

Jan. 13, 1931.

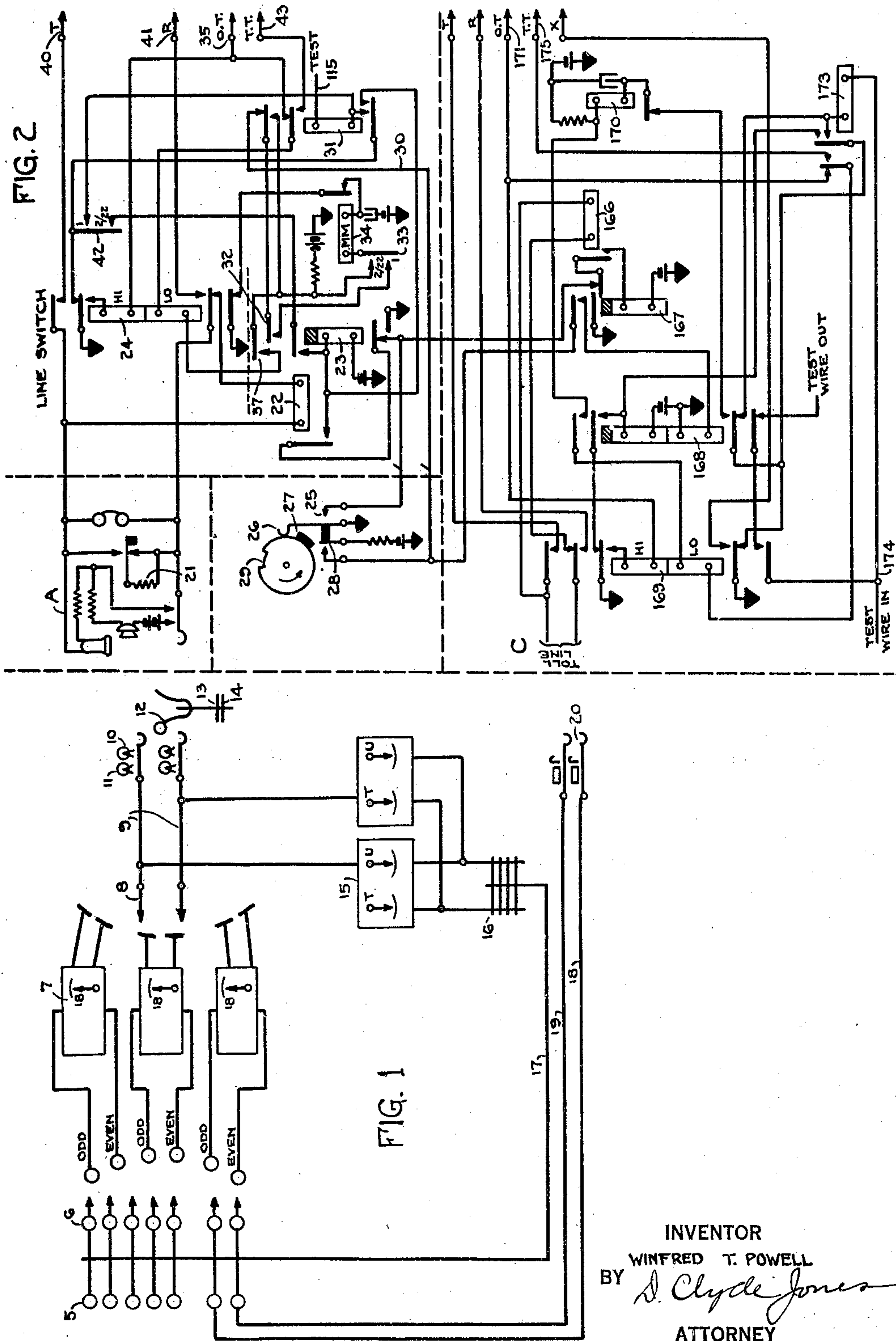
W. T. POWELL

1,788,471

REMOTE CONTROL MAGNETO TELEPHONE SYSTEM

Filed March 1, 1929

4 Sheets-Sheet 1



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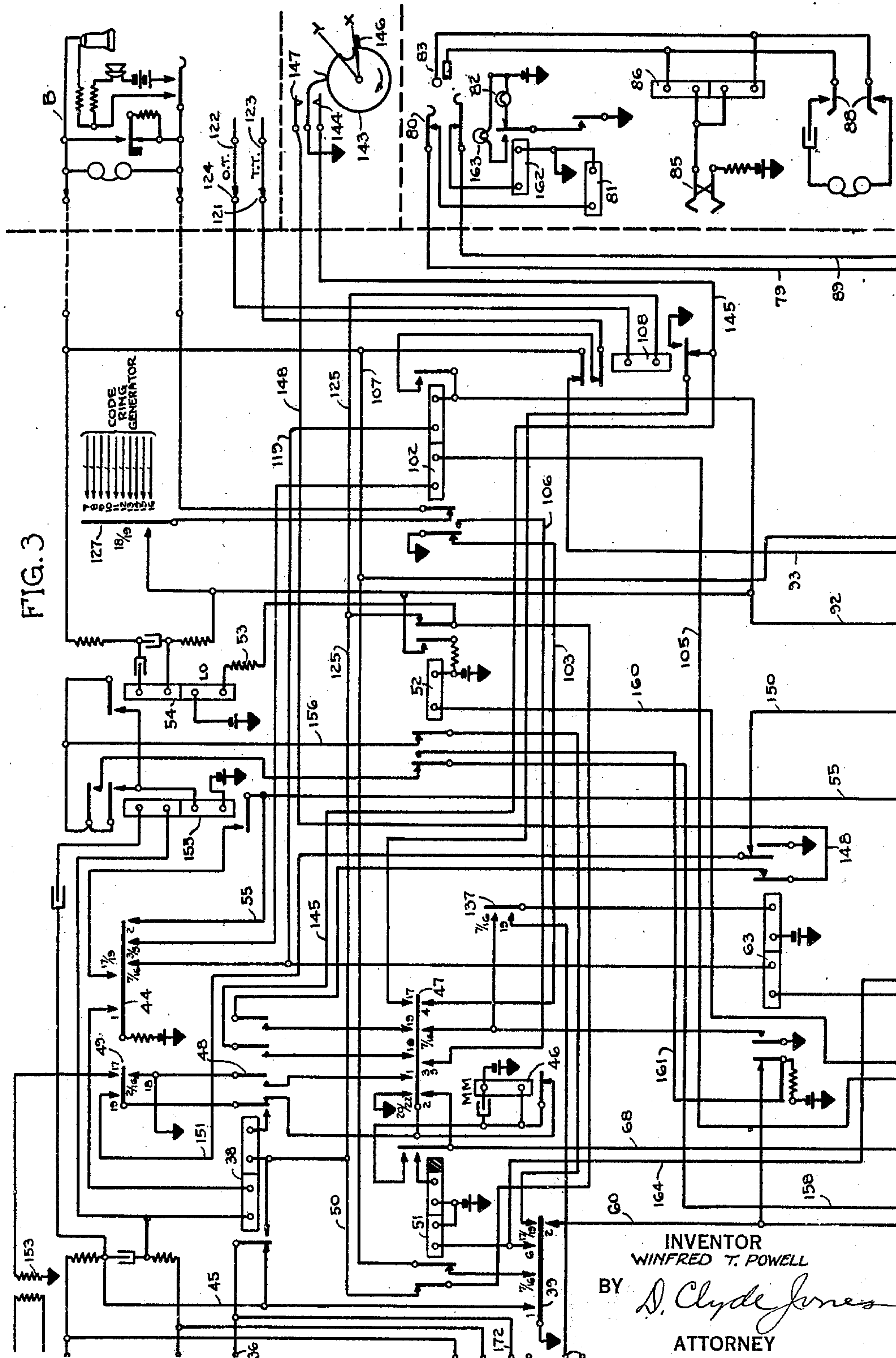
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REMOTE CONTROL MAGNETO TELEPHONE SYSTEM

Filed March 1, 1929

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Jan. 13, 1931.

