

March 2, 1926.

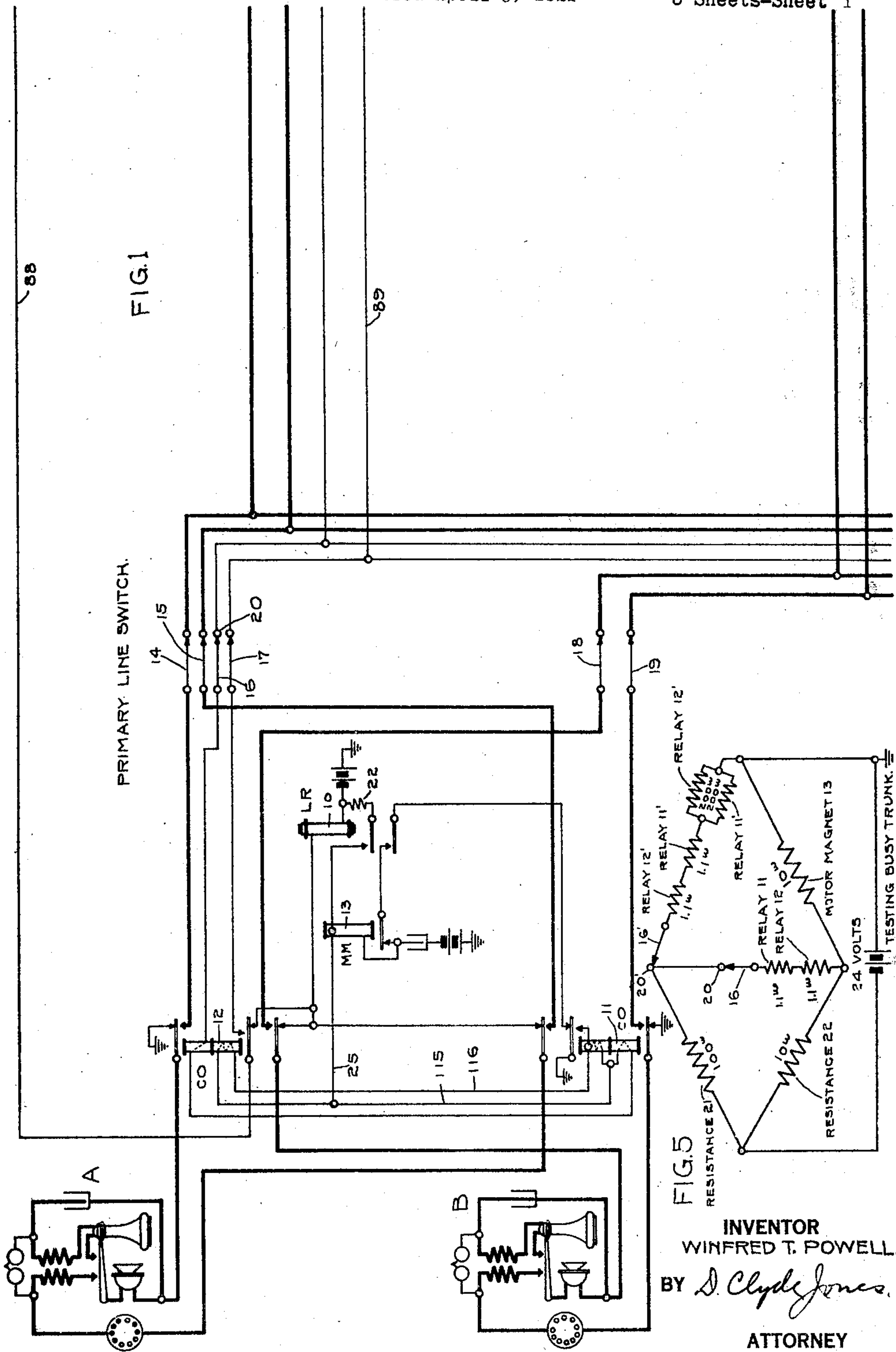
W. T. POWELL

1,575,602

AUTOMATIC TELEPHONE SYSTEM

Filed April 3, 1922

5 Sheets-Sheet 1



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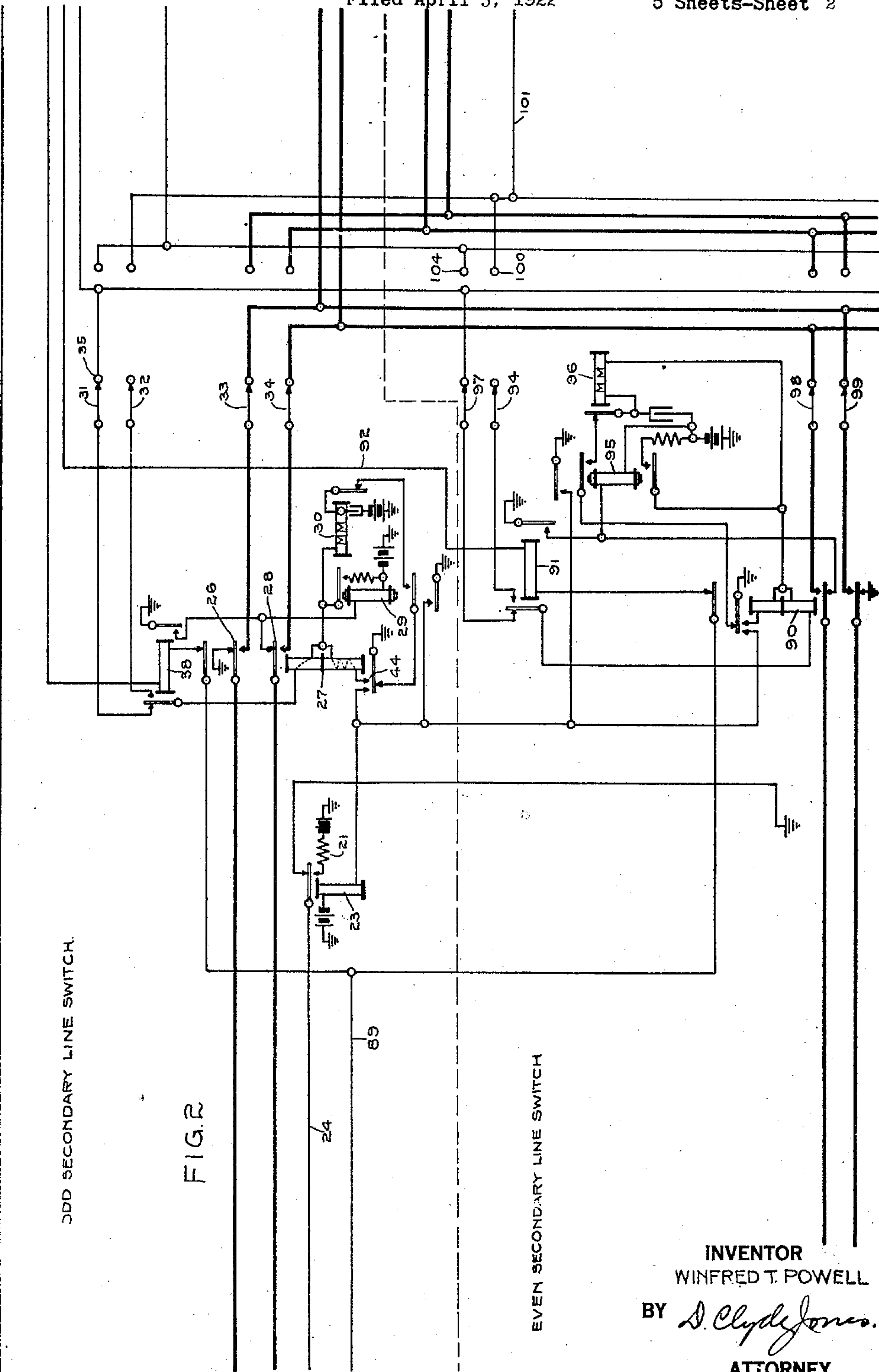
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AUTOMATIC TELEPHONE SYSTEM

