Aug. 3, 1926.

1,594,690

W. T. POWELL

TELEPHONE SYSTEM

Filed June 6, 1924

2 Sheets-Sheet 1

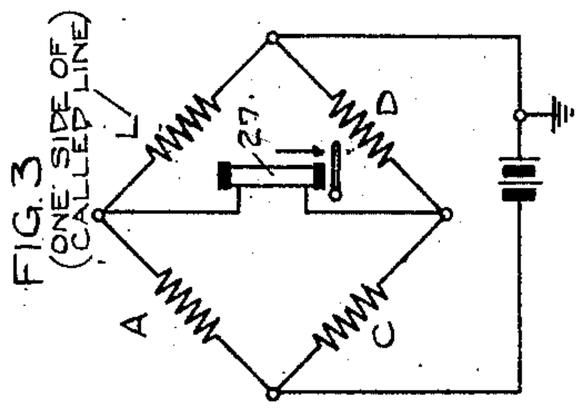

FIG. 3

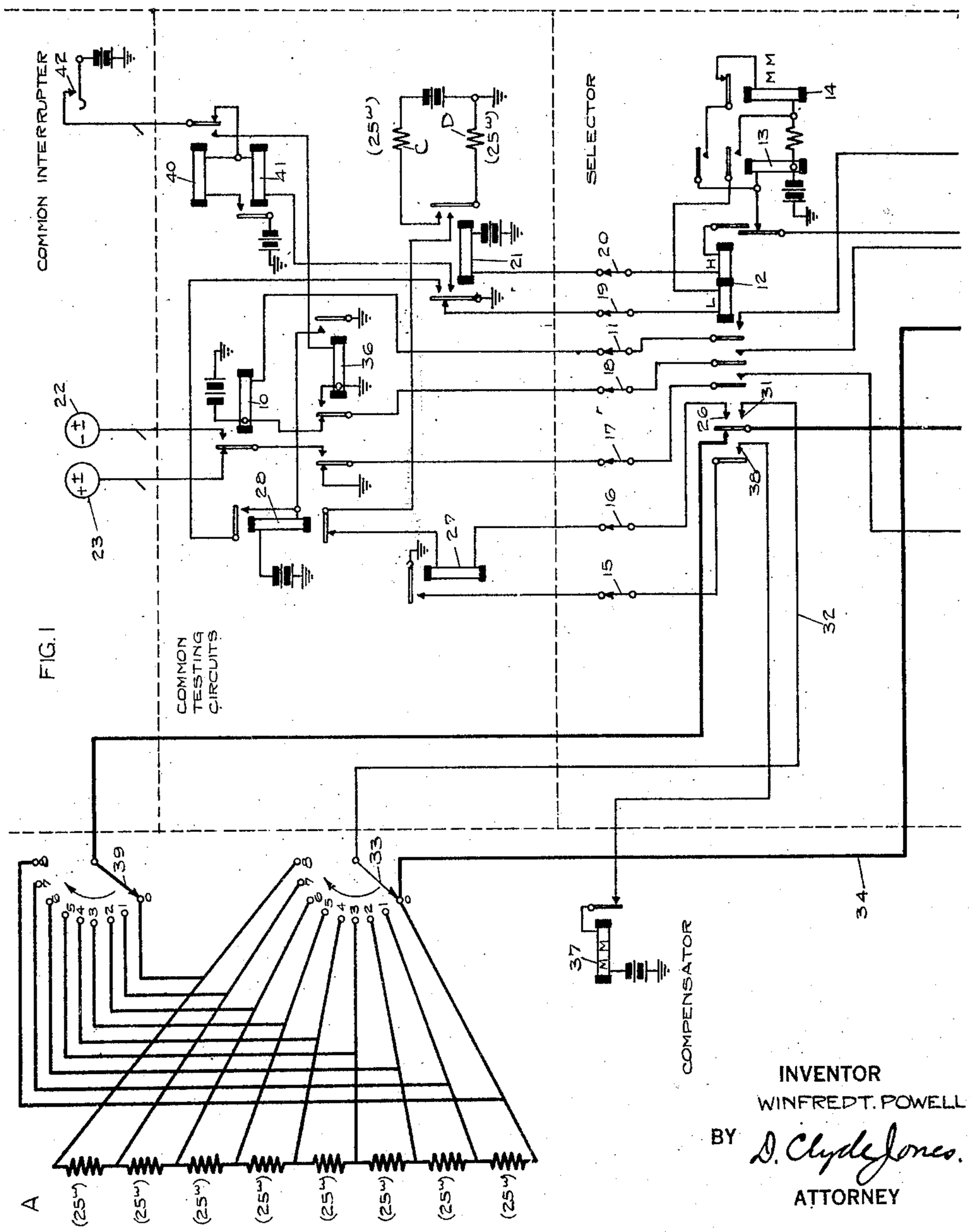