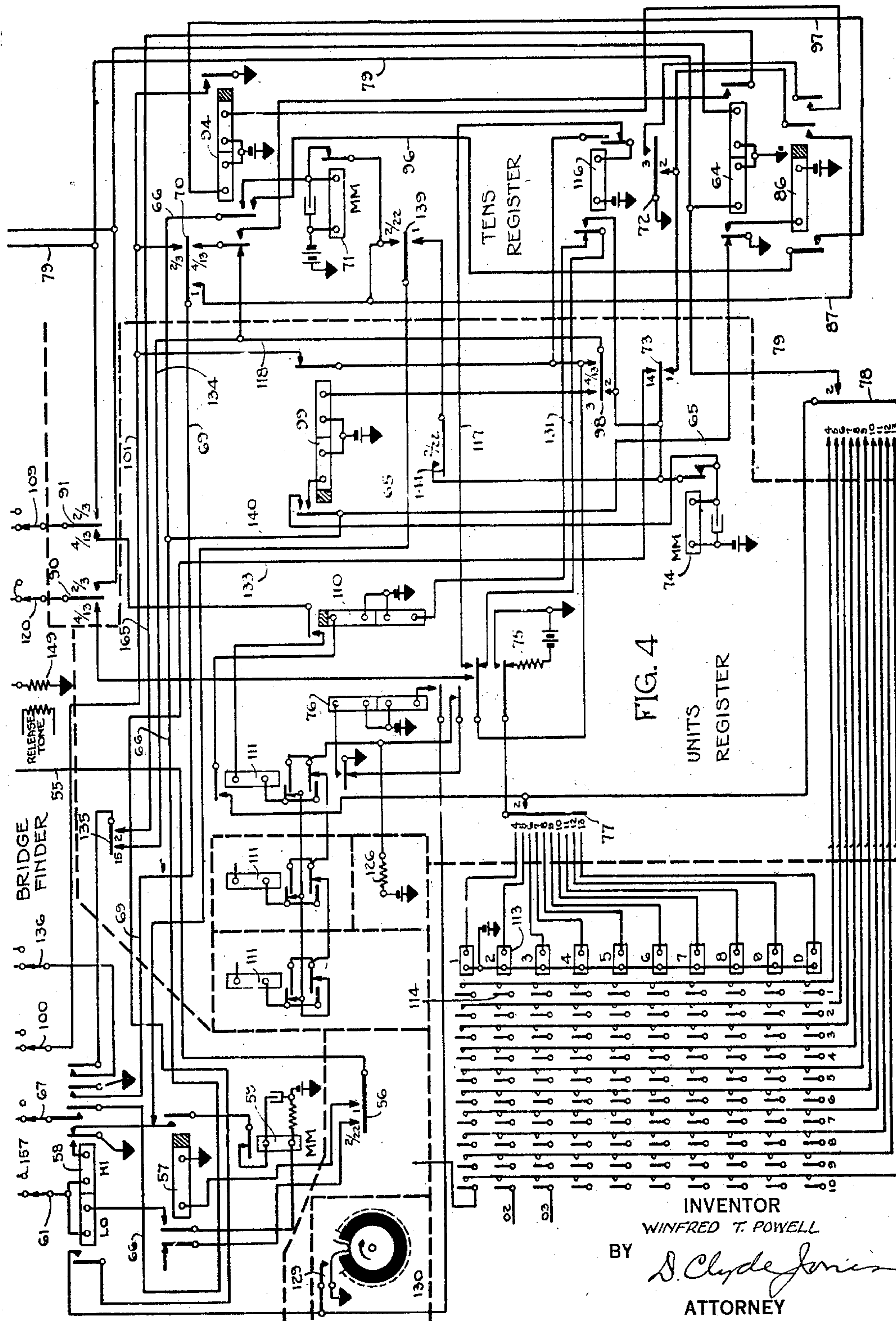
W. T. POWELL

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REMOTE CONTROL MAGNETO TELEPHONE SYSTEM

Filed March 1, 1929

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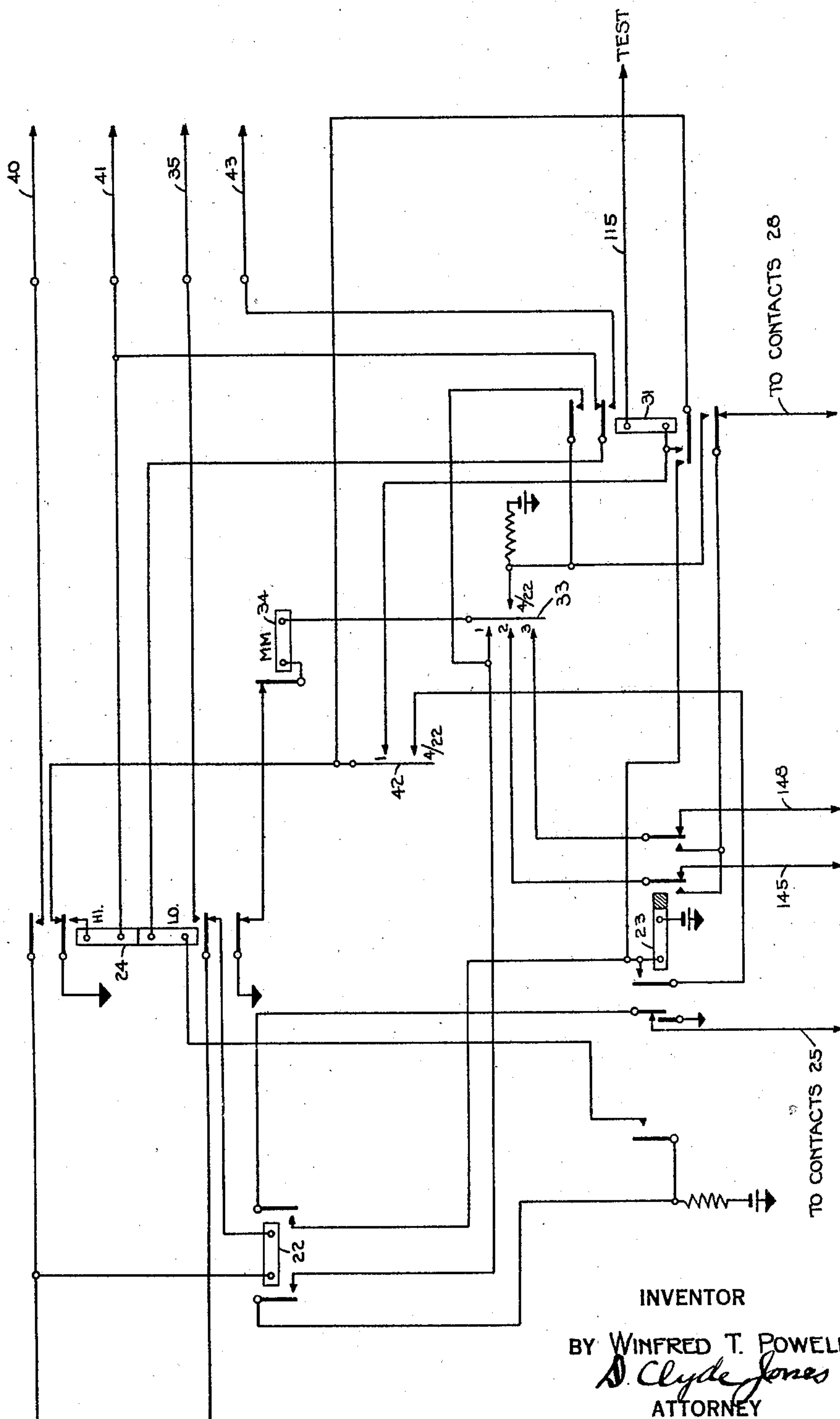
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REMOTE CONTROL MAGNETO TELEPHONE SYSTEM

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FIG 5



UNITED STATES PATENT OFFICE

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

REMOTE-CONTROL MAGNETO-TELEPHONE SYSTEM

Application filed March 1, 1929. Serial No. 343,709.

