to the fact that the outermost armature and front contact of the relay 78 is opened.

From the foregoing explanation, it will be understood that in response to one interruption the primary motor magnet advances the connector switch brush one step. It also operates the switching relay 85 to extend the conductors 71 and 68 of the trunk to a particular set of connector switch brushes. Likewise in the case of a series of two interruptions, the primary motor magnet 80 is operated only once but at this time the switching relay 85 is not actuated so that a different set of connector switch brushes is effective. From this it will be understood that the connector switch is operated one step for each odd interruption, or for each pair of odd and even interruptions. In the case of the odd interruptions, however, a relay such as 85 distinguishes between odd and even interruptions to render effective one or another set of connector brushes. In the present instance it has been assumed that the wanted number is "102", therefore the tens series of interruptions are ten in number as a result of which the primary motor magnet 80 is operated in the manner already described to elevate the connector switch brush five vertical steps. In response to the units

series of interruptions the impulse relay 66 is energized and deenergized twice with the result that the secondary motor magnet 131 rotates the connector switch brushes one step in their secondary movement. In this instance the relay 132 is not operated due to the fact that the units series of interruptions is even in number.

At the close of this last series of interruptions the change-over relay 76 deenergizes at which time the test of the called line is made, which test is effected in a circuit completed from grounded battery, winding of the escape magnet 77, continuity spring and back contact of relay 76, winding of test relay 82, its continuity spring and back contact, side switch wiper 83 in its second position, armature 84 and back contact of relay 85, uppermost armature and back contact of relay 132, test brush 86, test terminal 87. If the wanted line is idle, its test terminal is characterized by full battery potential applied through the resistance 88, which causes the escape magnet 77 to deenergize to advance the side switch wipers into their third position. The called party is now signalled by ringing current applied from the ringing generator through the inner back contact and armature of trip relay 89, side switch wiper 90 in its third position, armature 91 and back contact, back contact and armature 92, connector brush 93, over the lower side of the wanted line and through the bell at the wanted sub-station, over the upper side of the wanted line, connector brush 94, armature 95 and back contact, back contact and armature 96 of relay 85, armature and back contact of trip relay 89, upper winding of relay 89, conductor 95′, side switch wiper 75 to grounded battery. Signalling current is applied over this circuit until the subscriber at substation B responds by removing his receiver from its switch hook, at which time the trip relay 89 is energized to complete a locking circuit for itself through its lower winding, front contact and armature, off normal contacts 97 to ground. The trip relay on energization also closes a break-point in the talking circuit.

When the called party answers, talking battery is supplied through the winding of relay 67, causing this relay to energize with the result that the current is reversed in conductors 68 and 71 to cause the operation of the polarized relay 98 of Fig. 3. It will be remembered that a circuit is closed through the lower winding of polarized relay 98, as soon as relay 56 is operated and when the current is reversed in conductors 71 and 68, the upper winding of relay 98 is energized in such a manner as to cooperate with the lower winding as a result of which the armatures of this relay are attracted. The energizing circuit of the upper winding of relay 98 is traceable from grounded battery, right hand winding of relay 66, inner armature and continuity spring of relay 67, conductor 71, uppermost front contact and armature of relay 63, conductors 70 and 69, right hand winding of relay 99, conductor 100, lowermost continuity spring and back contact of relay 60, upper winding of relay 98, conductor 101, back contact and armature of relay 65, upper front contact and armature of relay 56, conductor 68, outer continuity spring and armature of relay 67, left hand winding of relay 66 to ground. With the relay 98 operated, the relay 60 is actuated in a circuit closed from grounded battery, its winding, innermost lower armature and front contact of relay 98 to ground. Relay 60 on energization reverses the connection of conductors 58 and 59 to the impulse relay 63 of Fig. 3.

Talking battery is supplied to the calling subscriber through the windings of relay 63 of Fig. 3, while talking battery is supplied to the called subscriber at substation B, through the windings of relay 67 of Fig. 4.

