

Aug. 20, 1946.

P. L. WRIGHT

2,406,053

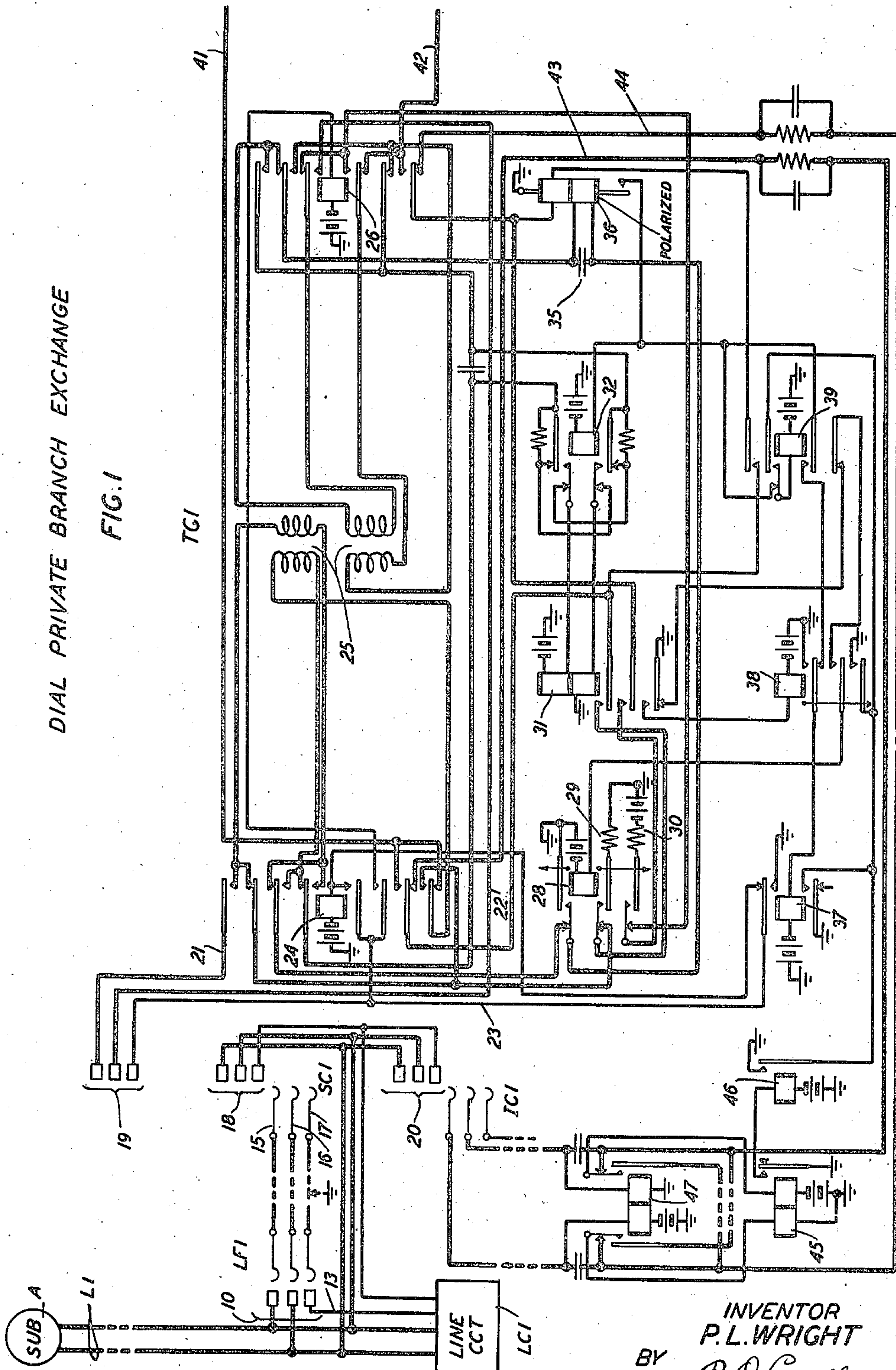
TELEPHONE SYSTEM

Filed Sept. 2, 1944

4 Sheets-Sheet 1

DIAL PRIVATE BRANCH EXCHANGE