Filed April 3, 1922

5 Sheets-Sheet 2



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March 2 , 1926.

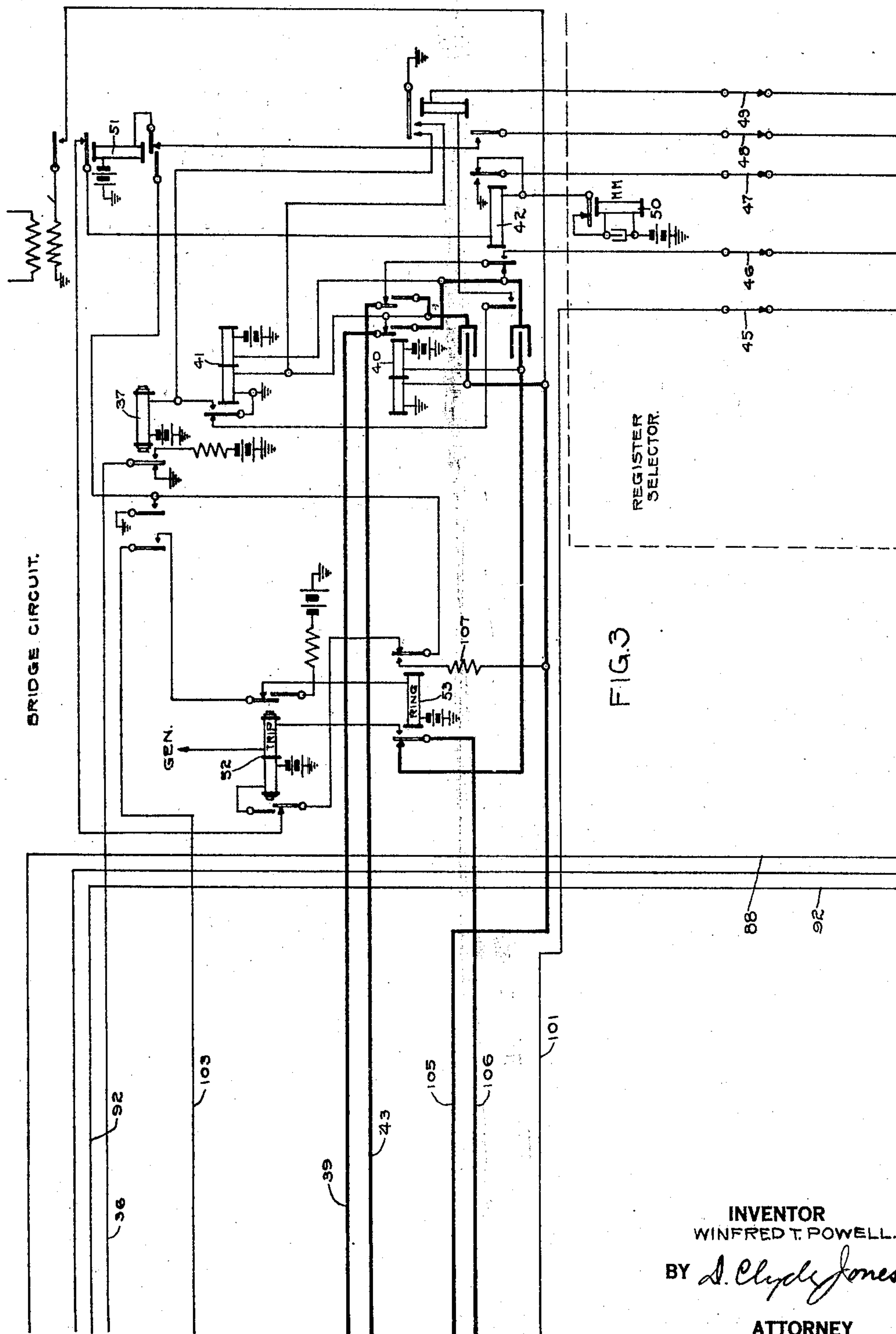
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AUTOMATIC TELEPHONE SYSTEM