At the conclusion of the conversation, when the subscriber at A replaces his receiver on its switch hook, the relay 63 through which talking battery is supplied to the calling party, deenergizes and shortly afterwards the slow releasing relay 56 retracts its armatures to open the circuit including conductors 68 and 71 leading to the impulse relay 66, causing this relay to deenergize. It will be remembered that the holding circuit for the primary selector including conductor 57 is controlled at the armature 106 and front contact of relay 56, so that when this relay deenergizes the switching relay 32 retracts its armatures and at its lowermost armature and front contact opens the holding circuit of relay 31. This causes the release circuit of the primary selector switch to be completed from grounded battery, winding, armature and back contact of motor magnet 35, brush 36 in any of its off-normal positions, right hand back contact and armature of relay 31 to ground. Under the control of this circuit the primary selector is moved into its normal position The release of relay 31 also opens the holding circuit including conductor 142, which permits the switching relay 24 of Fig. 1 to release and at its lower armature and front contact opens the circuit for relay 18, providing that the even secondary line switch is not in use. The deenergization of relay 18 opens the holding circuit for the switching relay 9, which has been completed through line switch brush 13. Also the deenergization of relay 24 opens the circuit which has been maintaining the relays 21 and 6 operated. Since the primary and secondary line switches are of the type that remain in engagement with

the trunk last used their circuits are now in normal condition and in readiness to extend another connection.

It will be remembered that the termination of the call by the calling subscriber effected the deenergization of relay 66 of Fig. 4, and this in turn causes the deenergization of the slow releasing relay 72 whereupon a releasing circuit is closed from grounded battery, winding of the release magnet 108, off-normal contacts 109, left hand back contacts and armatures of relays 72 and 66 to ground. The release magnet is thus energized and releases the connector and its associated side switch into their normal position.

It should be mentioned at this point, that if the subscriber at substation C originates a call instead of the subscriber at A, the primary line switch of Fig. 1 operates in the manner already described, but the calling line extending from sub-station C is instead extended through the brushes 14, 15 and 16 to the even secondary line switch shown in the lower right hand corner of Fig. 1. It will also be understood that the subscribers at sub-station A and C may simultaneously initiate calls. In this case the primary line switch seizes an idle pair of trunks leading to an odd secondary line switch and to an even secondary line switch. The line switches operate independently to seize primary selector switches which may be operated in the manner already described.

Let it be assumed that the subscriber at A desires to converse with a called subscriber, whose line (not shown) terminates at a distant office, such as that represented in the lower right hand corner of Fig. 3. Under this assumption when the calling subscriber as substation A removes his receiver from its switch hook, his primary line switch operates in the manner already described to seize an idle secondary line switch which may be the one shown in Fig. 1 and this switch in turn operates to seize an idle primary selector switch as shown in Fig. 2. The calling subscriber thereupon operates his dial sender to transmit a series of impulses corresponding to the designation of the wanted office through which the called subscriber may be reached. Let it be assumed that this designation is "2" so that the calling subscriber sends two impulses, in response to which the primary selector switch advances its brushes 38, 39 and 40 into engagement with the conductors 109, 110 and 111 of a trunk through which the called party may be reached. Thereafter the secondary selector of Fig. 2 operates to seize an idle trunk leading to the wanted office. It is assumed that this selector seizes the trunk whose conductors are designated 112, 113 and 114 leading to Fig. 3. The condition of this idle trunk is indicated by ground potential applied through the back contact and armature of relay 116, left hand back contact and armature of relay 117, conductor 114 to terminal 115. The seizure of this trunk circuit is effected in the manner already described to extend the calling line to ground and grounded battery, through the windings of relay 118. This relay is energized and at its armature and front contact effects the operation of relay 117, which in turn applies the source of holding battery to the conductor 114 to maintain the connection. Also with the relay 117 energized, a trunk signal at the distant manual office is lighted in the following manner. The operation of relay 117 closes a circuit traceable from grounded battery, winding of relay 119, armature and back contact of relay 120, outermost front contact and armature of relay 117, conductor 121 of the selected trunk to the distant office, lower side of the repeating call, left hand winding of the relay 122, upper left hand winding of the repeating coil, conductor 123 of the selected trunk, winding of relay 116 to ground. The energization of relay 116 removes ground from the conductor 114 to prevent seizure of this trunk when the called portion of the connection is maintained, even after the calling subscriber releases. Also relay 119 is energized in this circuit and at its armature and front contact completes an operating circuit for the relay 124. This last named relay reverses the connection between conductors 112 and 113 and relay 118. The relay 122 is energized in the circuit described and lights the trunk lamp 125 in a circuit traceable from battery, lamp 125, resistance, front contact and armature of relay 122, lower armature and back contact of relay 126, resistance to ground.

