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W. T. POWELL

AUTOMATIC TELEPHONE SYSTEM

Filed Aug. 31, 1920

2 Sheets-Sheet 1

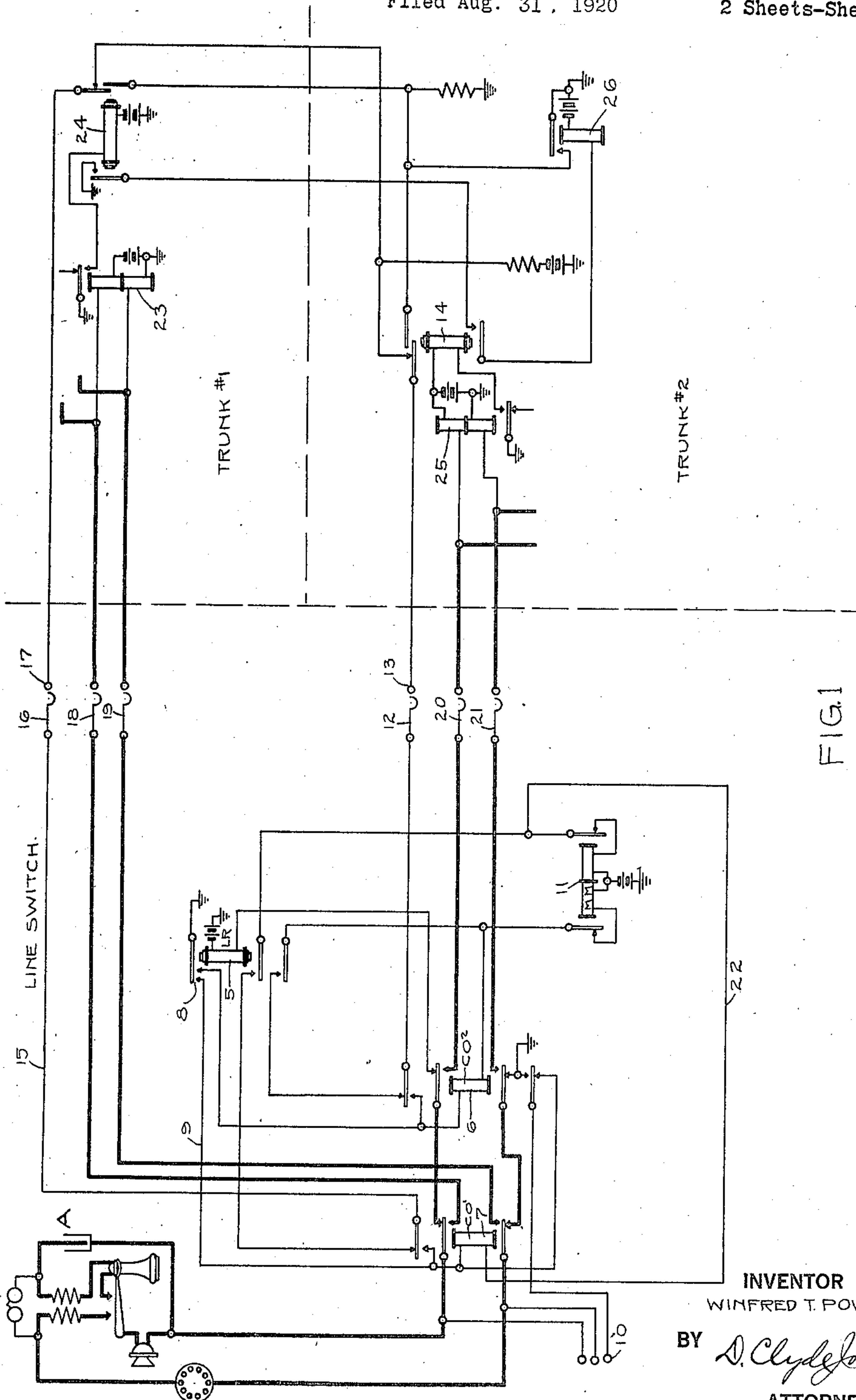


FIG. 1

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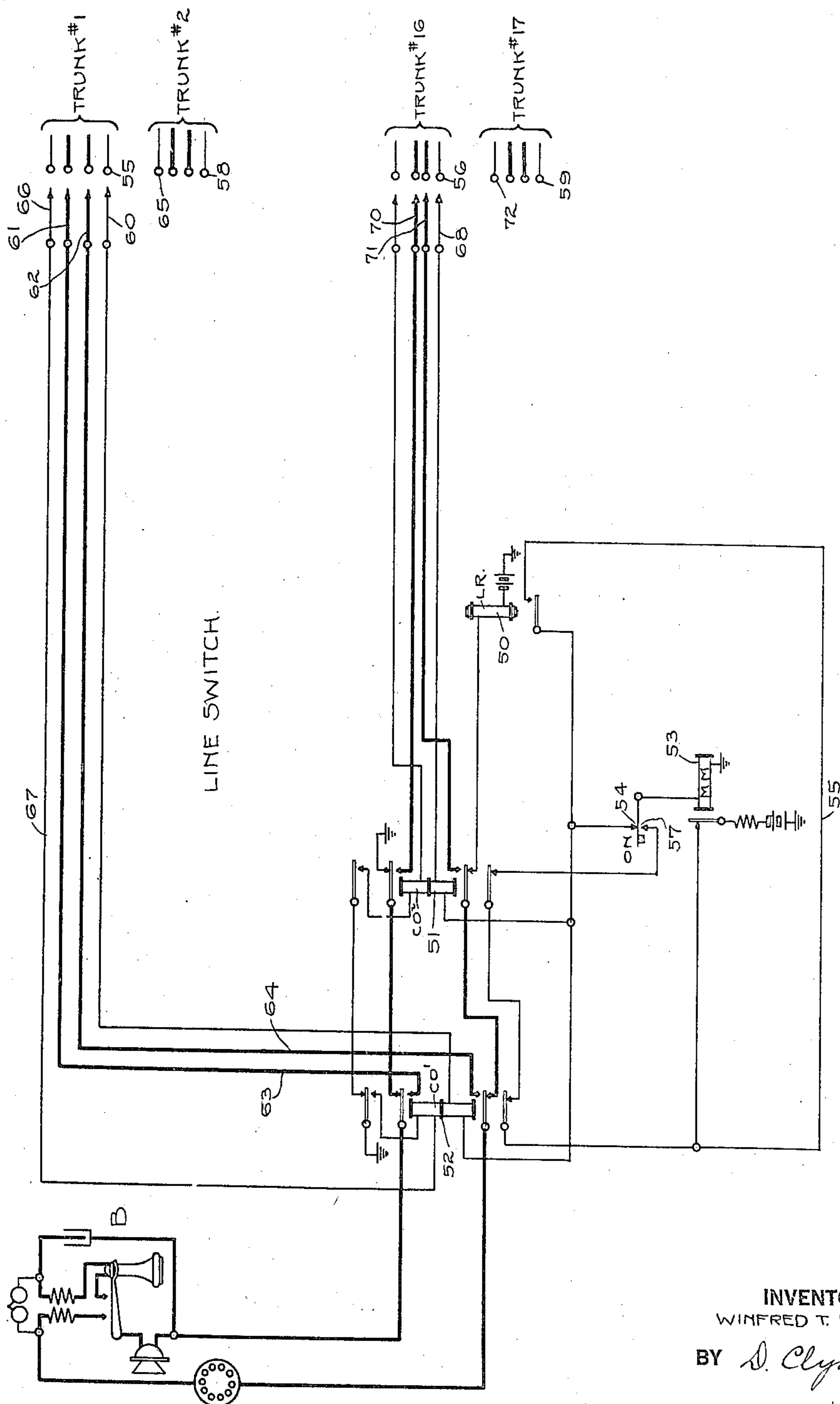
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WINFRED T. POWELL, OF ROCHESTER, NEW YORK, ASSIGNOR TO THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

AUTOMATIC TELEPHONE SYSTEM.

Application filed August 31, 1920. Serial No. 407,173.

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 automatic telephone systems, and more particularly to the circuits of non-numerical switches employed in such systems.

It has been found that it is more economical of apparatus in automatic telephone systems when the groups in which these pieces of apparatus are so arranged, are of large size, since in this manner a group of apparatus is common to a larger number of subscribers.

In former telephone systems the number of switches to which each individual non-numerical line switch has access has been limited owing to the amount of time consumed by the line switch in hunting over a large group of trunks having access to automatic switches.

In accordance with the present invention it is proposed to have a large number of trunks terminate at each line switch, so that each subscriber may have access to a large group of automatic switches, and it is further proposed to arrange the circuits of the line switches so that two different trunks are simultaneously tested. In this way the hunting of idle trunks is accomplished in half the time previously consumed.