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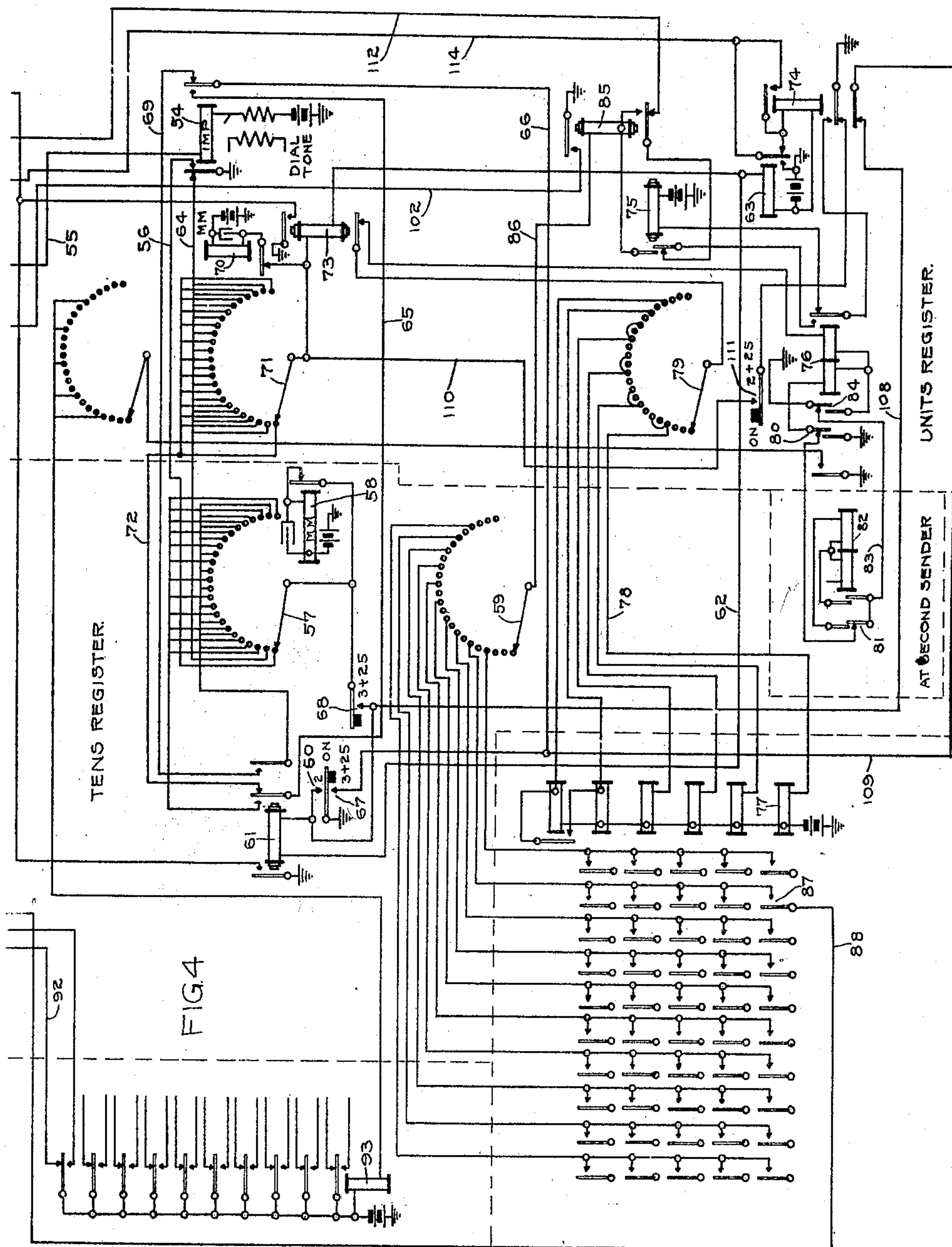
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AUTOMATIC TELEPHONE SYSTEM

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5 Sheets-Sheet 4



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March 2 , 1926.

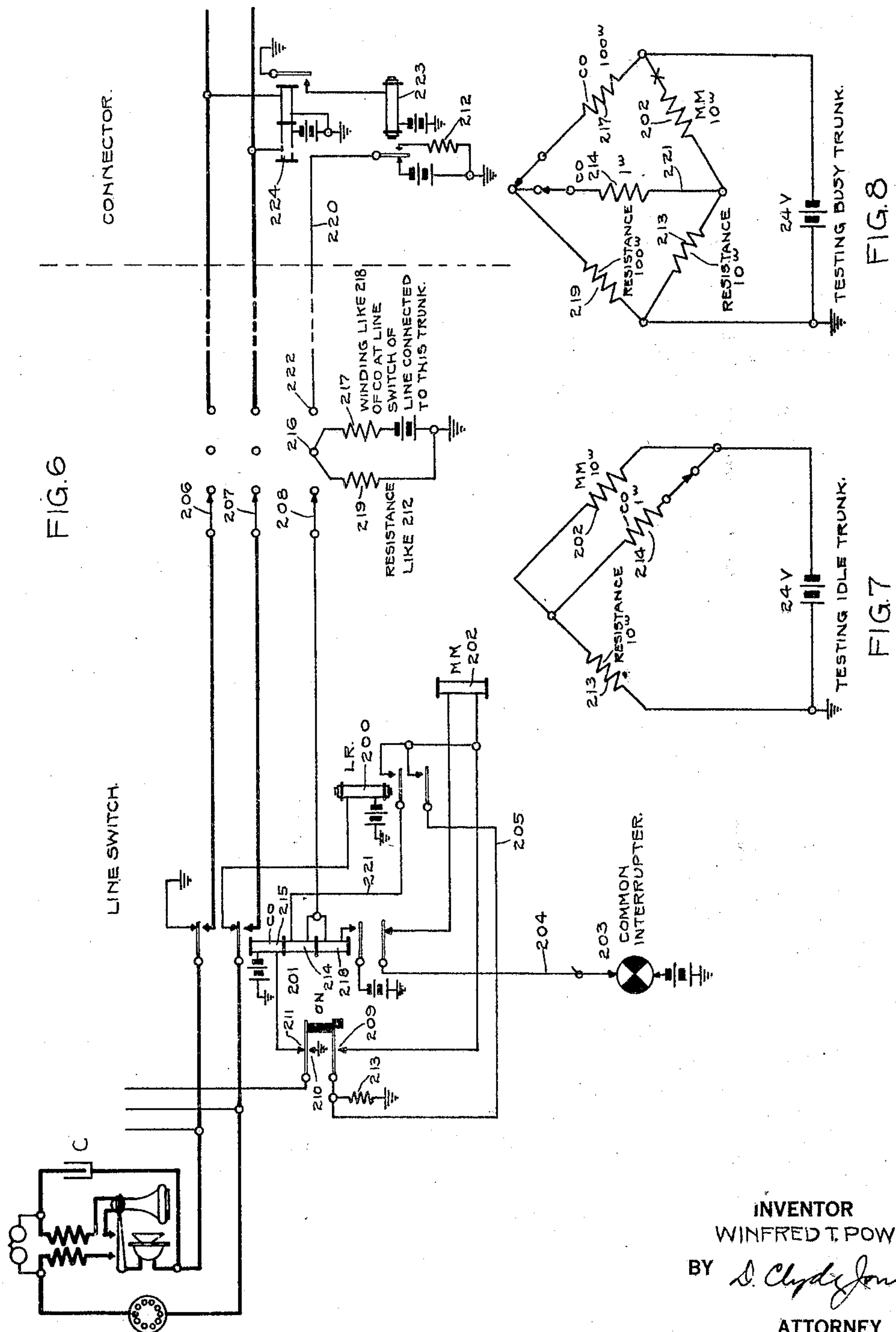
1,575,602

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AUTOMATIC TELEPHONE SYSTEM⁵

Filed April 3, 1922

5 Sheets-Sheet 5



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 April 3, 1922. Serial No. 548,943.

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.