This invention relates to telephone systems and more particularly to telephone systems in which automatic switches under control of subscribers and operators are employed to complete telephone connections.

It frequently happens that a small group of rural telephone subscribers are localized in a community which is rather remote to a telephone exchange. In such communities the subscribers' outside telephone lines are so poorly constructed that it is impossible to directly control automatic switches thereover. In addition the subscriber's substation equipment is of the local battery type in which a hand-operated generator signals the initiation and termination of a call. The rates in such communities are so low that they do not justify the replacement of the substation equipment and the rebuilding of the outside telephone lines so that impulse senders or dials and directly operated automatic switches may be employed to establish telephone connections. Furthermore, such communities are frequently so small that they do not justify the services of a telephone operator so that these subscribers are usually served from a remote telephone exchange. The use of such a remote telephone exchange requires the use of long subscribers' lines which are expensive to maintain and are inefficient in service.

In accordance with the present invention it is proposed to retain the subscriber's substation equipment without any change whatsoever and to extend the subscriber's telephone line under certain conditions to the remote exchange where an operator provided with an impulse sender may operate automatic switches of a single type to extend the calling telephone line to the line of a wanted subscriber. This service is provided while permitting a subscriber to signal a party on his own line by means of code ringing without the intervention of an operator.

The main feature of the invention is the circuit arrangement by which these results are accomplished and in which the circuit arrangement is efficient in operation and easy to maintain in service with a minimum of expense.

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

In the drawings Fig. 1 is a schematic showing of the present invention; Figs. 2, 3 and 4 with Figs. 2 and 3 arranged in the order named and with Fig. 4 placed below Fig. 3 diagrammatically represent a portion of a telephone system including the present invention. Fig. 5 shows a modified line switch circuit.

The general operation of this system will be understood by referring to Fig. 1 wherein 5 designates a telephone line having one or more subscribers' substations connected thereto and 6 designates a line switch individual to this line. For purposes of this description it is assumed that there are ninety-nine telephone lines although the invention is not limited to this number. The line switches such as 6 have access to bridge circuits 7 which are somewhat analogous to an operator's cord circuit in a manual telephone system and which may be seven in number in the present layout. The circuits of each line switch are so arranged that when its telephone line originates a call it seizes a bridge circuit terminal herein designated "odd." Each bridge circuit is provided with a code selector switch which controls the sequence of operations of the various circuits of the bridge circuit which determines the ringing code. As soon as a bridge circuit is seized by a line switch such as 6, a finder switch 8 (of which there may be two) connects the bridge circuit over an operator's trunk 9 to an operator's switchboard generally designated 10, where a lamp 10, associated with this trunk, is lighted to signal the operator to connect her cord circuit 12 to this trunk. There is associated with this cord circuit and connectible thereto by means of suitable keys (not shown), operator's listening equipment 13 and operator's impulse sending equipment 14 by which impulses corresponding to the subscriber's line may be transmitted to register-sender equipment 15 (of which two may be provided). After the wanted number is stored in this register sender, some one of a group of ten test relays

16 are operated to complete the test circuit 17 of the called line which starts the line switch of this line hunting for the terminal marked "even" of the selected bridge circuit 7. The ringing of the wanted subscriber's station is accomplished over the bridge circuit and as soon as the connection is thus established the finder 8, the register sender 15, and the operator's equipment revert to common use. In the lower part of this figure there are shown two toll lines 18 and 19 terminating in jacks 20 at the operator's position. These trunks are two way trunks so that a call for a subscriber in the remote exchange is extended by the operator in the manual exchange plugging into an idle trunk jack.

In the case of regular calls the subscriber is instructed to signal the termination of a connection by operating the magneto. In the event that the call is continued beyond a predetermined time interval, timing mechanism is provided to disestablish the telephone connection. In the case of toll calls the mentioned timing equipment does not function to terminate the connection.

All of the switches employed in this system are of the rotary type commonly known in the art as rotary line switches and are preferably of the 22-point type. For simplicity in disclosure the wiring to the various terminals of the switches has been omitted and instead small numerals associated with certain of the brushes indicate the brush positions in which connections are completed therethrough. For example 7/16 indicates that the connections through a brush are completed in positions 7 to 16 inclusive whereas if the oblique dash is omitted it indicates that the circuit connection is completed only in positions 7 and 16.

Let it first be assumed that a subscriber whose substation is designated A, desires to signal a party on his own line, which type of call is commonly known as a revertive call, he operates the magneto 21 associated with this station to send the proper code impulses which may be long or short rings to signal the wanted party. In the case of such a call the subscriber's line switch shown in the upper right hand corner of Fig. 2 does not function for a reason to be pointed out and the services of the operator at the remote exchange are not required.

When, however, the subscriber at A desires to establish a telephone connection to a wanted subscriber on another telephone line whose substation is herein designated B, the calling subscriber operates his magneto 21 to produce an especially long series of impulses of current. When the subscriber at A operates his magneto 21 to produce short and long series of code impulses, the relay 22 is operated over the subscriber's line through the inner, lower back contact and armature of the cut-off relay 24. As soon as the relay

22 is operated it closes a break point in the circuit of the timing relay 23 which circuit is traceable from grounded battery, winding of this relay, contact and armature of relay 22, continuity spring and back contact of relay 23 and contacts 25 of the timing device. When the spring tip 26 encounters the insulating cam 27, the contacts 25 are closed so that the timing relay 23 is operated whereupon it closes a locking circuit for itself from grounded battery, its winding, contact and armature of relay 22, its continuity spring and armature to ground. On revertive calls the operation of the relays 22 and 23 is of no avail, but when the operator is wanted, an especially long code ring is transmitted from magneto 21, the duration of which is sufficient to keep relay 22 energized until the contacts 28 are closed due to the spring 26 dropping into the notch 29 of the timing disc. A circuit is closed from grounded battery, resistance coil, contact 28, conductor 30, back contact and armature of the terminating test relay 31 of the calling line switch, armature 32 and contact of relay 23, brush 33 of the line switch in position 1, winding of the motor magnet 34, its back contact and armature, back contact and armature of cut-off relay 24 to ground. Under the control of this circuit the motor magnet 34 advances the brushes of the line switch into position 2. The timing relay 23 is locked operated from grounded battery, its winding, upper front contact and armature, brush 42 in any of its positions 2 to 22, upper back contact and armature of relay 24 to ground which maintains the relay 23 energized, because it is slow releasing, until battery is applied to the terminal 36 which will lock the cut-off relay 24 operated even after the slow releasing relay loses its current. If the "odd" test terminal of the first trunk tested by the outgoing test brush 35 is busy as indicated by the absence of ground potential on its test terminal similar to 36 of Fig. 3, the motor magnet will continue to advance its brushes in a circuit now traceable from grounded battery, brush 33 in any of its positions 2 to 22 inclusive, winding of motor magnet 34, its back contact and armature, back contact and armature of cut-off relay 24 to ground. The line switch continues to advance its brushes until its test brush 35 encounters an idle bridge circuit whose test terminal is characterized by the presence of ground potential at which time the circuit of the motor magnet 34 is interrupted due to the operation of the cut-off relay 24. This operating circuit extends from grounded battery, front contact and armature 37 of the timing relay 23, low resistance winding of the cut-off relay 24, inner armature and back contact of relay 31, test brush 35, test terminal 36 of the idle bridge circuit, armature and back contact of the bridge release

relay 38, code switch brush 39 in its first position to ground. The cut-off relay 38 on operation attracts its armatures to extend the subscriber's telephone line to the brushes 40 and 41 of the line switch and at the same time closes a locking circuit for itself from ground, its inner armature and front contact, its high resistance winding, thence to grounded battery, through the inner back contact and armature of relay 31 and through the low resistance winding of the cut-off relay, armature 37 of the timing relay 23 to grounded battery. Also when the cut-off relay 24 was operated, at its inner lower armature and back contact it disconnects the relay 22 so that current in the subscriber's line in the course of establishing a connection is not effective to disturb the relays 22 and 23 of the line switch.