FIG. 1



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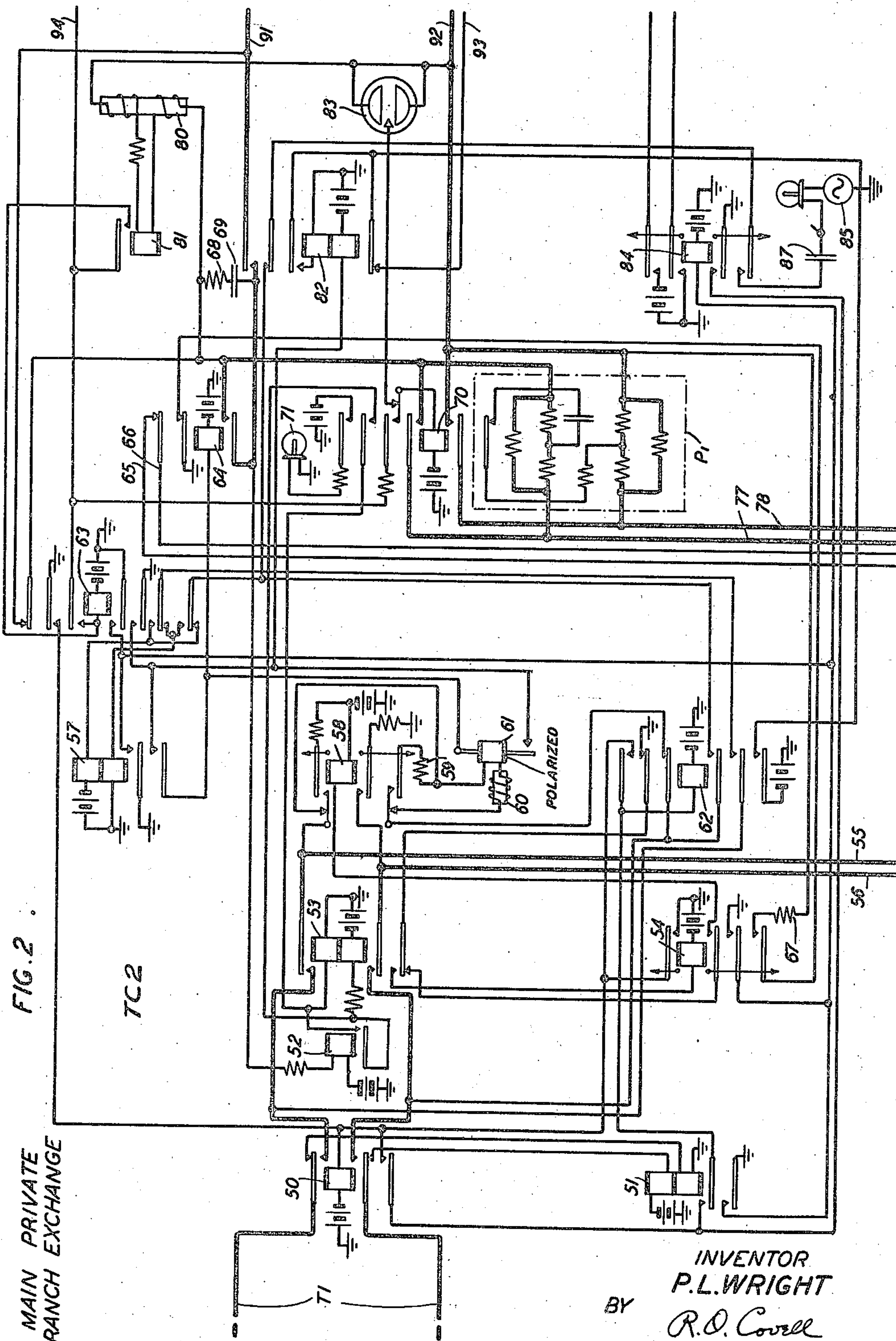
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TELEPHONE SYSTEM