FIG. 1

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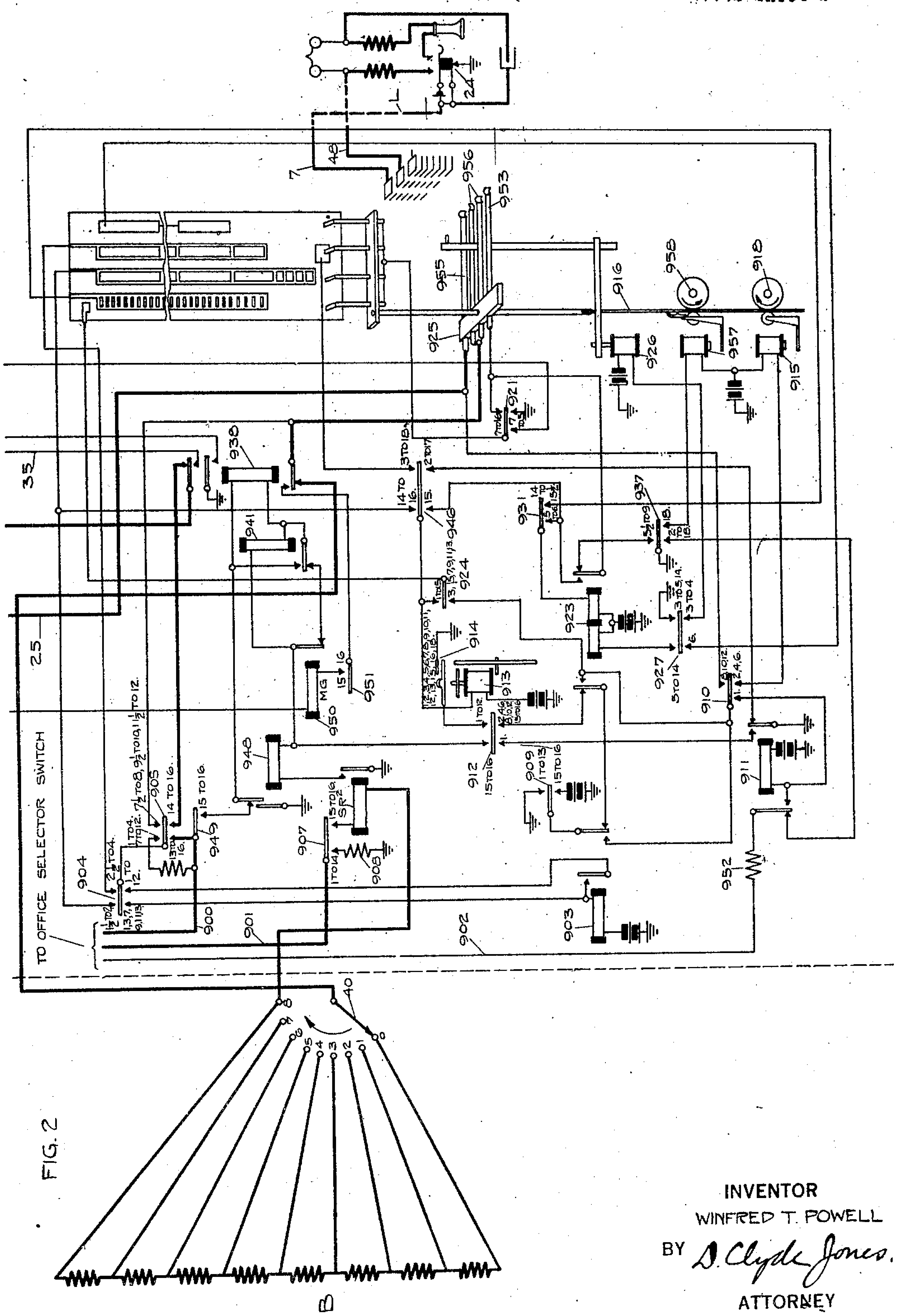
2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE.