It has previously been mentioned that when the line switch originates a call it seeks the "odd" set of terminals of an idle bridge circuit. When, however, this line switch is operating to extend its telephone line as a called line, it seeks the "even" terminals of the selected bridge circuit. This odd and even selection is affected by the use of an outgoing test brush 35 and a terminating test brush 43, either one or the other of these test brushes being rendered effective for testing by the condition of the terminating test relay 31. It will be understood that if this test relay is energized the terminating test brush 43 is effective to cause the line switch to seize the "even" terminals of the selected bridge circuit whereas if the relay 31 is deenergized the originating test brush 35 is operative to seize the "odd" terminals of any idle bridge circuit. As soon as the calling line is extended through the contacts of the cut-off relay 24 and through the line switch brushes 40 and 41 to the "odd" terminals of the selected trunk the relay 38 (Fig. 3) is energized in the circuit including this extended calling line through the left hand winding of the relay 38, code switch brush 44 at its position 1 to grounded battery, the remainder of the circuit being completed through the upper left hand winding of the repeating coil, conductor 45, brush 39 in its first position to ground. The operation of the relay 38 is effective to energize the motor magnet 46 from grounded battery, its winding, armature and back contact, brush 47 in its first position, front contact and armature 48 of relay 38 to ground. This circuit is effective to advance the brushes of the code switch into position 2 at which time the relay 38 is locked operated from ground, brush 49 in positions 2 to 19 inclusive, inner right hand armature and front contact of relay 38, its winding, conductor 50 and thence to grounded battery either through the back contact and armature of the relay 51 or the back contact and arma-

ture of the relay 52, resistance 53 and the low resistance winding of the relay 54.

With the code switch in position 2 a circuit for starting the finder switch shown in the upper part of Fig. 4, is closed from grounded battery, brush 44, the common starting conductor 55, units register brush 56 in position 1, winding of the slow releasing relay 57 of the finder switch to ground. It will be understood that if more than the operating trunk is provided there will be more than one finder switch so that the first idle finder switch in the series will always be started. Whenever the switch of a units register is away from position 1 its associated finder switch cannot be selected but the next one in the series will be taken.

The operation of the relay 57 completes a circuit from ground, inner-most armature and back contact of relay 58, continuity spring and armature of relay 57, armature, back contact and winding of the motor magnet 59 of the finder switch and resistance coil to grounded battery. Under the control of this circuit the motor magnet advances the brushes of the finder switch until they find the bridge circuit which has been selected for extending the call under consideration, which circuit is indicated by the fact that its code switch is in position 2. As soon as this bridge circuit is found the switching relay 58 is operated from ground at brush 39 of the code switch, conductor 60, finder brush 61, left hand winding of relay 58, front contact and armature of relay 57, and resistance coil to grounded battery. This circuit in addition to operating the switching relay 58 shunts the motor magnet 59 thereby stopping its operation. The relay 58 when operated locks itself in this condition from ground at its inner front contact and armature, its high resistance winding and low resistance winding in series, front contact and armature of relay 57, and thence to grounded battery. This locking circuit is effective until the relay 57 deenergizes after which the locking battery for the relay 58 is supplied through the finder brush 61, conductor 60, left hand back contact and armature of relay 63, through the resistance coil, to grounded battery.

At this time, a circuit is completed from ground at the left hand armature and back contact of relay 64, conductors 65 and 66, armature and front contact of relay 58, finder brush 67, conductor 68, brush 47 in position 2, back contact armature and winding of motor magnet 46 to grounded battery. Under control of this circuit magnet 46 advances the brushes of the code switch into position 3. Also as soon as switching relay 58 is operated a circuit is closed from ground at its right hand armature and contact, conductor 69 and brush 70 of the tens register in its first position, armature, back contact and winding of the motor magnet 71

to grounded battery. This circuit is effective to advance the tens register into its second position whereupon the units register is advanced into position 2 over a circuit completed from ground, tens register brush 72 in its second position, units register brush 73 in its first position, armature back contact and winding of motor magnet 74 of the units register to grounded battery.

As soon as the code switch brush 44 moves out of position 2 the common start conductor 55 is disconnected to prevent starting a second finder switch when the units register leaves position 1 and the relay 57 of the finder is deenergized. A circuit is now completed from grounded battery, high resistance coil 75, back contact and lower-most armature of relay 76, brush 77 in its second position, brush 78 of the tens register in its second position, over the tip side 79 of the operating trunk, tip contacts 80 at the operator's switchboard, winding of the signal relay 81 to ground. It will be noted that the left hand winding of the relay 64 (Fig. 4) is connected to the tip conductor 79 but the resistance of the unit 75 is sufficiently high to prevent this relay from operating but does permit the operation of the signal relay 81 at the operator's switchboard to close a circuit through the white lamp 82 as an indication to the operator that an originating call is connected to this trunk. The operator then inserts the plug 83 into the trunk jack and thereby applies battery through the impulse sender contacts 85 and the windings of impedance coil 86 to both the tip and ring conductors 79 and 89 of this trunk. This is effective to energize the impulse relay 64 which at its left hand armature and front contact effects the operation of the slow releasing relay 86. The tens register is now moved from position 2 to position 3 over a circuit from grounded battery, winding, back contact and armature of the motor magnet 71, conductor 87, right hand front contact and armature of relay 86, tens register brush 72 to ground. Slow releasing change-over relay 94 is then operated in the circuit completed at brush 72 in its third position.

The circuits are now in readiness to receive the code impulses corresponding to the number of the wanted subscriber and at this time the operator presses the listening key 88 to connect her telephone circuit across the conductors 79 and 89 and thence through brushes 90 and 91 of the tens register, the brushes 109 and 120 of the finder to conductors 92 and 93, through the upper and lower right hand windings of the repeating coil. It will be understood that the calling subscriber's telephone line is connected to the left hand winding of this coil shown in the upper left hand corner of Fig. 3 and since the connection is established between the subscriber

and the operator, the designation of the wanted line is transmitted to the operator whereupon she operates the impulse sender represented by the contacts 85 to transmit code impulses corresponding to the tens and units digits and the code ringing signal. If the wanted substation is an individual line, a code corresponding to one ring must be dialed in order to cause the circuits to complete their operation.

It will be assumed that the wanted number is 12-4 in which the number 4 corresponds to the code of the wanted substation on the called party line. When the operator actuates the impulse sender 85 to send one impulse corresponding to the tens digit, the impulse relay 64 deenergizes once and then remains energized. This deenergization closes a circuit from ground at the armature and back contact of relay 64, conductors 65 and 66, inner-most contact and armature of change-over relay 94, winding of the motor magnet 71, to grounded battery. This circuit advances the tens register brushes to position 4 corresponding to the tens digit #1. The change-over relay 94 is locked operated during the impulsing interval from grounded battery, its left hand winding, conductor 97, front contact and armature of relay 86, conductor 96, left hand front contact and armature of relay 94, conductors 66 and 65, back contact and armature of relay 64 to ground.

At the close of the tens series of impulses the relay 64 remains energized for a comparatively long interval which permits the slow releasing relay 94 to deenergize. This closes an operating circuit from ground at an armature and front contact of relay 58, conductor 69, brush 70 in positions 4 to 13 inclusive, back contact and armature of relay 94, brush 98 of the units register in its second position, armature, back contact, and winding of the motor magnet 74, to grounded battery. This is effective to advance the units register to position 3 where a circuit is extended from ground over conductor 69, brush 70, armature and back contact of relay 94, conductor 118, units register brush 98, right hand winding of the units change-over relay 99 to grounded battery.

When the tens register leaves position 3, ground potential is removed from the finder brush 100 at brush 70 of the register. The tens change-over relay 94, however, maintains ground potential on conductor 101 until the tens register is adjusted after which this ground is removed allowing the relay 102, which has been energized over conductor 101, to release whereupon the code switch is advanced from position 4 to position 5 (the code switch having been moved to position 4 on the operation of the relay 102) in a circuit completed from ground, armature and back contact of relay 102, conductor 103, brush

47 in its fourth position, back contact, armature and winding of the motor magnet 46 to grounded battery.