This invention has for its purpose the provision of novel testing means for a trunk hunting switch by which such switch may test a plurality of trunks, indicated as busy trunks and finally seize an idle trunk and hold the trunk thus seized.

Various features of the invention will appear in the course of the following description and the appended claims.

In the drawings Figs. 1, 2, 3 and 4 diagrammatically represent one form of telephone system incorporating the present invention, in which at the left of Fig. 1 there are represented substations and lines of two subscribers which terminate in a single primary line switch the brushes of which appear near the center of Fig. 1. In Fig. 2 there is represented the operating circuits of an odd secondary line switch shown above the dotted line, and below this line there is represented the operating circuits of an even secondary line switch. In the lower right hand corner of Fig. 3 there is represented the operating circuits of a register selector which functions to select an idle register sender and connect the same to a bridge circuit to which the calling line is connected. The remainder of this figure represents what may be termed, a bridge circuit over which a conversational circuit is finally completed. In the lower left hand corner of Fig. 4 there is shown a group of five test relays which may be common to one hundred lines. Near the center portion of Fig. 4 there appears the operating circuits of the tens register, while at the extreme right of this figure there appears the units register. Fig. 5 is a diagram showing conditions which exist during the testing of a busy trunk.

In Fig. 6 there is represented a modified form of the invention, while in Figs. 7 and 8 there is diagrammatically represented the condition which exists when the line switch of Fig. 6 tests a busy trunk and also when this line switch tests an idle trunk.

The mechanical structure of the switches employed in this system may be substantially similar to that disclosed in the patent to Clement #1,107,153 granted August 11, 1914, while the multi-contact relays may be similar to the structure of such relays which are now well known.

With this brief description of the apparatus, it is believed that the invention will best be understood by describing the method of establishing a telephone connection from a substation such as is indicated at A, to a substation which is indicated at B.

When the subscriber at A removes his receiver from its switch hook, a circuit is completed for the line relay 10, extending from grounded battery, winding of this relay, uppermost back contact and armature of cut-off relay 11, over the lower side of the calling line and through the substation circuits in series, over the upper side of the calling line, upper armature and back contact of the cut off relay 12 to ground. The line relay is energized in this circuit and attracts its armatures, thereby completing an operating circuit for the motor magnet 13 extending from grounded battery, resistance 22, inner armature and front contact of line relay 10, winding of the motor magnet 13, its back contact and armature, lowermost front contact and armature of line relay 10, inner upper armature and back contact of cut-off relay 11 to ground. Under the control of this circuit the motor magnet 13 advances the brushes 14, 15, 16, 17, 18 and 19 of the primary line switch until its test brush 16 engages an idle test terminal such as 20. This idle condition is indicated by the presence of ground potential on the test terminal 20 which is applied through the back contact and armature of a relay such as 23, over test conductor 24. In the event that the first trunk tested is busy, its test terminal similar to 20 is characterized by the presence of battery potential thereon, applied through resistance 21, front contact and armature of relay 23, test conductor 24

to the test terminal 20. The application of battery potential to this test terminal results in the inclusion of the energizing winding of the cut-off relays such as 11 and 12 of the line switch of Fig. 1 in the neutral branch of the Wheatstone bridge with the result that these relays are not operated and the motor magnet 13 continues to advance the primary line switch brushes until the idle trunk is located.

This condition is diagrammatically represented in Fig. 5 wherein the resistance values of the different resistances and windings of the relays and magnets are given. This diagram indicates that when a trunk is seized, a circuit is closed from the battery through resistance 21, test terminal 20, test brush 16' of the line switch that has already seized this trunk through the low resistance windings of the cut-off relays 12' and 11' associated with that line switch and through the high resistance windings in multiple of the cut-off relays 11' and 12' associated with that switch, to ground, also at the time of this test another circuit is closed from the battery, resistance 22, and through the winding of the motor magnet 13 to ground. It will thus be seen that the ratio arms of the Wheatstone bridge are of such resistance values that sufficient current does not pass through the low resistance windings of the cut-off relays 11 and 12, test brush 16 and multiple terminal 20, to operate these last mentioned relays. At this time a circuit is completed from ground, back contact and armature of relay 23, test conductor 24, test terminal 20, test brush 16, upper low resistance winding of cut-off relay 12, the lower winding of cut-off relay 11 which is of low resistance, conductor 25, inner front contact and armature of line relay 10, resistance 22, to grounded battery.

The cut-off relays 11 and 12 are energized in this circuit and the calling line is extended through the uppermost armatures and front contacts of relays 11 and 12 to the line switch brushes 14 and 15 and thence to ground through armature 26 and back contact of relay 27 and through the armature 28 and back contact of relay 27 and the winding of relay 29 to grounded battery. The relay 29 is energized in this circuit and immediately operates the relay 23 over a circuit traceable from grounded battery, winding of this relay, lowermost front contact and armature of relay 29 to ground. With the relay 23 operated holding potential is applied to the test terminal 20, over conductor 24, and thence through test brush 16, upper winding of cut-off relay 12, through both windings in series of cut-off relay 11, front contact and armature of this relay to ground which holds relay 11 operated. A circuit in multiple of that just described includes the lower winding of relay 11, conductor 115,

lower winding of cut-off relay 12, conductor 116, inner upper front contact and armature of relay 11 to ground. This circuit maintains relay 12 operated.

It should be noted that during the interval between the energization of the cut-off relays 11 and 12 and the consequent deenergization of the slow releasing line relay 10, holding circuits for the cut-off relays 11 and 12 are completed. The circuit for cut-off relay 11 may be described as extending from grounded battery, resistance 22, inner armature and front contact of relay 10, conductors 25 and 115, upper winding, front contact and armature of relay 11 to ground. The circuit for cut-off relay 12 extends in multiple with the last directed circuit and may be traced from grounded battery, resistance 22, inner armature and front contact of relay 10, conductors 25 and 115, lower winding of relay 12, conductor 116, front contact and armature of relay 11 to ground.