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

TELEPHONE SYSTEM.

Application filed June 6, 1924. Serial No. 718,210.

This invention relates to telephone systems and more particularly to telephone systems employing automatic switches in completing some portion of a telephone connection.

In telephone systems the length of telephone lines and line characteristics vary greatly, with the result that unless suitable means are provided, speech transmission is far from uniform.

It is the purpose of the present invention to provide novel means for rendering certain of the characteristics of all the telephone lines of a group uniform so that standard efficiency of transmission may be maintained.

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

The drawings with Fig. 1 placed above Fig. 2, diagrammatically represent the invention which may be incorporated in telephone systems now in use. Fig. 2 represents a trunk circuit terminating in a selector switch, indicated at the right of the figure. The portion of the drawing at the left of the dotted line of Fig. 2 together with Fig. 1 represent the means which may be associated with the trunk circuit of Fig. 2 and which may be adjusted to render the characteristics of a portion of a telephone connection of a predetermined value. In the lower part of Fig. 1 there is shown a selector switch for seizing an idle one of a plurality of testing devices. Fig. 3 shows a schematic arrangement to indicate the means for testing whether or not the condition for uniform transmission has been established in the telephone connection.

For convenience in description and disclosure it is assumed that the present invention is incorporated into a large sized telephone system of the type disclosed in the patent to Lundell #1,403,861, granted January 17, 1922. In that patent it is shown that a calling telephone line is extended to a wanted telephone line through a district selector switch, an office selector switch, an incoming selector switch and a final selector switch. These switches are variably and selectively controlled by a register sender and its associated controlling means.

The present invention has been incorporated in the mentioned system in the incoming selector switch shown in Fig. 10 of the mentioned patent, which has been modified to include the present invention, but where possible the same reference characters used in the patent have been retained.

It is believed unnecessary to disclose and describe in detail how a calling line is extended through a district switch and an office switch to the mentioned incoming selector, but it has been assumed that the calling line has been extended in the manner described in the patent and that the incoming selector switch has been operated to connect the trunk, whose conductors are designated 900 and 901, to the trunk whose conductors are referred to as 7 and 48 leading to a final selector switch, which is then operated to seize the wanted line. The method of operating the incoming selector is now well known in this art and it is sufficient to state that when the trunk leading to the final selector has been seized and when the final selector switch has been operated, the sequence switch 913 is standing in position 15.

The circuits are now in condition for applying ringing current of the proper character to signal the wanted station on the called line and in the event that this line is a party line, the selection of the proper ringing current is determined by the position of the sequence switch 913. If it is stopped in position 15 ringing current of one character is applied to the called line and if this sequence switch is stopped in position 16, the relay 10 is energized to apply ringing current of another character.

In position 15 of the sequence switch 913, a circuit is closed from grounded battery through the lower contact of sequence switch spring 909, the outer armature and back contact of relay 903, the left hand armature and back contact of relay 923, the lower right hand and upper left hand contacts of sequence switch spring 912, the armature and back contact of relay 950, back contact and inner armature of relay 941, winding of relay 938, the continuity spring and back contact of relay 948, sequence switch contact 949, conductor 900 and thence to ground at a preceding switch in the series.