The sender is now in condition to receive the code impulses corresponding to the units digit of the wanted number and the operator actuates the impulse sender 85 to transmit two impulses corresponding to the digit #2. This is effective to cause the impulse relay 64 to deenergize twice after which it is held operated for a relatively long interval. Each deenergization of the impulse relay is effective to close a circuit from ground through the back contact of this relay, left hand armature and front contact of the units change-over relay 99, winding of the units register motor magnet 74, to grounded battery. This circuit is effective to advance the units register to position 5 since this is the position corresponding to the units digit #2. During the transmission of the units impulses the units change-over relay 99 is maintained energized through its left hand winding, front contact and armature, conductor 65, to ground at the back contact and armature of the impulse relay 64.

At the close of the unit series of impulses the relay 99 deenergizes and thereby operates relay 102 of Fig. 3. This operating circuit is completed from ground at the middle armature and front contact of relay 58 (Fig. 4) conductor 69, brush 70 in positions 4 to 13, left hand armature and back contact of relay 94, brush 98 in positions 4 to 13 inclusive, right hand armature and contact of relay 99, conductor 101, finder brush 100, conductor 105, left hand winding of relay 102, brush 44, resistance coil to grounded battery. With relay 102 operated the motor magnet 46 of the code switch is operated from grounded battery, its winding, armature and back contact, brush 47 in its fifth position, conductor 106, outer front contact and armature 52 to ground, advancing the code switch to position 6. The code switch now closes a circuit from ground, brush 39 in its sixth position, left hand winding of code change-over relay 51 to grounded battery. This relay when energized prepares the bridge circuit to receive the code impulse.

Since it has been assumed that the code is #4, the operator actuates the impulse sender 85 to transmit four impulses which are effective to cause the impulse relay 64 to deenergize four times after which it will remain energized for a comparatively long interval. Each deenergization of the relay 64 closes a circuit from ground through its back contact, conductors 65 and 66, armature and front contact of relay 58, finder switch brush 67, conductor 68, armature and front contact of relay 51, winding of the motor magnet 46 to grounded battery. In response to each closure of this circuit the code switch is advanced one step bringing it into position 10

which is the position corresponding to the code #4. These impulses are also effective to maintain the slow releasing change-over relay 51 operated through its right hand winding. When, however, the code switch is set relay 51 deenergizes and thereby closes a circuit from ground at brush 39, inner back contact and armature of relay 51, conductor 107, upper-most armature and back contact of relay 108, conductor 93, finder switch brush 109, units register brush 91, upper armature and front contact of slow releasing relay 110, winding of the series relay 111, through the series contacts controlled at the armatures of other relays 111, resistance unit 126, to grounded battery. When the relay 111 is thus energized, it closes a circuit for operating the relay 76 which circuit is completed at the lower-most contact and armature of relay 111. The operation of the relay 76 extends a circuit from ground, lower-most contact and armature of relay 76, units register brush 77 in position 5, winding of the relay 113 to grounded battery. The operation of the relay 111 also completes a circuit from grounded battery, upper winding of the relay 110, upper armature and front contact of relay 111, tens register brush 78 in position 4, inner-most contact and armature 114 of relay 113 and thence to a test conductor like 115 of Fig. 2, winding of a terminating test relay similar to 31 of the called line switch and thence to ground at that switch if it is idle, through a brush thereof similar to 42 in position 1 and through the back contact and armature of its cut-off relay similar to 24, to ground. With the relay similar to 31 operated, a timing relay similar to 23 at the called switch is operated, from grounded battery, winding of this relay, lower contact and armature of a relay similar to 31, back contact and armature of a cut-off relay similar to 24 of the called line. With the timing relay such as 23 energized, an operating circuit for the motor magnet, similar to 34, of the called line switch is completed from ground at an armature and back contact of its cut-off relay, similar to 24, armature, back contact and winding of this motor magnet, line switch brush such as 33, in position, front contact and armature of its timing relay 23, upper armature and front contact of its relay 31, to grounded battery through the resistance coil. Under the control of this circuit the called line switch advances its brushes to test the "even" terminals of the several bridge circuits since the terminating test brush such as 43 is connected in circuit while the originating test brush such as 35 is disabled for testing. As soon as the motor magnet of the called line switch has moved its brushes into position 2 another circuit is completed from grounded battery, line switch brush, such as 33, in position 2, winding of the motor magnet, such as 34, its back con-

contact and armature, back contact and armature of the cut-off relay 24 of the called line to ground. Under the control of this circuit, the motor magnet advances the brushes of the called line switch until the bridge circuit previously seized by the called line has been found. This bridge circuit is characterized by the presence of a distinctive test condition which will now be described.

A circuit is now effective for energizing the relay 116 of Fig. 4 from grounded battery, its winding, continuity spring and back contact, conductor 117, front contact and armature of relay 76, units brush 98 in position 5, conductor 118, back contact and armature of relay 94, tens register brush 70 in position 4, conductor 69, front contact and armature of relay 58 to ground. The relay 116 when thus energized closes a locking circuit for itself through its continuity spring and armature, units register brush 98 and thence to ground over conductor 118 and the remainder of the circuit previously described. At this time the relay 102 (Fig. 3) is energized to apply the distinctive test condition to the terminating end of the bridge circuit connected to the calling line. This relay is operated in a circuit completed from grounded battery at code switch brush 44, conductor 119, right hand winding of relay 102, conductor 92, finder brush 120, units register brush 90 in its fifth position, front contact and armature of relay 76, units register brush 98 in position 5, conductor 118, back contact and armature of relay 94, tens register brush 70, conductor 69, to ground at the front contact and armature of relay 58. With the relay 102 operated, the ground potential on conductor 92 is applied through the right hand armature and front contact of relay 102, back contact and armature of relay 108 to the terminating test terminal 121. It has previously been mentioned that the line switch of the wanted line has been advancing its brushes 122 and 123 under the control of a motor magnet similar to 34 of Fig. 2 and that its terminating test relay associated therewith similar to 31 has rendered the terminating test brush 123 effective to test the bridge instead of the originating test brush 122. Referring again to Fig. 2 when the terminating test brush of the called line switch encounters the grounded terminal 121 of the bridge, the cut-off relay of the called line similar to 24 is operated from grounded battery, front contact and armature similar to 37, of a relay similar to 23, low resistance winding of the cut-off relay, armature and front contact of a terminating test relay similar to 31, terminating test brush 123 to the grounded test terminal 121. The cut-off relay is now locked in a circuit from ground, its armature, front contact and high resistance winding, originating test brush 122, test terminal 124, winding of the relay 108, conductor 125, back

contact and armature of relay 52 to grounded battery through the lower winding of relay 54. Relay 108 is thus energized and at its inner upper armature and back contact disconnects the terminating test terminal 121 so that there is no chance for another line switch being stopped on this terminal.

The operation of the relay 108 also opens the circuit to ground otherwise completed over conductor 107 and code switch brush 39, which has been holding the relay 111 operated and the release of this relay completes a circuit from ground, armature and front contact of relay 76, resistance unit 126 to grounded battery. This last mentioned circuit prevents the operation of any of the other relays 111 until the relay 76 is released.

Since the code switch of Fig. 3 is now in position 10, the code ringing circuit corresponding to the #4 code is connected by way of the brush 127 to the inner back contact of relay 102, but this relay is maintained energized at this time to prevent the application of code ringing current to the called line at any time except at the beginning of the code signal. The relay 102 is maintained energized as long as the relay 76 is operated and this last named relay is locked through its lower winding and contacts 129 of an interrupter 130. It should be understood that the contacts 129 are closed at all times except when the projection on one of the contacts drops in the notch in the insulating cam of the interrupter. After the code ringing period has been completed, the springs 129 of the interrupter are opened to remove ground from the locking circuit including the lower winding of the relay 76 which permits this relay to deenergize and which in turn opens the circuit previously described as extending through a winding of the relay 102. This relay now releases and connects the code ringing generator through the brush 127, inner back contact and armature of relay 102, thence over the lower side of the called line to substation B, and over the upper side of the called line, conductor 107, armature and back contact of relay 51, code switch brush 39 to ground.