Since it has been assumed that the calling line is of odd designation, the odd secondary line switch of Fig. 2 is now operated to select an idle bridge circuit. This is effected as soon as the relay 29 is operated, since it completes an actuating circuit for the motor magnet 30 from grounded battery, resistance, front contact and armature of relay 29, winding, armature and back contact of motor magnet 30, inner front contact and armature of relay 29, back contact and armature of relay 27 to ground. Under the control of this circuit the odd secondary line switch advances its brushes 31, 32, 33 and 34 until its outgoing test brush 31 encounters an idle test terminal such as 35, which condition is indicated by the presence of ground potential on such test terminal. Let it be assumed that the first bridge circuit tested by the test brush 31 is busy, a condition which is indicated by the presence of battery potential on the test terminals such as 35 which is applied over test conductors such as 36, through the innermost armature and front contact of relays such as 37. As long as the test brush 31 encounters test terminals which are characterized by busy potential, the switching relay 27 will be included in the neutral branch of the Wheatstone bridge so that it will not be operated but the relay 29 remains operated and the motor magnet 30 continues to advance the brushes of its line switch. When, however, the idle bridge circuit is reached by the test brush 31, ground potential is applied through the innermost back contact and armature of relay 37, over conductor 36, to its terminal 35 where the circuit is completed through the test brush 31, back contact and armature of relay 38, upper winding of relay 27, armature and front contact of relay 29 and through the resistance to grounded battery. The motor mag-

net 30 will be shunted by this circuit and will cease its operation while the relay 27 is operated and extends the connection thus far completed from the calling line through the front contacts and armatures 26 and 28 to line switch brushes 33 and 34 from which the circuit is completed from brush 33, over conductor 39, inner continuity spring and back contact of relay 40, left hand winding of relay 41 to ground and from grounded battery through the right hand winding of relay 41, back contact and armature of relay 42, outer back contact and continuity spring of relay 40, conductor 43 to the line switch brush 34. The relay 41 is energized in this circuit and at its front contact and armature effects the operation of the slow releasing relay 37 which maintains the portion of the connection already completed. With the relay 37 operated a holding circuit is completed from grounded battery, resistance, innermost front contact and armature of relay 37, conductor 36, test terminal 35, test brush 31, back contact and armature of relay 38, through both windings in series of relay 27, its front contact 44 and armature to ground.

It should be stated that the brushes 45, 46, 47, 48 and 49 of the register selector are normally standing in engagement with the terminals of this selector which are connected to an idle register sender so that when the relay 37 is operated, a circuit is completed for the relay 42 starting from grounded battery, winding of the motor magnet 50, its back contact and armature, winding of relay 42, inner armature and back contact of relay 51, back contact and continuity spring of trip relay 52, right hand back contact and armature of ringing relay 53, middle contact and armature of relay 37 to ground.

The relay 42 when energized, at its inner right hand armature opened the operating circuit of the motor magnet 50 of the register selector and at its inner right hand front contact and armature closed a circuit from ground through brush 47, conductor 114, armature and back contact of relay 63, winding of sender holding relay 74 to grounded battery. Relay 74 when operated closes a locking circuit for itself through its armature and contact. At the inner left hand armature and contact of relay 42 the impulse relay 54 appearing at the upper right hand corner of Fig. 4 is included in the impulse circuit which extends from grounded battery, secondary winding of the induction coil, winding of relay 54, conductor 55, selector brush 46, front contact and armature of relay 42, outer back contact and continuity spring of relay 40, over conductor 43 and the lower side of the calling line through the dial at the calling substation over the upper side of the calling

line, conductor 39, inner continuity spring and back contact of relay 40, left hand winding of relay 41 to ground. The relay 41 is thus maintained energized in this circuit to keep the holding relay 37 operated. Also at this time the source of dial tone indicated in the upper right hand corner of Fig. 4 is inductively connected to the impulse circuit to transmit a tone to the calling subscriber to indicate that the circuit is in readiness to receive the directive impulses from the dial sender at the calling substation. As soon as the relay 54 is energized it closes a circuit from ground, its left hand armature and front contact, conductor 56, tens register brush 57 in its normal position, armature back contact and winding of the motor magnet 58 to grounded battery. This motor magnet is thus operated and advances the brushes 57 and 59 of the tens register into their second position, and this closes a circuit from ground, off normal contacts 60, winding of the tens change-over relay 61, conductor 62, winding of the relay 63 to grounded battery. The tens register is now in condition to receive directive impulses from the dial sender corresponding to the tens digit of the wanted number. Let it be assumed that this digit is "2" and that the dial sender is therefore operated to send two impulses. In response to the first of these impulses, the relay 54 retracts its armatures to close a circuit from ground, over conductor 64, and register brush 57 in its second position, back contact, armature and winding of the motor magnet 58, to grounded battery, which circuit advances the units register brushes into their third position. At the close of the first impulse the impulse relay attracts its armatures to complete a circuit extending from grounded battery, winding, back contact and armature of the motor magnet 58, tens register brush 57 in its third position, inner front contact and armature of relay 61, conductor 65, right hand front contact and armature of impulse relay 54, conductor 66, off-normal contact 67 to ground. The tens register thereby steps its brushes into their fourth position. At this time a multiple circuit is closed for the change-over relay 61, extending from grounded battery, winding of relay 63, conductor 62, winding of relay 61, off-normal contact 68, register brush 57, over the remainder of the circuit previously described as extending to ground, over conductors 65 and 66. In response to the second and last impulse of the tens series of impulses, relay 54 again retracts its armature and closes a circuit from ground, off-normal contacts 67, conductor 66, right hand armature and back contact of relay 54, conductor 69, outer right hand front contact and armature of relay 61, register brush 57 in its fourth position, armature, back contact and winding of the

motor magnet 58 to grounded battery. The motor magnet interrupts its own circuit and advances its brushes one step into their fifth position. When the impulse relay is again operated at the close of this series of impulses the motor magnet 58 advances the register brushes into their sixth position over the circuit from grounded battery, winding of the motor magnet 58, back contact and armature of this magnet, register brush 57 in its fifth position, innermost front contact and armature of relay 61, conductor 65, front contact and armature of relay 54, conductor 66, off normal contact 67 to ground.

The change-over relay 61 which is slow releasing and which is held energized in multiple with the operating circuit of the motor magnet 58 now deenergizes to prepare an operating circuit for the motor magnet 70 of the units register. The deenergization of the change-over relay 61 closes a circuit which advances the units register into its second position. This circuit is from ground-battery, winding, armature and back contact of the motor magnet 70, units register brush 71, conductor 72, inner back contact and armature of relay 61, conductor 65, front contact and armature of relay 54, conductor 66, off normal contacts 67 to ground. With the units register in its second position, the apparatus is in condition to receive the series of impulses corresponding to the units digit of the wanted number. Let it be assumed that this units designation is "2", therefore the calling subscriber operates his dial sender to transmit two impulses. In response to the first of these impulses the impulse relay 54 retracts its armature and thereby closes a circuit from ground, its left hand armature and back contact, conductor 64, register brush 71, back contact, armature and winding of the motor magnet 70 to grounded battery. Under the control of this circuit the units register is advanced into its third position. During this operation of the motor magnet the units change-over relay 73 is operated in a circuit in multiple of that for the motor magnet which extends from grounded battery, winding of the relay 63, winding of the relay 73, through the remainder of the multiple circuit extending through the register brush 71. At the close of this first impulse the impulse relay 54 attracts its armature to complete another operating circuit for the motor magnet 70 from grounded battery, winding of this magnet, its armature and back contact, register brush 71, in its third position, conductor 72, inner back contact and armature of relay 61, conductor 65, front contact and armature of relay 54, conductor 66, off normal contacts 67 to ground.