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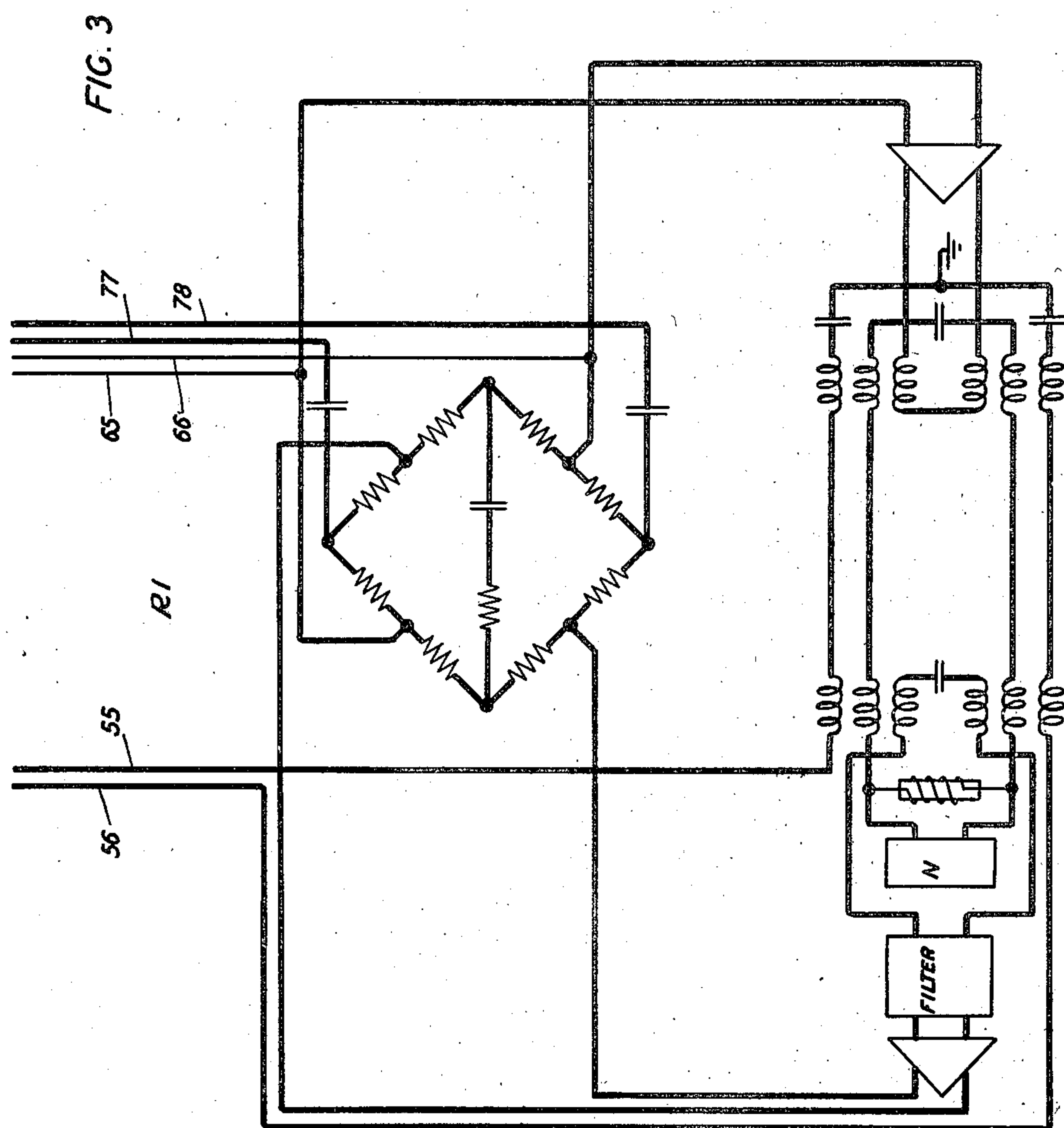
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TELEPHONE SYSTEM