The operation of the relay 938 closes a circuit from ground at the inner armature and front contact of this relay, continuity spring and back contact of relay 12, winding of relay 13 to grounded battery. This circuit operates the relay 13 and extends the last described circuit through the upper-

most armature and front contact of relay 13, armature, back contact and winding of motor magnet 14, resistance, to grounded battery. Under the control of this circuit the motor magnet 14 advances the brushes 15, 16, 17, 18, 11, 19 and 20 of the selector switch until an idle testing net-work is seized. When such an idle net-work is found, a circuit is closed from ground at the armature and back contact of relay 21, brush 19, left hand winding of relay 12, inner armature and front contact of relay 13, through the resistance to grounded battery. This last circuit is effective to energize relay 12 and to stop the operation of the motor magnet 14. As soon as relay 12 is operated, it closes a locking circuit for itself, from grounded battery, winding of relay 21, selector brush 20, high resistance winding of the relay 12, the armature and continuity spring of this relay, inner front contact and armature of relay 938 to ground. Relay 12 extends the circuit of relay 10 through the selector brush 11 and the innermost armature and front contact of relay 12, to the sequence switch contacts 921 and if the sequence switch 913 is standing in position 16, the mentioned relay 10 is operated to apply ringing current from the source designated 22. If, however, the sequence switch is standing in position 15, relay 10 is not operated and ringing current from the source 23 is applied to the called line.

The operation of the relay 938 opens the trunk conductors 900 and 901 leading back to the register sender, (not shown), thereby causing the register sender and its associated controlling mechanism to be restored to common use as is described in the mentioned patent.

With the relay 12 operated a circuit is closed from ground at contact 24 of the switchhook at the called substation over the lower side of the called line and through the final selector switch (not shown), trunk conductor 7, selector brush 955, conductor 25, armature and contact 26, of relay 12, brush 16, winding of the relay 27, back contact and armature of relay 28, through the right hand contacts and armature of relay 21 in multiple, through resistance C, to grounded battery and through resistance D, to ground. At the armature and contact 31 of relay 12, a branch circuit in mutiple of that just described is extended over conductor 32, brush 33 in any one of its positions, through the resistance units such as A, conductor 34, uppermost armature and front contact of relay 938, conductor 35, front contact and armature of relay 12, brush 18, inner armature and back contact of relay 36 to grounded battery. The circuit just described with its several branches is in effect a Wheatstone bridge arrangement, which may be schematically represented as shown in Fig. 3.

The Wheatstone bridge circuit just described is established as soon as the called line is selected. It will be further noted that the resistance designated L in Fig. 3, is the one side of the called line, which is also indicated by the symbol L in Fig. 2. In order for the relay 27 to be inactive the ratio of the resistance arms A/C and L/D must be equal. If this bridge is not properly balanced, relay 27 is energized and closes an operating circuit for the motor magnet 37 from grounded battery, its winding, armature and back contact, contact 38 and armature of relay 12, selector brush 15, front contact and armature of relay 27, to ground. Under the control of this circuit the motor magnet 37 advances its brushes 33, 39 and 40, until a sufficient number of the resistance units A are introduced into the Wheatstone bridge, so that it is balanced and the relay 27 deenergizes. At that time the motor magnet 37 stops the selector brushes to preserve the established balance.

It is believed that the operation of the compensator will best be understood by referring to specific conditions. For example, if the predetermined value of the loop resistance of all the lines is to be 400 ohms, the compensator brush 40 must advance until it includes a sufficient number of the resistance units B, so that the sum of these resistance units and the resistance of the upper side of the called line equals 200 ohms, that is, one half of the predetermined resistance. The resistance units B rendered effective by the compensator brush 40, are included in the called end of the circuit traversed by the voice currents, so that it is necessary to connect in the lower side L, of the called line, the same amount of resistance units A, in order to establish a balanced line condition. Battery is connected to one terminal of the A resistance units, while the circuits are in the condition for signaling the called line and when the circuits are completed for conversation, the A resistance units are connected in this talking circuit. Thus the A resistance units serve the double purpose of acting as an arm of the Wheatstone bridge for testing the line after which a sufficient number of these units are connected in the called line for establishing a balanced line condition.