In response to the second and last im-

pulse of this series of impulses, the impulse relay 54 retracts its armatures and thereby advances the units register into its fifth position, in a circuit completed from grounded battery, winding, armature and back contact of motor magnet 70, brush 71 in its fourth position, conductor 64, back contact and armature of relay 54 to ground. At the close of this impulse, the impulse relay 54 is again operated and the units register is moved into its sixth position in a circuit closed from grounded battery, winding of the motor magnet 70, its armature and back contact, register brush 71 in its fifth position, conductor 72 to ground, over the remainder of the circuit previously described. During the operation of the units register the slow releasing change-over relay 73 has been held operated, but when the impulse relay at the close of the units series of impulses is held operated for a relatively long period, this change-over relay deenergizes to remove the tens and units registers from any further control of the dial sender during this call.

It will be remembered that the relay 74 is operated and closes a locking circuit for itself as soon as its register sender of Fig. 4 is seized, also at this time slow-releasing relay 75 is operated. If now, no other register sender of the group of lines under consideration is making a test the relay 77 is operated from grounded battery, winding of this relay, conductor 78 and its register brush 79 in its sixth position, lowermost armature and back contact of relay 73, through both windings in series of relay 76, continuity spring 80 and back contact, back contact and continuity spring 81 of a relay 82 associated with a second register sender, conductor 83, back contact and continuity spring 84 to ground. The relays 76 and 77 are energized in this circuit and since the relay 75 is slow releasing it will be held operated momentarily even though its circuit is now opened at the right hand back contact and armature of relay 76. With relays 74, 75 and 76 operated, a test circuit is now completed from ground, inner armature and front contact of relay 74, armature and front contact of relay 76, continuity spring and armature of relay 75, winding of relay 85, conductor 86, tens register brush 59, contact 87 and armature of relay 77, conductor 88, inner armature and front contact of relay 12, primary line switch brush 17, conductor 89, uppermost armature and back contact of relay 90, winding of relay 91, conductor 92, uppermost armature of multi-contact relay 93 to grounded battery. The relays 91 and 85 are operated in this circuit and the relay 85 closes a locking circuit for itself over conductor 86, winding of relay 85, its front contact and armature, back contact and continuity

spring of relay 75, front contact and armature of relay 76, front contact and armature of relay 74 to ground.

With relay 91 operated the terminating test brush 94 is rendered effective and operates the slow releasing relay 95 in a circuit closed from grounded battery, winding of relay 95, front contact and armature of relay 91 to ground.

With relay 95 operated, an actuating circuit for the motor magnet 96 is completed from grounded battery, resistance, lower front contact and armature of relay 95, winding, armature and back contact of motor magnet 96, inner front contact and armature of relay 95, inner armature and back contact of relay 90 to ground. Under the control of this circuit, motor magnet 96 advances the brushes 94, 97, 98 and 99 of the even secondary line switch until the test brush 94 encounters the terminating end of the bridge circuit to which the calling line has been extended. At this time, the switching relay 90 is operated in a circuit traceable from grounded battery, resistance, front contact and armature of relay 95, lower winding of relay 90, armature and front contact of relay 91, terminating test brush 94, test terminal 100 of the bridge circuit which has been previously selected, conductor 101, register selector brush 45, conductor 102, upper front contact and armature of relay 85, to ground. The relay 90 is energized in this circuit and at its upper armature and contact opens the circuit of relay 91. The relay 91 deenergizes and completes a circuit for the ringing relay 53 from grounded battery, winding of this relay, right hand back contact and continuity spring of trip relay 52, outer left hand front contact and armature of relay 37, conductor 103, terminal 104, brush 97, through both windings in series of relay 90, front contact and armature of this relay to ground. The relay 90 is thus locked operated and the ringing relay attracts its armatures to close a ringing circuit from the source of ringing current GEN, right hand winding of trip relay 52, left hand armature and front contact of relay 53, conductor 106, even secondary line switch brush 99, to the called substation, through the line switch brush 19, over the lower and upper sides of the called line, brush 18, through the upper side of the link circuit to brush 98, conductor 105, resistance 107, right hand front contact and armature of relay 53, middle front contact and armature of relay 37 to ground. Ringing current is applied over this circuit until the called party responds at which time trip relay 52 is energized to effect the deenergization of the ringing relay 53, which stops the ringing of the called station; also at this time a locking circuit is closed for the trip relay 52, through the

left hand winding of this relay, its armature and continuity spring, right hand back contact and armature of relay 53, middle contact and armature of relay 37 to ground.

Talking battery is supplied to the calling subscriber through both windings in series of relay 41, while talking battery is supplied to the called subscriber through both windings in series of relay 40.

As soon as the ringing relay 53 is energized it opens the energizing circuit of the relay 42 which has previously maintained the register sender of Fig. 4, operated. When relay 42 deenergizes the holding relay 74 of the register sender deenergizes and in turn effects the restoration of its register sender in the following manner: The release of relay 74 closes a circuit from grounded battery, winding, back contact and armature of motor magnet 58, off normal contact 68, conductor 108, lowermost back contact and armature of relay 74, conductor 109, off normal contacts 67 to ground. Under the control of this circuit the motor magnet 58 advances the brushes of the tens register into their first or normal position. The units register is restored by a circuit closed from grounded battery, winding of the motor magnet 70, conductor 110, off normal contacts 111, inner back contact and armature of relay 74 to ground. Under the control of this circuit the motor magnet 70 advances the brushes of the units register into their first or normal position.

In the event that the called line is busy its test circuit previously described will not be complete with the result that the relay 85 is not energized, the relay 51, will thereupon be operated in a circuit traceable from grounded battery, winding of this relay, its continuity spring and back contact, outer right hand front contact and armature of relay 42, brush 48, conductor 112, lower back contact and armature of relay 85, back contact and continuity spring of relay 75, right hand front contact and armature of relay 76, inner front contact and armature of relay 74 to ground. The test relay 51 when thus operated closes a locking circuit for itself through its continuity spring and armature, through the middle armature and contact of relay 37 to ground.

At the termination of the connection when the calling subscriber at A replaces his receiver on its switch hook, the relay 41 deenergizes and shortly afterwards slow releasing relay 37 retracts its armature and thereby opens the holding conductor 36 which has been maintaining the relay 27 energized. At the lower armature and front contact of relay 27 the holding circuit of relay 23 is opened and this relay then opens the holding circuit 24 of the primary line switch so that the cut-off relays 11 and 12 deenergize to place the primary line switch

in its normal condition in readiness for the next call.