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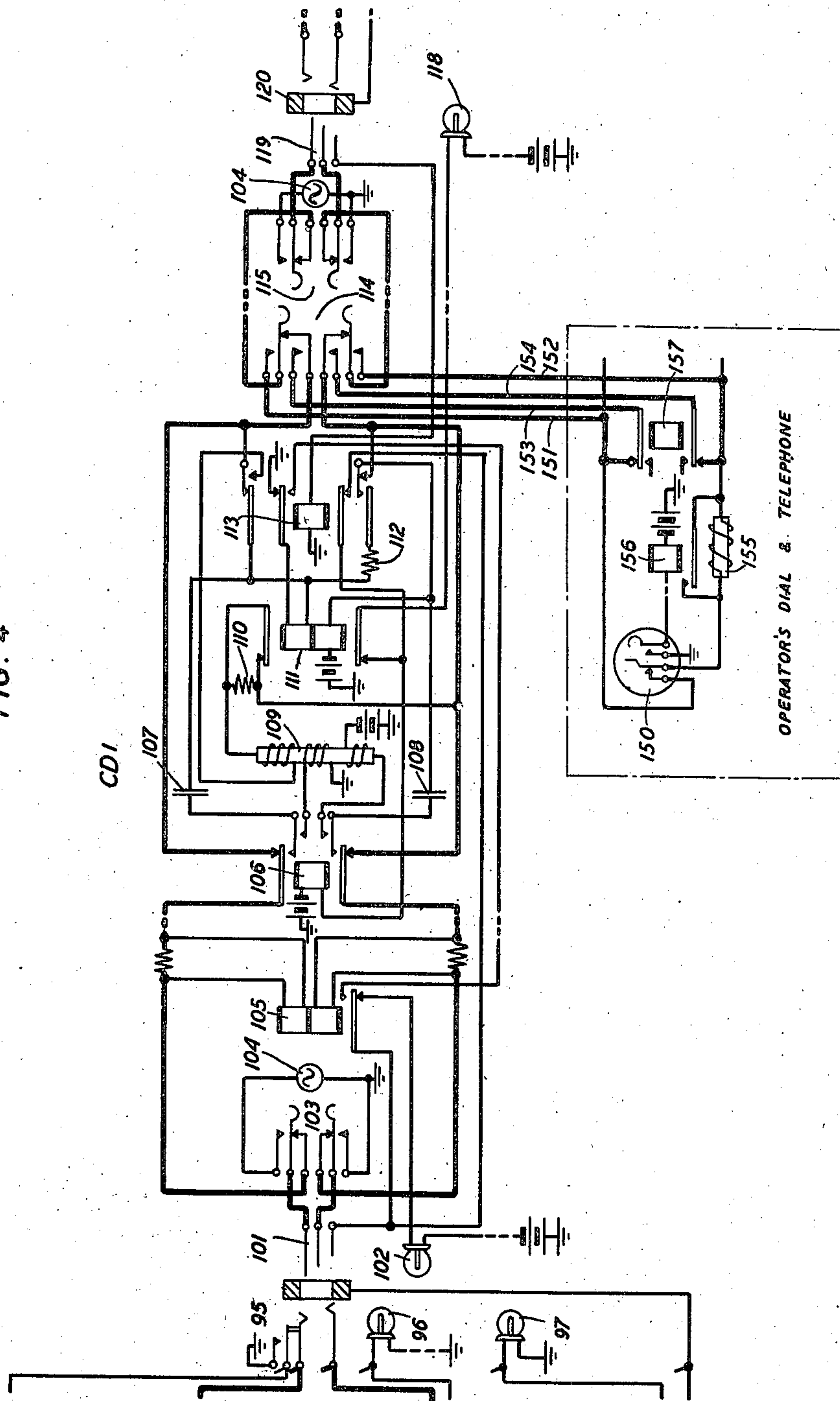
2,406,053

TELEPHONE SYSTEM

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FIG. 4



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UNITED STATES PATENT OFFICE

2,406,053

TELEPHONE SYSTEM

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Application September 2, 1944, Serial No. 552,403

10 Claims. (Cl. 179—27)

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This invention relates to telephone systems and particularly to systems comprising automatic switching apparatus selectively controlled by subscribers and operators to establish desired connections.