On the release of the relay 76 of Fig. 4 a circuit is closed from ground at the armature and front contact of relay 58, conductor 69, tens register brush 70, armature and back contact of relay 94, conductor 118, units register 98 in its position 4 to 13, armature and back contact of relay 76, conductor 131, armature and front contact of relay 116, armature, back contact and winding of motor magnet 74 of the units register which magnet is effective to advance the units register to position 14.

The code switch of Fig. 3 remains in position 10 until one complete cycle of the code ringing generator has been completed but it will be understood that this cycle may include one or more complete code rings as de-

sired. At the end of the ringing cycle the interrupter 130 closes its contacts 129 to complete a circuit from ground, left hand contact and armature of relay 58, conductor 133, units register brush 73 in its fourteenth position, armature, back contact and winding of magnet 74, to grounded battery, which circuit advances the units register into its fifteenth position. This completes a circuit from ground at relay 58, over conductor 69, tens register brush 70 in position 4, armature and back contact of relay 94, conductor 134, units register brush 135 in position 15, outer armature and front contact of relay 58, finder brush 136, left hand winding of relay 63, code brush 44 in positions 7 to 16, and thence to grounded battery. The relay 63 is then locked operated from grounded battery, its right hand winding, code brush 137 in positions 7 to 16, inner front contact and armature of relay 63, to ground. The operation of this relay also advances the code switch to position 17 over a circuit from grounded battery, winding of its motor magnet 46, its armature and back contact, code brush 47 in positions 7 to 16, inner front contact and armature of relay 63 to ground. The code switch is then advanced to position 18 over a circuit closed through brush 47 and the lower front contact and armature of relay 108. In position 18 the calling substation A and the called substation B are connected for conversation since the lower right hand winding of the repeating coil is connected to the lower side of the called line through brush 127 and inner back contact and armature of relay 102.

The operation of the relay 63 opens the circuit to grounded battery, over conductor 60 that was holding the relay 58 operated which causes this relay to deenergize and to restore the finder switch to its normal condition. The release of the relay 58 also restores the tens and units registers to normal position. The restoring circuit of the tens winding, back contact and armature of motor register extends from grounded battery, magnet 71, brush 139 in any of its positions 2 to 22 inclusive, conductor 140, back contact and continuity spring of relay 57, back contact and armature of relay 58 to ground. As soon as the tens register is restored to normal the restoring circuit of the units register is completed from grounded battery, winding of its motor magnet 74, back contact and armature, brush 141 in its positions 2 to 22 inclusive, tens brush 139 in position 1 and thence to ground at the armature and back contact of relay 58 over conductor 140. The finder and register sender are thus in condition for use in a succeeding call.

In position 18 of the code switch, a circuit is completed for advancing this switch from position 18 to 19 which circuit may be traced from ground at interrupter 143, contact spring 144, conductor 145, armature and front

contact of relay 38, brush 47 in position 18, back contact, armature and winding of motor magnet 46 to grounded battery. After a certain time interval for example five minutes, the insulating cam 146 of the interrupter 143 will connect the contact 147 to ground which effects the completion of a circuit over conductor 148, inner armature and back contact of relay 63 (now deenergized since its circuits are now open at brushes 44 and 137) outermost armature and contact of relay 38, brush 47, in position 19, back contact, armature and winding of motor magnet 46 to grounded battery, which moves the code switch from position 19 to position 20. In position 19 of this switch the ground which locks the relay 38 operated through its right hand winding is connected through a tone induction coil 149 shown in the upper part of Fig. 4 so that a short time, such as a quarter of a minute, before conductor 148 is connected to ground at interrupter 143 a tone is applied to this coil which is transmitted over conductor 150, back contact and continuity spring of relay 63, conductor 151, brush 49 in position 19, right hand armature, front contact and winding of relay 38, conductor 125, right hand armature and back contact of relay 52, resistance coil 53 and low resistance winding of relay 54 to grounded battery. This tone is induced in the upper winding of relay 54 and since this winding is connected across the condenser in series with the windings of the repeating coil, the calling subscriber will hear the tone which is an indication that the conversation must be completed within a quarter of a minute otherwise the connection will be terminated at the expiration of that period. When the code switch is moved out of position 19 by the completion of the circuit including conductor 148, closed to ground at interrupter 143, the code switch is advanced through positions 2 to 22 inclusive to its normal position in a circuit traceable from grounded battery, winding armature and back contact of motor magnet 46, brush 47 in positions 20 to 22 inclusive, to ground.

Let it now be assumed that the called line was busy at the time it was tested. Under this condition relay 110 although it has been energized through its lower winding, does not have its holding circuit completed through its upper winding, front contact and armature of relay 111, brush 78, front contact and armature 114 of relay 113, since ground on the test conductor 115 of the busy line switch has been removed. Therefore, relay 110 deenergizes in the case of a busy call before the relay 111. The release of relay 110 at its upper armature and contact opens the circuit of relay 111 causing it to deenergize, and the register sender including the tens and units registers pass through their cycle of operations as described above

in connection with a call to an idle line. In this case, however, relay 108 (Fig. 3) of the bridge circuit is not operated because the called line switch is not connected to this bridge circuit. The code switch when it gets to position 17 stops there because there is no ground applied to brush 47 at this position to continue the advance of the switch. In position 17 the ground which locks the relay 38 is connected through a common busy induction coil 153 and this tone is applied through the right hand winding of relay 38, conductor 125, armature and back contact of relay 52 and thence to grounded battery, through the resistance unit 53 and the lower winding of relay 54. Tone in this circuit is induced in the upper winding of the relay 54 and is applied to the calling line through the windings of the repeating coil.

When either the calling or the called subscriber desires to terminate the connection, he rings off by operating the substation magneto such as 21. At this time the code switch is in position 17, 18 or 19 and if it is the calling subscriber who rings off, the relay 155 will be energized by that magneto current over the calling line and the originating end of the bridge circuit in series with the upper winding of relay 155. If it is the called subscriber who rings off, magneto current will be transmitted over his telephone line and the terminating end of the bridge circuit in series with the upper winding of the relay 54. On the operation of either the relay 54 or 155 this last-named relay is locked operated through its lower winding and either its upper armature and front contact or the upper armature and front contact of relay 54 depending on which of these relays is operated, conductor 156, back contact and armature of relay 52, brush 39 in positions 17 to 19 inclusive to ground. The operation of relay 155 closes the start wire 55 which is effective to cause an idle finder switch to associate its register sender and operating trunk with this bridge circuit, which start circuit may be described as extending from grounded battery, brush 44, lower front contact and armature of relay 155, conductor 55, brush 56 now in position 1, winding of relay 57 to ground. Relay 57 is thus operated and causes the motor magnet 59 of the finder switch to operate its brushes. In this case the finder brushes select the right hand set of contacts of the two sets shown. In other words there is an originating set of terminals and a terminating set of terminals for each bridge circuit in each finder switch. The finder switch continues to hunt for the bridge circuit in use which is characterized by the presence of ground on its test terminal 157. This ground potential is applied from code switch brush 39 in any of its positions 17 to 19, back contact and armature of relay 52, upper armature and contact of relay 155, back contact and armature of relay 52, conductor 158, terminal 157. The relay 58 is operated by ground on terminal 157 and is locked operated in the manner previously described in connection with the original seizure of the register sender. The tens and units register are likewise advanced into position 2 as in the case of their original operation. With the tens register in position 2 the relay 52 is actuated from grounded battery, its winding, conductor 160, finder brush 100, conductor 101, tens register brush 70, conductor 69, front contact and armature of relay 58 to ground. The operation of relay 52 also at its outer left hand armature and contact connects grounded battery over conductors 161 and 158 in series with terminal 157 for holding the relay 58 in its operated condition. The signal relay 81 at the operator's position is again operated from ground, its winding, tip springs 80 of the jack, conductor 79, tens brush 78, units brush 77, armature and back contact of relay 76, resistance unit 75 to grounded battery. In addition the relay 162 at the operator's position is actuated from ground, winding of this relay, ring contacts of the jack, conductor 89, units brush 90, finder brush 120, conductor 92, front contact and armature of relay 52 to grounded battery. With the relays 81 and 162 at the operator's position in operated condition the disconnect lamp 163 has its lighting circuit closed to the front contacts and armatures of these relays. The lighting of the disconnect lamp 163 signals the operator for disconnection and she thereupon inserts the plug 83 into the jack of the trunk in use. The operator then actuates the listening key 88 to make sure that there is no conversation on this bridge and thereafter actuates the impulse sender 85 to send one or more impulses. The impulse or impulses are effective to operate the impulse relay 64 in the manner previous described which causes the tens register magnet 71 to advance this register to some one of the positions 4 to 13 inclusive. At the close of the operation of the impulse sender with the tens register in some position from 4 to 13 a circuit is closed for operating the relay 51 through its left hand winding, conductor 164, finder brush 136, front contact and armature of relay 58, brush 135 in position 2, conductor 165, armature and front contact of relay 64, front contact and armature of relay 94, brush 70, conductor 69, front contact and armature of relay 58 to ground. Relay 52 is held operated during this setting of the tens register in a circuit including conductors 160 and 101, connected to ground at the front contact and armature of relay 94. With the relays 51 and 52 operated, the holding battery at the relay 54 is disconnected from the holding terminal 36 of this bridge circuit which permits the calling line