In the modified form of the invention shown in Fig. 6, a common interrupter is provided for operating the motor magnets of a group of line switches. Prior to the use of such common interrupter it was found in practice that where contacts are placed on each motor magnet by which it interrupted its own circuit such contacts were a frequent source of trouble due to their being out of adjustment.

When the subscriber at C removes his receiver from its switch hook a circuit is closed for the line relay 200 extending from grounded battery, winding of this relay, inner upper armature and back contact of the cut-off relay 201, over the lower side of the calling line and through the substation circuits in series, over the upper side of the calling line and through the uppermost armature and back contact of the cut-off relay to ground. The slow releasing line relay 200 on operation closes an operating circuit for the motor magnet 202 of the line switch, which circuit is traceable from grounded battery, through the common interrupter generally designated 203, conductor 204, lowermost armature and back contact of the cut-off relay, winding of the motor magnet, lowermost front contact and armature of the line relay, conductor 205 and resistance 213 to ground. Under the control of this circuit the motor magnet advances its brushes 206, 207, and 208 of the line switch one step forward.

This operation of the line switch closes its off-normal contacts 209 and 210 and opens the contacts 211. The closure of contacts 210 renders the calling line busy and prevents its seizure as a called line, while the closure of contacts 209 completes a substitute operating circuit for the motor magnet extending from ground, resistance 213, off normal contacts 209, winding of the motor magnet 202, lowermost back contact of the cut-off relay, conductor 204, common interrupter 203 to grounded battery. Under the control of this circuit the motor magnet advances the brushes of the line switch so that its test brush 208 successively tests the terminals of the trunks terminating in this switch.

Let it be assumed that the first trunk tested is busy, a condition indicated by the presence of ground potential on its test terminal 216, at which time the circuit condition diagrammatically represented in Fig. 8 exists. The test terminal 216 is at this time connected through a resistance 219 which corresponds to resistance 212 at the connector of the busy trunk to ground. This test terminal is also extended through a test brush similar to 208 of a line switch which has previously seized this trunk and

through a winding 217 similar to 218 of the cut-off relay associated with that line switch and through the innermost front contact and armature of this relay to grounded battery. For this reason when the brush 208 engages test terminal 216, the winding 214 of the cut-off relay is included in the neutral branch of the Wheatstone bridge represented by conductor 221. The other side of the Wheatstone bridge extends from grounded battery, interrupter 203, conductor 204, lowermost armature and back contact of the cut-off relay, winding of the motor magnet 202, off normal contacts 209, resistance 213 to ground. Since the winding 214 of the cut-off relay is at this time included in the neutral branch of the Wheatstone bridge it will not be operated, but the motor magnet will continue to operate in the last described circuit until the test brush 208 of the line switch encounters a test terminal such as 222 of an idle trunk. When such an idle trunk is tested, the circuit condition diagrammatically represented in Fig. 7 exists. At this time a circuit is closed for the winding 214 of the cut-off relay extending from grounded battery, back contact and armature of relay 223, conductor 220, test terminal 222, test brush 208, winding 214 of the cut-off relay, inner armature and front contact of line relay 200, off normal contacts 209, resistance 213 to ground. The cut-off relay is operated in this circuit but the motor magnet is shunted thereby so that it does not advance the line switch further. As soon as the cut-off relay is operated it extends the calling line to the brushes 206 and 207 of the line switch and through the windings 224 of the impulse relay of the next switch in the connection to grounded battery. This relay is energized in the circuit and operates a slow releasing relay 223, which extends a circuit from ground through resistance 212, front contact and armature of relay 223, conductor 220, test terminal 222, test brush 208, lower winding 218, front contact and armature of relay 201 to grounded battery.

The operation of the next numerical switch in the series which is here shown as a connector switch is directly controlled from the dial at the calling substation to extend the connection in the well known manner.

At the termination of the conversation when the calling subscriber replaces his receiver on its switch hook the impulse relay 224 deenergizes and effects the deenergization of the slow releasing relay 223, which removes the holding ground from the conductor 220 to effect the deenergization of the cut-off relay 201. When this last named relay retracts its armatures an operating circuit is closed for the motor magnet 202, extending from ground, resistance 213, off nor-

mal contacts 209, winding of the motor magnet 202, lowermost back contact and armature of the cut-off relay 201, conductor 204, interrupter 203 to grounded battery.

5 What is claimed is:—

1. In an automatic telephone system, a plurality of telephone lines, a plurality of trunks, a plurality of automatic switches for interconnecting calling telephone lines and
10 idle trunks, testing means associated with each automatic switch arranged to be successively extended to said trunks by the operation of its automatic switch, and various resistances arranged to be connected
15 with certain of said testing means in the form of a Wheatstone bridge during the testing of busy trunks.

2. In an automatic telephone system, a plurality of telephone lines, a plurality of trunks, automatic switches for interconnecting calling telephone lines and idle trunks, a cut-off relay associated with each automatic switch, a line relay arranged to be
20 operated over a telephone line on the initiation of a call for starting the operation of an automatic switch, a motor magnet for each automatic switch arranged to be operated under the control of said line relay, said cut-off relay functioning to disable said
25 line relay, a plurality of resistance elements including said motor magnet, and means including an automatic switch for arranging said resistance elements to form arms of a Wheatstone bridge with said cut-off relay
30 in the neutral branch of said Wheatstone bridge circuit during the testing of a busy trunk and for operating said cut-off relay when an idle trunk is located.

3. In an automatic telephone system, a plurality of telephone lines, a plurality of trunks, each provided with a test conductor, automatic switches for interconnecting lines and trunks, a battery, a motor magnet for
40 advancing each automatic switch, means controlled over the calling telephone line for initiating the operation of a motor magnet to advance its automatic switch, resistance units, a relay for disabling said motor magnet when an idle trunk is reached, said
45 relay during the advance of said switch having one of its terminals connected to opposite poles of said battery through said motor magnet and a resistance unit, means including said switch and the test conductor
50 associated with a busy trunk for connecting the other terminal of said relay to the opposite poles of said battery when said busy trunk is tested, whereby said relay is rendered inoperative, and means including
55 the test circuit of an idle trunk having one of said resistance units in series to operate said relay when an idle trunk is located.