In the drawings, Fig. 1 represents a portion of a telephone system in which that part of the drawing at the left of the dotted line represents a subscriber's line with its individual line switch. The rectangle shown at the upper right of Fig. 1 represents one trunk and a very small portion of the circuits of the numerical switch to which this trunk has access. At the lower right hand corner there is similarly represented a second trunk. Fig. 2 represents a modified form of the invention which diagrammatically represents a subscriber's line with the line switch individual thereto. In this arrangement it is assumed that there are fifteen trunks in each group.

The structure of the line switch employed in this invention may be substantially simi-

lar to that disclosed in the patent to Clement, #1,107,153, patented Aug. 11, 1914, except that the switch will be designed for a larger number of brushes or wipers, and co-operating sets of contacts than disclosed in that patent. The sets of terminals of two trunks may be placed one above the other, and two sets of brushes may be placed one above the other to operate with these sets of contacts. It is also to be understood that all the trunks to which the line switch has access, may be arranged in one plane in the arc of a circle, and that the switch will then be provided with two sets of brushes arranged at such an angle to each other that they will simultaneously test different trunks at the same time.

In the course of the description of the so called "stay-put" line switch circuits of Fig. 1, reference will be made to the well known interlocking arrangement between the line and cut-off relays, such as is disclosed in the patent to Lamb, #1,193,160 patented August 1, 1916.

It is believed that the invention will best be understood by describing the method of operating the line switch on the initiation of a call. When the calling subscriber whose substation circuits are indicated at A on Fig. 1 removes his receiver from its switchhook, the slow releasing line relay 5 is operated in a circuit closed from grounded battery, winding of this relay, inner upper back contact and armature of the secondary cut-off relay 6, inner upper back contact and armature of the primary cut-off relay 7, through the calling line and substation circuits, lower armature and back contact of relay 7, inner lower armature and back contact of relay 6 to ground. The line relay is operated in this circuit and attracts its armatures. At its upper armature and contact 8, it applies a guarding potential over conductor 9, through lower-most back contact and armature of relay 6, through the multiple test terminals 10 of the group of connectors that have access to the calling line. At the lower armatures and front contacts of the line relay, break points are closed in the circuits of the motor magnet 11 of the line switch.

Let it be assumed that both of the trunks being tested by the line switch are busy, in which case there will be a direct ground potential placed on the test terminals, such

as 13 and 17 of these trunks. Such guarding potential is applied in the following manner. Whenever a trunk circuit is seized and being held during a connection, its slow releasing relay such as 14 and 24 is operated, and with the release controlling relays such as 14 and 24 of associated trunks operated, a circuit is closed for relay 26 from grounded battery, lower armature and front contact of relay 14, left hand armature and front contact of relay 24 to ground. With the relays 14 and 24 operated, a direct ground potential is applied through the armature and front contact of relay 26, upper armature and continuity spring of relay 14 to test terminal 13 and through the right hand armature and continuity spring of relay 24 to the test terminal 17. The motor magnet 11 thus has two operating circuits closed for itself, the first extending from grounded battery, right hand winding, back contact and armature of this magnet, inner armature and front contact of line relay 5, upper-most back contact and armature of relay 7, conductor 15, test brush 16, test terminal 17 to direct ground at the armature of relay 26. The other energizing circuit for the motor magnet 11 extends from grounded battery, its left hand winding, back contact and armature, lower armature and front contact of line relay 5, upper-most back contact and armature of cut-off relay 6, test brush 12, test terminal 13 to ground at the upper armature of relay 26. Under the control of these operating circuits, the motor magnet 11 advances brushes 16, 18, 19, 12, 20 and 21 over the groups of trunks until either one or both of the test brushes 12 and 16 encounter an idle trunk, whereupon the motor magnet will cease to operate.

Let it be assumed that the first idle trunk tested by either the test brush 12 or 16 while the two sets of brushes are being simultaneously advanced is that trunk whose test terminal is designated 17. This idle condition will be indicated by the presence of battery potential on its test terminal. The primary cut-off relay 7 will therefore be operated over a circuit extending from grounded battery, resistance, back contact and continuity spring of relay 24, test terminal 17, brush 16, conductor 15, upper armature and back contact of cut-off relay 7, inner front contact and armature of line relay 5, conductor 22, winding of cut-off relay 7, conductor 9, contact 8 and upper armature of relay 5 to ground, and when cut-off relay 7 is once operated it will be held energized in a circuit extending from grounded battery, right hand winding of magnet 11, its back contact and armature, conductor 22, winding of relay 7, conductor 9, contact 8 and armature of relay 5 to ground. It should be noted that as soon as the line re-