The operator at the distant office on noting that the lamp 125 is lighted, depresses the listening key L. K. to connect her head set to the extended connection and inquires the designation of the wanted subscriber. Thereafter the operator connects the tip of the plug of the selected cord circuit to the sleeve of the jack J, leading to the wanted substation, and the absence of a distinctive click in the operator's head set at this time indicates to her that the wanted line is idle, whereupon she inserts the plug P into the jack J. This operation completes an energizing circuit for the sleeve relay 126 closed from grounded battery, through the lamp 125, winding of this relay, through the sleeve contacts of the plug and jack and resistance to ground. The energization of relay 126 closes a substitute circuit for itself from grounded battery, its lower front contact and armature, armature and front contact of relay 122, through the resistance and winding of relay 126, sleeve contacts of plug and jack, through the resistance to ground.

In this way the signal 125 is extinguished. The operator now depresses the ringing key R. K. to close a signaling circuit from ground through ringing generator 128, left hand winding of the trip relay 129, contacts of the ringing key, over the lower side of the cord circuit, through the ring contacts of the plug and jack over the lower side of the called line and its substation (not shown), over the upper side of the called line, tip contacts of the jack and plug, armature and front contact of relay 126 through the ringing key contacts to ground.

It should be stated that although any well known ringing arrangement may be used, the present disclosure makes use of a ringing key R. K. which is of that design which is locked in its depressed position by a relay such as 127 until it is released by the deenergization of said relay. When the called party responds the trip relay 129 is operated and thereupon opens the holding circuit of the relay 127, which releases the ringing key to close break points in the talking conductors and to disconnect the ringing generator from the called line.

Talking battery for the calling party is supplied through the windings of relay 118, while talking battery is supplied to the called party through the right hand windings of the repeating coil.

At the termination of a conversation when the calling party replaces his receiver on its switch hook, relay 118 deenergizes to effect the release of the slow releasing relay 117, and this last named relay at its outer armature and front contact opens the circuit which has been maintaining the relay 122 operated. The release of relay 122 removes the shunt which has existed during the conversation about the supervisory signal 125, whereupon this signal is lighted to inform the operator at the distant office to dis-establish the connection by removing the plug P from the jack J. The deenergization of relay 117 opens the holding conductor 114 to permit the deenergization of the holding relay 32 in the upper left hand corner of Fig. 2. This relay by deenergizing effects the release of the automatic switches of the connection in the manner already described.

Let it be assumed that after the calling party has released and the automatic switches of the connection are in their normal position that the operator at the distant manual office fails to remove the plug P from the jack J. Under this condition it is necessary to prevent the trunk whose conductors are designated 112, 113, and 114 and which lead to the plug P, from being seized again. The seizure of this operator's circuit is prevented by the continued energization of the relay 116, which removes the idle ground condition from test conductor 114. The relay 116 is maintained operated in a circuit now traceable from ground, winding of relay 116, conductor 123, upper winding of the repeating coil, back contact and armature of relay 122, lower armature and front contact of relay 126 to grounded battery. As soon as the operator removes her plug P from the jack J, this circuit is interrupted at the lower armature and front contact of the sleeve relay 126.