switch to release and causes the relay 38 to deenergize. Thereupon the code switch is advanced to position 20 in a circuit from grounded battery, motor magnet 46, its armature and back contact, back contact and armature of relay 38, brush 49 to ground. The code switch is then advanced to normal position in a circuit completed from grounded battery, winding of its motor magnet 46, its armature and back contact, brush 47 to ground. After ground potential is removed from the finder brush 100 by deenergization of the relay 94, the relay 52 of the bridge circuit deenergizes and removes the holding battery for the relay 58 of the finder switch and the release of this relay restores the tens and units registers to normal as previously described.

If another subscriber attempts to ring in on a talking connection, the relay 155 will be operated in the same manner as in the case of a disconnect signal or a ring, but in this case the connection must not be disestablished. The trunk to the operator's position is seized in the same manner as previously described and the operator is signalled by means of the disconnect lamp 163 as before. In this case when the operator listens on a connection she hears a conversation and knows that the connection should not be interrupted. She thereupon removes the plug 83 from the jack without operating the impulse sender 85. This releases the relay 64 and closes a temporary circuit for locking the relay 94 through its left hand winding, conductor 97, left hand front contact and armature of relay 86, conductor 96, front contact and armature of relay 94, conductor 66, conductor 65, back contact and armature of relay 64 to ground. Motor magnet 71 of the tens register is now energized in a circuit in multiple of that just described and completed through the front contact and armature of the relay 94, but does not advance its brushes until it releases so that the tens register switch will stay in position 3 until after relays 86 and 94 deenergize. Another operating circuit for the relay 94 is completed through its right hand winding, right hand front contact and armature of release relay 86, register brush 72 in its third position to ground. Since the relay 94 deenergizes before the tens register leaves position 3, there is no ground applied through the right hand armature and contact of the impulse relay 64 and the outer left hand front contact and armature of relay 94, over conductors 165 and 164, to energize relay 51 (Fig. 3). Therefore, relay 52 will be energized but since relay 51 is not energized the holding battery through the resistance coil 53 is not disconnected from the relay 38 of the bridge. When, however, relay 52 deenergizes the finder switch and the register switch will be restored to normal

as previously described without disturbing the established connection.

Toll operation

The operation of establishing a connection to or from a toll line such as is shown in the lower left hand corner of Fig. 2 is substantially the same as the operation of establishing a connection between two regular subscribers' lines except that the time disconnect feature is not effective on a toll connection, that is, such a connection is maintained as long as the subscriber desires to converse. The line switch associated with the toll trunk is of the type that remains in the position last used whereas the line switches of the regular subscribers are of the type that advance to normal on release. It will be noted that the terminals of the toll trunk line switch are multiplied with those of the other switches so that it has access to the bridge circuits the same as other lines.

It is believed that the operation of the line switch will best be understood by describing the operation of extending the toll line C to a bridge circuit such as that shown in Fig. 3. To initiate such a call over the toll line C, a long impulse of magneto current is transmitted over the two sides of the toll line in series, to the relay 166 which operates and as soon as the contacts 25 of the timing device are closed a circuit is extended from ground through these contacts, continuity spring and back contact of relay 167, make contact of relay 166, winding of relay 167 to grounded battery. As long as the relay 166 is operated in response to magneto current, relay 167 is locked through the front contact and armature of this relay, continuity spring and armature of relay 167 to ground. If the duration of the signal to relay 167 is sufficiently long, the relay 167 will be held operated until the contacts 28 of the timing device are closed whereupon a circuit is extended from grounded battery, upper armature and contacts of relay 167, winding of the relay 168 to ground. This relay when energized locks itself in this condition from grounded battery, through its upper winding, front contact and armature, back contact and armature of relay 169 to ground. With the relay 168 actuated, an operating circuit is closed for the motor magnet 170 from grounded battery, winding of this magnet, its armature and back contact, front contact and armature of relay 168, back contact and armature of relay 169 to ground. Under control of this circuit the motor magnet 170 advances the brushes of the line switch until the test brush 171 encounters an idle test terminal such as 172 of an idle bridge circuit at which time the motor magnet 170 is shunted and the cut-off relay 169 operated from grounded battery, front contact and armature of relay 168, low resist-

ance winding of the cut-off relay 169, armature and back contact of relay 173, brush 171, terminal 172, armature and back contact of relay 38 to ground. The cut-off relay when thus operated closes a locking circuit for itself from ground, its armature and front contact, its upper winding, brush 171, terminal 172, to grounded battery at the winding of relay 54 when the relay 38 is energized as previously described.

In the case of a call to the toll line C, a subscriber such as A establishes connection to a bridge circuit of Fig. 3 and informs the operator that a toll connection is desired. The operator then actuates the impulse sender 85 to set the tens and units registers in common with the designation of the trunk line. This is effective to complete a test circuit through an armature and contact of some one of the tens common test relays shown at the lower left of Fig. 4, to the test conductor 174 of Fig. 2 where the circuit is completed through the winding of relay 173, back contact and armature of relay 168, back contact and armature of relay 169 to ground. Relay 173 is operated in this circuit and disables the test brush 171 and connects the terminating test brush 175, in circuit. Also the operation of the relay 173 affects the energization of the relay 168, from grounded battery, its upper winding, front contact and armature of relay 173, back contact and armature of relay 169 to ground. The operation of the relay 168 completes a driving circuit for the motor magnet 170 as previously described which causes this magnet to advance the brushes of the line switch to seize the terminating end of the bridge circuit to which the calling line is connected.

It will be noted in the arrangement just described that no provision is made for causing a calling line to test busy in the case of a revertive call. If it becomes desirable to supply such busy protection for calling lines, the modified type of line switch circuit shown in Fig. 5 may be used. It will be understood that the circuits of this figure may be substituted for the line switch circuits shown in the upper right hand corner of Fig. 2 and determined by the rectangle defined by the margin of the drawing and the broken lines. In this arrangement when the subscriber at A operates his magneto generator 21 to produce long and short code impulses of the code ringing characteristic, for signaling another station on his line the relay 22 is operated over the two sides of this line in series and inner armature and back contact of the cut-off relay 24.