lay 5 is operated an energizing circuit for the cut-off relays 6 and 7 is closed, but these relays are shunted by a circuit closed for the motor magnet 11 including the test conductors of busy trunks. It should also be pointed out that the cut-off relays 6 and 7 will operate in series with the motor magnet 11, but this last mentioned motor magnet will not operate in series with a cut-off relay. As soon as the primary cut-off relay 7 is operated, it extends the calling line to the brushes 18 and 19 of the line switch and through the terminals of the selected trunk through both windings of relay 23 in series to grounded battery. The relay 23 which may be the impulse or stepping relay of the first selector switch attracts its armature and in turn closes a circuit for the slow releasing relay 24. This last named relay on operating closes a holding circuit from ground, through resistance, right hand armature and continuity spring of relay 24, test terminal 17, test brush 16, conductor 15, upper-most armature and front contact of the cut-off relay 7, winding of this relay, armature, back contact and right hand winding of the motor magnet 11 to grounded battery.

Let it be assumed that both of the trunks which are being simultaneously tested are idle, under which condition there will be battery potential on test terminals 13 and 17. Under this condition the primary cut-off relay 7 will be operated in the manner just described, and the secondary cut-off relay 6 will be operated in a circuit extending from grounded battery, resistance, upper contact and continuity spring of relay 14, test terminal 13, test brush 12, upper-most armature and back contact of relay 6, lower-most front contact and armature of line relay 5, winding of the cut-off relay 6, and upper contact and armature of line relay 5 to ground. The operation of the primary cut-off relay 7 prevents the extension of the calling line to the brushes 20 and 21, and thus prevents the energization of the impulse relay 25 with the result that the slow releasing relay 14 is not operated to apply holding ground on the terminal 13, so that the secondary cut-off relay 6 deenergizes shortly after this operation when line relay 5 deenergizes.

At the termination of the connection the holding ground will be removed from terminal 17 with the result that the cut-off relay 7 deenergizes and disconnects the calling line from the line switch brushes 18 and 19 which have just been used in this connection. It will be recalled that the line switch employed in the circuit of Fig. 1 is of the stay-put type, that is; remains in engagement with the trunk terminals last used, so that at the time of release it is only necessary to disengage the line switch brushes from the

calling line, which is done by the deenergization of the cut-off relay as has been described.

When the line terminating at substation A is seized as a called line over the connector terminals appearing at the lower left of Fig. 1, a circuit is closed from ground at the connector switch (not shown) that has seized this line, conductor 10, lowermost armature and contact of relay 6, winding of cut-off relay 7, conductor 22, armature back contact and winding of motor magnet 11 to grounded battery. The magnet 11 does not operate at this time but relay 7 is actuated. It has been pointed out that line relay 5 and cut-off relay 7 are interlocking, that is, if line relay 5 has its armature attracted when relay 7 is energized then this last mentioned relay fully attracts its armature to disconnect the line relay from the line and to extend this line to brushes of its line switch. If, however, cut-off relay 7 alone is operated its armature is attracted only enough to disconnect line relay 5 from the line. Thus when a line is called its line relay is disabled and it is not extended through its line switch to an idle trunk.

The circuit arrangement shown in Fig. 2 is similar to that disclosed in Fig. 1, except that in Fig. 2 an advance to normal switch having two sets of brushes with four brushes in each set is used, whereas in the arrangement shown in Fig. 1 the switch is of that type which remains in engagement with the trunk last used and is provided with two sets of brushes, of three brushes in each set.

It is believed that the operation of the line switch circuits of Fig. 2 will best be understood by describing the method of initiating a call. When the subscriber at B removes his receiver from its switchhook, the slow releasing line relay 50 is energized in a circuit traceable from grounded battery, winding of this relay, inner lower back contact and armature of the secondary cut-off relay 51, inner lower back contact and armature of the primary cut-off relay 52, through the calling subscriber's line and substation circuits, inner upper armature and back contact of relay 52, inner upper armature and back contact of relay 51 to ground. The line relay on energizing closes an initial energizing circuit for motor magnet 53, through off normal contact 54, armature and front contact of line relay 50, conductor 55, back contact and armature of the motor magnet 53, and resistance to grounded battery. Under the control of this circuit the motor magnet advances its brushes into engagement with the first two trunks terminating at the switch. In the event that both of these trunks are busy, this condition will be indicated by absence of ground potential on the test terminals corresponding to 55 and 56. With this condition, the primary cut-