Let it now be assumed that the line called has a loop resistance of 100 ohms in which case each side of the called line is equivalent to a resistance of 50 ohms. The resistance coils C and D of Fig. 1 are constant and for purposes of this description it will be assumed that coil C has a value of 25 ohms and coil D a value of 25 ohms, although it will be understood that these coils may have a wide variety of values. In order to have a balanced condition of the line, the ratio

of the arms of the Wheatstone bridge arrangement should be such that L/D=A/C or 50/25=A/25. Since it has been assumed that L equals 50 ohms, D equals 25 ohms and C equals 25 ohms, therefore, a sufficient number of the A resistance units must be included in the circuit to equal 50 ohms. From this it will be seen that to render the upper side of the called line of the same value as the lower side of the called line plus the B resistance units, the complement of the value of 50 ohms, that is 200—50 or 150 ohms must be included in the called line.

As a further illustration assume that the called line has a total loop resistance of 50 ohms. In this case each side of the called line is equal to 25 ohms. In this instance the ratio A/C=L/D becomes A/25=25/25, which means that the A resistance units included in the testing circuit must equal 25 ohms. But one side of the calling line has a resistance of 25 ohms and to bring this resistance up to the predetermined amount of 200 ohms, 175 ohms of resistance A must be included in the talking circuit.

It should be noted that from the above mentioned examples, two conditions must be satisfied by the compensator circuit. First, the Wheatstone bridge testing condition, where the A resistance must increase as the line resistance increases and second, the condition arising from the fact that the called line must have a predetermined loop resistance, so that in the talking condition the A resistance must decrease as the line resistance increases. In Fig. 2 it is shown that the value of A increases as the switch brush 33 moves in a clock-wise direction, therefore, when the line resistance is large, the A resistance must be increased by the movement of the brush 33.

During the talking condition, compensator brush 39 becomes effective and brush 33 is disabled. The contacts engaged by the switch brush 39 are so connected to the resistance units A, that as the brush 39 moves in a clock-wise direction, the value of these resistance units in the circuit decreases and during the talking condition, relay 12 is deenergized, so that brush 39 becomes effective. From this arrangement one group of resistance units is used for testing and a complement of this number is used in the talking circuit.

In order to insure that a sufficient interval of time is allowed for the compensator to take its setting, after the called line is selected relays 40 and 41 are provided. When the relay 21 is operated as previously explained, a circuit is extended from ground at the left hand armature and front contact of relay 21, winding of relay 41, back contact and armature of relay 40 and to grounded battery, whenever the contacts 42 of the common interrupter are closed. The operation of relay 41 at its armature and front contact prepares a circuit through the windings of the relays 40 and 41. As soon as the contacts 42 are open, this last described circuit energizes relay 40, which in turn locks itself operated in series with the relay 41. With the relay 40 operated and when contacts 42 of the interrupter are closed, the relay 36 is operated and at its right hand armature and front contact it closes an operating circuit for relay 28 and this last named relay on operation closes a locking circuit for itself, through its upper front contact and armature, left hand front contact and armature of relay 21 to ground.

When the called party answers the relay 950 is operated which effects the deenergization of relay 938, which in turn releases the relay 12. The release of the last named relay restores the common testing circuit for use in other connections.

At the close of the conversation the release of the operated equipment takes place in the well known manner.

What I claim is:

1. In a telephone system, telephone lines, means including a link circuit for interconnecting a pair of telephone lines, means for compensating for variations in one of said telephone lines of a connection, and means including a testing net-work common to a plurality of link circuits for controlling the operation of said compensating means.