With the relay 22 operated a circuit is closed from grounded battery, resistance, left hand armature and contact of relay 22, line switch brush 33 in position 1, winding of the motor magnet 34, its armature and back contact and armature of the relay 24 to ground. Under

the control of this circuit the motor magnet advances the brushes 33, 35, 40, 41, 42, and 43 into position 2 where they remain until interrupter 143 connects ground to conductor 145 which is effective to operate motor magnet 34 and advance the brushes into position 3. Since the line switch brush 42 has moved from position 1, the calling line can not be seized as a called line due to the fact that the test conductor 115, which starts the line switch of the desired line, is open at this brush. At the end of the predetermined period permitted for any call, the timing interrupter 143 functions to ground conductor 148 which is effective to operate motor magnet 34 and advance the brushes into position 4. In positions 4 to 22 inclusive a circuit is closed for advancing the brushes to normal extending from grounded battery, resistance, brush 33, winding and back contact of motor magnet 34, and back contact of relay 24 to ground. A connection of this class is not effective to operate relay 24 since relay 23 is not operated in any positions in which brushes 40, 41, 35 and 43 are connected to bridge circuits. In the case of a regular call the connection is established and released in the same manner as described in connection with the first mentioned modification.

What I claim is:

1. The method of interconnecting the stations of subscribers located on party lines which comprises using code magneto current to signal a wanted subscriber in the case of a revertive call, employing magneto current in a different code to extend a calling subscriber to an operator, informing the operator of the designation of the wanted subscriber, employing direct current code impulses corresponding to the wanted subscriber's designation to connect the wanted subscriber to the calling subscriber.
2. The method of interconnecting the stations of subscribers located on party lines which comprises using code magneto current to signal a wanted subscriber in the case of a revertive call, employing magneto current in a different code to extend a calling subscriber to an operator, informing the operator of the designation of the wanted subscriber, employing direct current code impulses corresponding to the wanted subscriber's designation to connect the wanted subscriber to the calling subscriber, and automatically disconnecting the operator from the calling subscriber when the connection between the calling and the called subscribers has been completed.
3. The method of interconnecting the stations of subscribers located on party lines which comprises using magneto current to code-signal a wanted subscriber in the case of a revertive call, employing said magneto current in a different code to extend a calling subscriber to an operator, informing the

operator of the designation of the wanted subscriber, employing direct current code impulses corresponding to the wanted subscriber's designation to connect the wanted subscriber to the calling subscriber, automatically disconnecting the operator from the calling subscriber when the connection between the calling and the called subscribers has been completed, and employing magneto current to reconnect the operator to the connection between the calling and the called subscribers.

4. The method of interconnecting subscribers which comprises automatically extending a calling subscriber to an operator in response to a code impulse of magneto current, informing the operator of the wanted subscriber's designation, employing code impulses corresponding to the wanted subscriber's designation to set up a condition whereby the wanted subscriber is non-numerically, automatically connected to the calling subscriber.

5. The method of completing connections between subscribers located on party lines which comprises employing magneto current to code-signal a wanted subscriber in the case of a revertive call, employing magneto current of a different code to automatically, non-numerically connect a calling subscriber to an operator in the case of a non-revertive call, discriminating between the magneto currents of different codes whereby the calling subscriber is extended to an operator only in the case of magneto current control of one code, employing operator-transmitted code impulses corresponding to a wanted subscriber to cause said wanted subscriber to be non-numerically automatically extended to the calling subscriber.

6. In an automatic telephone system, local battery telephone party lines, a magneto generator for each party on a line for signalling the other subscribers, a non-numerical switch for each party line, bridge circuits multiply connected at each of their ends to said automatic switches, an operator's position provided with an impulse transmitter, a register sender associated therewith, means including a non-numerical switch for connecting an idle register sender and said operator's position to a bridge circuit taken for use, said register sender being adjusted in accordance with impulses corresponding to the designation of the wanted subscriber transmitted from the operator's impulse transmitter, and means controlled by said adjusted register sender for causing the non-numerical switch of a wanted telephone line to seize the bridge circuit which has been connected to the calling subscriber's line.

7. In an automatic telephone system, local battery telephone party lines, a magneto generator for each party on a line for signalling the other subscribers thereon, a non-numerical

switch for each party line, bridge circuits multiply connected at each of their ends to said automatic switches, an operator's position provided with an impulse transmitter, a register sender associated therewith, means including a non-numerical switch for connecting an idle register sender and said operator's position to a bridge circuit taken for use, said register sender being adjusted in accordance with impulses corresponding to the designation of the wanted subscriber transmitted from the operator's impulse transmitter, and discriminating means for preventing a non-numerical switch of a calling telephone line from seizing an idle bridge circuit when a subscriber on said calling telephone line operates his magneto to signal another subscriber on said line in the case of a revertive call.

8. In an automatic telephone system, local battery telephone party lines, a magneto generator for each party on a party line for signalling the other subscribers thereon, a non-numerical switch for each party line, bridge circuits multiply connected at each of their ends to said automatic switches, an operator's position provided with an impulse transmitter, a register sender associated therewith, means including a non-numerical switch for connecting an idle register sender and said operator's position to a bridge circuit taken for use, said register sender being adjusted in accordance with impulses corresponding to the designation of the wanted subscriber transmitted from the operator's impulse transmitter, and discriminating means in the form of a timing device for preventing a non-numerical switch of a calling telephone line from seizing an idle bridge circuit when the subscriber on said calling telephone line operates his magneto to signal another subscriber on said line in the case of a revertive call.

9. In an automatic telephone system, a plurality of local battery party telephone lines, a magneto for each party on a telephone line, an automatic non-numerical line switch for each subscriber's line, a plurality of link circuits, each link circuit having an originating end and a terminating portion ending in said automatic switches, means controlled by the magneto of the calling subscriber on a line for causing its line switch to seize the originating end only of a link circuit, an operator's position, means for connecting said operator's position to a bridge circuit that has been selected by a calling telephone line, and means controlled by impulses corresponding to a wanted subscriber's line transmitted from said operator's position to cause the automatic switch of a wanted subscriber's line to seize the terminating portion of the selected bridge circuit.

10. In an automatic telephone system, telephone lines, means including automatic

switches for connecting a calling telephone line with a called telephone line, means operating automatically at the close of a predetermined time interval for releasing the automatic switches of a connection independently of subscriber's control, and means controlled over one of the telephone lines of a connection operating within said predetermined time interval for releasing the automatic switches of a connection.

11. In an automatic telephone system, telephone lines, means including automatic switches for connecting a calling telephone line with a called telephone line, means operating automatically at the close of a predetermined time interval for releasing the automatic switches of a connection independently of subscriber's control, and means controlled over either of the subscribers' lines of a connection for releasing the automatic switches of said connection.

12. In an automatic telephone system, two classes of telephone lines, means including automatic switches for completing a connection between two telephone lines of one class and for completing a connection between two telephone lines of different classes, automatic means operating at the close of a predetermined time interval for releasing the automatic switches of the connection between telephone lines of one class, and means operated over one of the telephone lines of a connection between different classes of lines for releasing the automatic switches of the connection independently of any time interval.

13. In an automatic telephone system, telephone lines, means including automatic switches for interconnecting said telephone lines, means operating at the close of a predetermined time interval for releasing the automatic switches of a connection, and means for transmitting a warning signal to one of the subscribers of a connection prior to the termination of the predetermined time interval.

14. In an automatic telephone system, telephone lines, means including automatic switches for interconnecting said telephone lines, means including circuits at an operator's position cooperating in the interconnection and release of a connection between two subscribers' lines, and two signals at the operator's position controlled over one of the lines of said connection, one of said signals indicating the initiation of a call over a telephone line and the other signal indicating the termination of a call.

15. In an automatic telephone system, a plurality of telephone lines, a plurality of bridge circuits, means including automatic switches for connecting the calling telephone line and a called telephone line to a bridge circuit, operator's position equipment for controlling the completion and the release of a connection between two telephone lines, an

automatic switch for connecting over one path an operator's position equipment to a bridge circuit taken for use, said last mentioned automatic switch operating on the termination of a connection for connecting said operator's position equipment over another path to the bridge circuit connecting said telephone lines.

In witness whereof, I hereunto subscribe my name this 27th day of February, A. D. 1929.

WINFRED T. POWELL.

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