off relay 52 and the secondary cut-off relay 51 will remain inactive and a substitute operating circuit for the motor magnet 53 will now be closed from ground, winding of this magnet, off normal contacts 57, lowermost back contacts and armatures of relays 51 and 52, back contact and armature of the motor magnet, and resistance to grounded battery. Under the control of this circuit the switch advances its sets of brushes over the terminals of busy trunks until an idle trunk, such as #2 is reached. This idle trunk is characterized by the presence of ground potential on the test terminal 58, and a circuit will thereupon be completed from test terminal 58, test brush 60, lower winding of the cut-off relay 52, armature and front contact of relay 50, conductor 55, back contact and armature of the motor magnet 53, and resistance to grounded battery. The cut-off relay 52 is operated in this circuit and extends the calling line to the line switch brushes 61 and 62, over conductors 63 and 64. An impulse relay (not shown) associated with the numerical switch of trunk #2 will thereupon be energized in a circuit including both sides of the selected trunk and both sides of the calling line in series. In response to the operation of this impulse relay a release relay, (not shown) is operated to apply a holding battery to the holding terminal 65 of trunk #2, holding brush 66, conductor 67, upper winding, front contact and armature of the cut-off relay 52 to ground. In the event that the test terminals 58 and 59 of trunks #2 and #17 which it is assumed are being simultaneously tested are idle, both of the cut-off relays 51 and 52 will be energized. The cut-off relay 52 being energized over the circuit previously described and the cut-off relay 51 being operated in a circuit completed from ground at test terminal 59, test brush 68, lower winding of the cut-off relay 51, armature and front contact of relay 50, conductor 55, back contact and armature of the motor magnet 53, and resistance to grounded battery. In this case only trunk #2 will be seized, since the primary cut-off relay 52 at its inner armatures and back contacts prevents the extension of the calling line to the brushes 70 and 71 of the line switch, thus preventing the energization of the impulse relay (not shown) of trunk 17, and this last mentioned relay thereby fails to provide the application of holding battery to the holding terminal 72 of trunk 17.

Also at the uppermost armature and back contact of the primary cut-off relay 52 the holding circuit of the relay 51 is opened.

At the termination of the connection the holding battery is removed from the holding terminal of the selected trunk, such as terminal 65 of trunk #2; thereupon the locking circuit of primary cut-off relay 52

is opened, and this relay retracts its armatures. An operating circuit is thus completed for the motor magnet 53 to advance the brushes of the line switch to normal position. This operating circuit extends from ground, winding of the motor magnet, off normal contacts 57, lower-most back contacts and armature of relays 51 and 52, contact and armature of the motor magnet 53, and resistance to grounded battery. Under the control of this circuit the motor magnet advances the line switch to its normal position, at which time the off normal contacts 57 are opened and the normally closed contacts 54 are closed in readiness for another call.

What I claim is:

1. In a telephone system, a subscriber's line, a plurality of trunks arranged in groups, an automatic non-numerical switch for the use of said line, means for causing said switch to simultaneously test a trunk in each group, means for preventing the seizure by said switch of more than one of the trunks which are being simultaneously tested, and releasing means for said switch.

2. In a telephone system, a subscriber's line, a plurality of trunks arranged in groups, an automatic non-numerical switch for the use of said line, means for causing said switch to simultaneously test a trunk in each group, means for preventing the seizure by said switch of more than one of the trunks which are being simultaneously tested, a holding circuit completed over each trunk seized, and means for preventing the completion of more than one holding circuit simultaneously in each switch.

3. In a telephone system, a subscriber's line, a plurality of trunks arranged in groups, an automatic non-numerical switch for the use of said subscriber's line, means for causing said switch to simultaneously test a trunk in each group, a cut-off relay for each group of trunks arranged to be simultaneously tested, said cut-off relays controlling the seizure of a trunk by said line switch, and means for preventing more than one cut-off relay from seizing a trunk at the same switch.

4. In a telephone system, a subscriber's line, a plurality of trunks arranged in groups, an automatic non-numerical switch individual to said line, means for causing said switch to simultaneously test a trunk in each group, means including primary and secondary cut-off relays for the groups for controlling the seizure and holding of idle trunks, means controlled by said primary and said secondary cut-off relays for preventing the holding of more than one trunk.