2. In a telephone system, a plurality of telephone lines having varying electrical characteristics, means including link circuits for interconnecting said telephone lines in pairs, compensating units for rendering of a predetermined value certain of the characteristics of a telephone line of a connection, a plurality of networks common to said link circuits for determining the number of units to be actively associated with said telephone connection, and means including an automatic switch for selecting an idle net-work.

3. In a telephone system, a plurality of telephone lines of varying electrical values, means including link circuits for interconnecting said telephone lines in pairs, means for rendering the characteristics of a called telephone line of a predetermined value, and means controlled over one side only of a telephone line for controlling said means.

4. In a telephone system, a plurality of telephone lines, of varying electrical characteristics, means including link circuits for interconnecting said telephone lines in pairs, a plurality of electrical units arranged to be associated with one of the telephone lines of a connection for rendering said line equal to a predetermined value, and means including a testing arrangement controlled over said last mentioned telephone line for measuring the electrical value of said line

and for connecting electrical units therein equal to the complement of the value of the tested telephone line.

5. In a telephone system, a plurality of telephone lines of varying electrical characteristics, means including link circuits for interconnecting said telephone lines in pairs, a plurality of units arranged to be associated with one of the telephone lines of a connection for rendering said telephone line equal to a predetermined value, a plurality of common mechanisms including a testing arrangement controlled over said last mentioned telephone line for measuring the electrical value of said line and for connecting electrical units therein equal to the complement of the value of the tested telephone line, and automatic means for associating an idle mechanism with a telephone connection.

6. In a telephone system, a plurality of telephone lines of varying electrical characteristics, means including automatic switches and link circuits for interconnecting said telephone lines in pairs, a plurality of units arranged to be associated with one of the telephone lines of a connection for rendering said telephone line equal to a predetermined value, a plurality of common mechanisms including a testing arrangement controlled over said last mentioned telephone line for measuring the electrical value of said line and for connecting electrical units therein equal to the complement of the value of the tested telephone line, and automatic means for associating an idle mechanism with a telephone connection.

7. In a telephone system, a plurality of telephone lines each provided with a ringer, means including link circuits for interconnecting said telephone lines in pairs, signaling equipment, circuits through which said signaling equipment is connected to a link circuit extended to the ringer of a called telephone line of an interconnected pair of lines, means including a progressively movable switch for selecting and completing an idle circuit to said signaling equipment, and means for disconnecting said signaling equipment from said link circuit before said first mentioned interconnection is terminated.

8. In a telephone system, a plurality of telephone lines each provided with a ringer, means including automatic switches and link circuits for interconnecting said telephone lines, signaling equipment, circuits through which said signaling equipment is connected to a link circuit extended to the ringer of a called telephone line of an interconnected pair, means including a progressively movable switch for selecting and completing an idle connecting circuit, and means for disconnecting said signaling equipment from said link circuit before said first mentioned interconnection is terminated.

9. In a telephone system, a plurality of telephone lines, means including a link circuit for interconnecting a pair of telephone lines, means for compensating for variations in one of said telephone lines of a connection, means including a testing network common to a plurality of link circuits for controlling the operation of said compensating means, a source of ringing current, and means including an automatic switch for seizing said testing net-work when idle for connecting said source of ringing current to said link circuit.

10. In a telephone system, telephone lines, means including a link circuit for interconnecting a pair of telephone lines, means for compensating for variations in one of said telephone lines of a connection, and a Wheatstone bridge arrangement for controlling the operation of said compensating means, said Wheatstone bridge arrangement including a testing network common to a plurality of link circuits.

11. In a telephone system, a plurality of telephone lines having varying electrical characteristics, means including link circuits for interconnecting said telephone lines in pairs, compensating units for rendering of a predetermined value, certain of the characteristics of a telephone line of a connection, a Wheatstone bridge arrangement for determining the number of units to be actively associated with said telephone connection, said Wheatstone bridge arrangement including one of a plurality of networks common to said link circuits, and means including an automatic switch for associating an idle network with the link circuit of a connection.

In witness whereof, I hereunto subscribe my name this 4th day of June A. D. 1924.

WINFRED T. POWELL.