4. In an automatic telephone system, a plurality of telephone lines, a plurality of

trunks, a plurality of line switches, each
65 telephone line being connected to a line switch, a motor magnet for operating each line switch to extend its associated telephone line to an idle trunk, a plurality of resistance units, a relay for disabling said motor
70 magnet, a test circuit completed during the testing of each busy trunk, said circuit having two branches connected in multiple, one branch including a resistance unit and said motor magnet, said other branch including
75 at least two resistance units, said relay being connected at points between the resistance units of one branch and the resistance unit and the motor magnet of the other branch, the resistance of said resistance units
80 and motor magnet being such that said relay is in a substantially neutral circuit, and means including one of said branches for operating said relay when an idle trunk is located.
85

5. In an automatic telephone system, a plurality of telephone lines, a plurality of trunks, a test conductor for each trunk, an automatic switch to which each line is connected and by which said telephone line is
90 extended to an idle trunk, one or more brushes for each line switch, means including a motor magnet operating on the initiation of a call on a line for advancing its line switch to successively engage the various trunks, a cut-off relay for disabling its associated motor magnet when an idle trunk is located, an initial energizing circuit for
95 said cut-off relay extending through a brush of said line switch and the test conductor of an idle trunk to one terminal of said battery, and a holding circuit for said cut-off relay extending through a second winding of said cut-off relay, said line switch brush and said conductor to the other pole of
100 battery.

6. In an automatic telephone system, a plurality of automatic switches, each provided with sets of movable contacts and fixed terminals, a plurality of pairs of telephone
110 lines, each pair of telephone lines terminating in the movable contacts of an automatic switch, a plurality of pairs of trunks multiply connected to the fixed terminals of a plurality of said switches, a test conductor
115 for each pair of trunks, means including a motor magnet for advancing the movable contacts of each switch on the initiation of a call over one of its lines to successively engage the fixed contacts of the various pairs of trunks, a battery, a cut-off relay for disabling said motor magnet when an idle pair of trunks is located, an initial energizing circuit for said cut-off relay extending
120 through a movable contact of said switch and the test conductor of an idle pair of trunks to one terminal of said battery, and a holding circuit for said cut-off relay extend-
125

ing through a second winding of said cut-off relay, said switch contact and said conductor to the other pole of battery.

7. In an automatic telephone system, a plurality of telephone lines, a plurality of trunks, automatic switches for inter-connecting calling telephone lines and idle trunks, cut-off relays associated with each automatic switch, a motor magnet for advancing each automatic switch, a line relay arranged to be operated over a telephone line on the initiation of a call for controlling a motor magnet, the cut-off relays functioning to disable said line relay, and a plurality of resistance elements including said motor magnet, said resistance units during the testing of busy trunks being included by said automatic switches in a Wheatstone bridge arrangement, said cut-off relays being included in the neutral branch of said Wheatstone bridge during the testing of the busy trunks and operating when an idle pair of trunks is located.

8. In an automatic telephone system, a plurality of telephone lines, a plurality of trunks, a test conductor for each trunk, an automatic switch to which each telephone line is connected and by which said telephone line is extended to an idle trunk, one or more brushes for each automatic switch, means including a motor magnet for advancing its automatic switch to successively engage the various trunks, a battery, a cut-off relay for disabling said motor magnet when an idle trunk is located, said cut-off relay being provided with two windings, an initial energizing circuit for said cut-off relay extending through one winding, a brush of said line switch and a test conductor of an idle trunk to one terminal of said battery, and a holding circuit for said cut-off relay extending through the second winding of said cut-off relay, said line switch brush and said conductor to the other pole of battery.

9. In an automatic telephone system, a plurality of telephone lines arranged in pairs, a plurality of trunks, an automatic switch for interconnecting a pair of lines and a pair of trunks, a motor magnet for each switch operating on the initiation of a call to advance said switch to an idle pair of trunks, a pair of cut-off relays associated with each pair of lines, contacts for each of said cut-off relays, each telephone line of a pair having its conductors controlled at contacts of each cut-off relay, each cut-off relay serving to disable said motor magnet, and means responsive to the interconnection of a pair of telephone lines and a pair of trunks for operating the associated cut-off relays.

10. In an automatic telephone system, a plurality of telephone lines arranged in pairs, a plurality of trunks arranged in pairs, a switch for each pair of telephone

lines for extending the same to idle pairs of trunks, a motor magnet for advancing each automatic switch past busy trunks, a single line relay associated with and arranged to be operated over a pair of telephone lines to control its motor magnet, a pair of cut-off relays associated with each pair of telephone lines for disabling said line relay to stop said motor magnet, each of said cut-off relays controlling a break point in each telephone line of a pair, and means for energizing said cut-off relays when a pair of idle trunks are located.

11. In an automatic telephone system, a plurality of telephone lines, a plurality of trunks, test conductors associated with certain of said trunks, means including automatic switches for interconnecting said telephone lines with idle trunks, a motor magnet for each switch to advance the same, a line relay associated with each motor magnet, said line relay being operated on the initiation of a call over any one of several lines to start the operation of said motor magnet, a cut-off relay for each telephone line, a circuit closed in series through several of said cut-off relays over a conductor of a trunk when the same is seized by an automatic switch, and a locking circuit for said cut-off relays including multiple circuits also extending through said test conductor, said cut-off relays on energization serving to disable said line relay and in turn the motor magnet of the automatic switch.

12. In an automatic telephone system, pairs of telephone lines, pairs of trunks, an automatic switch for each pair of telephone lines for extending the same to idle pairs of trunks, a motor magnet for each switch for advancing the same, a single wound line relay for each pair of telephone lines serving when energized to cause the operation of its associated motor magnet, multiple operating circuits for each line relay including the two sides in series of each of the calling telephone lines of a pair, a cut-off relay for each telephone line of a pair, means including said cut-off relays for disabling the associated line relay, and means for operating said cut-off relays when an idle pair of trunks is located.

13. In an automatic telephone system, a plurality of pairs of telephone lines, a plurality of pairs of trunks, a switch individual to each pair of telephone lines for extending the same to idle pairs of said trunks, means associated with each switch for advancing the same, testing means associated with each automatic switch arranged to be successively extended to said trunks by the operation of its automatic switch, and various resistances arranged to be connected with said testing means in the form of a Wheatstone bridge during the testing of busy trunks.

14. In an automatic telephone system, a

plurality of pairs of telephone lines, a plurality of pairs of trunks, a switch individual to each pair of telephone lines for extending the same to idle pairs of said trunks, means
5 associated with each switch for advancing the same, testing means associated with each automatic switch arranged to be successively extended to said trunks by the operation of its automatic switch, various resistances arranged to be connected with said testing
10 means in the form of a Wheatstone bridge for testing the busy or idle condition of the various pairs of trunks, and non-numerical switching means for extending each trunk.

In witness whereof, I hereunto subscribe
15 my name this 1st day of April A. D. 1922.

WINFRED T. POWELL.