5. In a telephone system, an automatic non-numerical switch having fixed terminals and movable brushes, a plurality of groups of trunks terminating in groups of fixed terminals

at said switch, a subscriber's line arranged to be connected to a plurality of sets of brushes, means for causing said sets of brushes to simultaneously test a plurality of groups of trunks, a plurality of relays arranged to be variably operated dependent on the groups in which a trunk is seized, means for connecting said subscriber's line to one set of brushes at front contacts of one of said relays and to the other set of brushes through back contacts of said last mentioned relay, and means for operating one of said relays over a seized trunk.

6. In a telephone system, a subscriber's line, a plurality of trunks arranged in groups, an automatic non-numerical switch provided with fixed terminals in which said trunks terminate, and with two sets of brushes individual to said subscriber's line, means for operating the brushes of said switch to simultaneously test a trunk in each group, means including a primary cut-off relay and a secondary cut-off relay for seizing an idle trunk in one of said groups and for connecting the subscriber's line to the set of brushes in engagement with terminals of the trunk seized, and means for preventing the operation of more than one of said cut-off relays.

7. In a telephone system, a subscriber's line, a plurality of trunks arranged in groups, an automatic switch individual to said subscriber's line, for extending said line to any of said trunks, means including a line relay energized over said subscriber's line for causing said automatic switch to simultaneously test a trunk in each group, means including primary and secondary cut-off relays for the groups of trunks for controlling the seizure and the holding of idle trunks, and means controlled by said primary and said secondary cut-off relays for preventing the holding of more than one trunk, said last mentioned means including an operating circuit for said primary and secondary cut-off relays completed at said line relay.

8. In a telephone system, a subscriber's line, a plurality of trunks arranged in groups, an automatic switch individual to said line, a line relay energized over said subscriber's line, a motor magnet controlled by said line relay for causing said switch to simultaneously test a trunk in each group, a cut-off relay for each group of trunks, means responsive to the testing of an idle trunk for operating one of said cut-off relays to seize an idle trunk in its associated group of trunks and conductors for said subscriber's line by which to seize said line as a called line, one of said conductors serially including a winding of one of said cut-off relays.

9. In a telephone system, a subscriber's line, a plurality of trunks arranged in groups, an automatic switch individual to

said line, a single wound line relay, means including a circuit extending over the two sides of said subscriber's line in series for operating said line relay, a motor magnet for causing said automatic switch to simultaneously test a trunk in each group, a circuit for said motor magnet controlled by said line relay and means responsive to the testing of an idle trunk for seizing the same and for disabling said line relay.

10. In a telephone system, a subscriber's line, a plurality of trunks arranged in groups, an automatic switch individual to said line, a line relay energized over said incoming line, a double wound motor magnet for causing said automatic switch to simultaneously test a trunk in each group, circuits for said motor magnet, each including a winding of said motor magnet and controlled at said line relay, and means for seizing an idle trunk in one of said groups of trunks as soon as it is tested and for disabling said line relay.

11. In a telephone system, an automatic switch having fixed terminals and sets of movable brushes, a plurality of groups of trunks terminating in groups of fixed terminals, a subscriber's line arranged to be connected with a plurality of sets of brushes, a line relay operated over said incoming line, a double wound motor magnet for advancing said brushes over said fixed terminals a test conductor for each trunk, operating circuits for said motor magnet each serially includ-

ing a winding of said motor magnet, contacts of said line relay and a test conductor of the trunk being tested, and means responsive to the testing of an idle trunk for seizing the same and for interrupting the operating circuits of the motor magnet.

12. In a telephone system, a subscriber's line, a plurality of trunks arranged in groups, an automatic switch provided with fixed terminals in which said trunks terminate and with sets of movable brushes in which said subscriber's line terminates, a double wound motor magnet for advancing said brushes to test a trunk in each group simultaneously, a line relay energized over said incoming line, a cut-off relay for each group of trunks operating to disable said line relay, a test conductor for each trunk, operating circuits for said motor magnet, serially including the windings of said motor magnet, contacts of said line relay, contacts of said cut-off relays and test conductors of trunks being tested, and a circuit for each cut-off relay serially including a winding of said motor magnet, the winding of the cut-off relay and contacts of said line relay, said last mentioned circuit being disabled by one of said operating circuits for the motor magnet during the operation of said switch, and a holding circuit for an actuated cut-off relay.

In witness whereof, I hereunto subscribe my name this 24th day of August, A. D. 1920.
WINFRED T. POWELL.