It should be pointed out that when the subscriber at A is called, a plug of a manual cord circuit (not shown) is inserted into the calling jack of this line, shown in the upper left hand corner of Fig. 1. This operation is effective to energize the cut-off relay 6 in the well known manner which disconnects the line relay 5 from the called line and thereby prevents the operation of the primary line switch, when the subscriber at A answers by removing his receiver from its switch hook.

Attention should also be directed to the fact that as soon as the calling line from substation A has been connected to the repeater, in the lower left hand corner of Fig. 3, means are provided to prevent unnecessary flashing of signal lamp 125. If at this time the subscriber at A operates his dial sender, the impulse relay 118 operates in the manner already described, so that relays 117 and 120 are actuated. It will be recalled that the relay 117 at its outer armature controls a circuit including conductor 121 and while this series of impulses is being transmitted by relay 118, the relay 120 holds the circuit of relay 122 open, thus preventing the lamp 125 from being flashed.

What is claimed is:—

1. In an automatic 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 device for generating impulses in said incoming circuit. means responsive to each group of impulses for advancing said automatic switch one unit of space, and other means controlled by the number of impulses in a group for governing the interconnection effected by said automatic switch.

2. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch operable through primary and secondary movements to interconnect said incoming circuit with any of said outgoing circuits, a device for generating impulses in said incoming circuit, mechanism responsive to a group of impulses for advancing said automatic switch one unit of space in either of its primary and secondary movements, and other means controlled by the number of impulses in centrain of said groups for governing the interconnection effected by said automatic switch.

3. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch for interconnecting said incoming circuit with any of said outgoing circuits, said automatic switch having sets of brushes, a device for transmitting impulses over said incoming circuit, means responsive to each group of impulses for advancing said automatic switch one unit of space, and other means governed by the number of impulses in a group for determining which set of brushes of said automatic switch is to be effective in interconnecting said incoming circuit and a wanted outgoing circuit.

4. In an automatic telephone system, an incoming circuit, a plurality of outgoing circuits, an automatic switch for interconnecting said incoming circuit with any of said outgoing circuits, said automatic switch being provided with four sets of brushes, means including a pair of relays by which the sets of brushes of said switch are variably connected to said incoming circuit, a device for transmitting impulses over said incoming circuit, mechanism responsive to each group of impulses for advancing said automatic switch one unit of space, and other means controlled by a number of impulses in certain of said groups for variably operating said pair of relays.

5. In an automatic 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 relay connected to said incoming circuit arranged to respond to impulses transmitted over said incoming circuit from a distant point, a motor magnet for advancing said automatic switch, a pair of relays, a circuit for said motor magnet independently completed at each of said relays, means responsive to one operation of said impulse relay for actuating one of said relays, means responsive to a second operation of said impulse relay for actuating the other of said relays, and means controlled by said pair of relays for variably governing the interconnection effected by said automatic switch.

6. In an automatic telephone system, an incoming circuit, an automatic switch for interconnecting said incoming circuit with any of said outgoing circuits, said automatic switch being provided with a plurality of sets of brushes, a group of relays for variably connecting said sets of brushes to said incoming circuit, a motor magnet for directively advancing said automatic switch, an impulse relay connected to said incoming circuit arranged to be controlled by impulses transmitted thereover, a pair of relays a circuit for said motor magnet completed on the operation of either of said relays, means responsive to a single operation of said impulse relay for actuating one of said relays without actuating the other of said pair of relays, means responsive to the second operation of said impulse relay for actuating the second relay of said pair while retaining the first mentioned relay of said pair operated, other means responsive to a third operation of said impulse relay for effecting the deenergization of the first relay and retaining the second relay of said pair operated, means responsive to the fourth operation of said impulse relay for deenergizing the second relay of said pair, and means controlled by the variable operation of said pair of relays for controlling said group of relays to extend said incoming circuit to one of said sets of brushes and thence to one of said outgoing lines.

In witness whereof, I hereunto subscribe my name this 20th day of October A. D. 1922.

WINFRED T. POWELL.