Objects of the invention are the provision and improvement of transmission control in semi-automatic telephone systems and particularly the provision of a trunk circuit arranged for decreasing the attenuation of speech currents transmitted therethrough on connections which include high loss lines or trunks.

According to this invention, a trunk circuit, employed in establishing connections between an operator's position and an automatic branch exchange, includes a pad control relay connected to a talking conductor for operation by ringing current when the ringing key of a connected cord is operated, the impedance of the connection from the talking conductor through the pad control relay being sufficient to prevent interference with voice current transmission through the trunk circuit and to prevent interference with the transmission of dial impulses.

According to a feature of the invention, a pad control relay is connected through a high impedance device to one of the talking conductors of a trunk circuit, the operation of the relay responsive to the connection of a ringing current source thereto being effective to decrease the attenuation of the voice currents transmitted through the trunk circuit, to disconnect the relay from the talking conductor, and to close a holding circuit independent of the talking conductor.

The invention and its features will be better understood by considering a system in which the invention is embodied, one such system being shown in the drawings which form a part of this specification. The invention is, however, not limited in its application to the specific system shown but is generally applicable to systems comprising means including resistance pads for controlling the attenuation of a connection.

Referring to the drawings, Fig. 1 represents an automatic branch exchange comprising a subscriber's station A, line L1 and line circuit LC1, a line-finder LF1, a selector-connector SC1, an incoming connector IC1 and a trunk circuit TC1; and

Figs. 2 and 3 and 4 show in a second office a trunk circuit TC2, jack ended at an operator's position, a telephone repeater R1 individual to the trunk circuit, and a cord circuit CD1 at the operator position.

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The subscriber's station A is of the usual common battery type and includes a dial or other impulse sender for controlling the selective operation of the automatic switches through which desired connections are established. The line-finder LF1 and selector-connector SC1 and incoming connector IC1 may be of the usual two-motion step-by-step type. Reference may be had to Automatic Telephony, 2nd Edition by Smith and Campbell, pages 53 to 65 for description of the structure of such switches and their operation when used as selectors and connectors. Reference may be had to the patent to Stokely No. 1,799,654, granted April 7, 1931, for a description of a line-finder switch of the step-by-step two-motion type. Reference may be had to the patent to A. E. Hague No. 1,675,886, July 3, 1928, for a description of a selector-connector of the step-by-step two-motion type. The line-finder LF1 and selector-connector SC1 and incoming connector IC1 are each represented in the drawings by a set of brushes and either one or two sets of terminals, all other apparatus associated therewith being omitted. The line L1 is connected to terminals 15 in the bank of finder LF1, to terminals 18 in the bank of selector-connector SC1 and to terminals 20 in the bank of the incoming connector IC1. The line circuit LC1, while not shown in detail, comprises the usual line and cut-off relays. The trunk circuit TC1 connected to terminals 19 in the bank of selector-connector SC1 in the automatic branch office is associated with a two-conductor trunk line T1 extending to the second office. In the second office, trunk T1 is connected to a trunk circuit TC2 having a jack 95 at an operator's position. The trunk circuits TC1 and TC2 are shown in detail in the drawings and their operations in establishing connections in both directions over the trunk T1 are hereinafter described. The telephone repeater is not shown in detail since such a showing is not necessary; and only so much of the operator's cord CD1 is shown as is necessary for a clear and complete explanation of applicant's invention.

Assume now that a call is initiated at the subscriber's station A, that the line circuit LC1 and a line-finder LF1 are operated to extend the line L1 to a selector-connector SC1, and that the selector SC1 is operated under the control of the dial at the calling station to select the terminals 19 to which the trunk circuit TC1 is connected. Upon seizure of the terminals 19, the selector-connector SC1 temporarily connects ground to brush 17 and therethrough to sleeve conductor

23 of trunk circuit TC1, thereby effecting the operation of relay 24. Relay 24 locks through its inner lower front contact to conductor 23 independent of relay 31 and connects conductor 23 to the winding of relay 26. With relays 24 and 26 operated, a circuit is closed for operating relay 31, this circuit being traced from battery through the upper winding of relay 31, upper continuity back contact and outer lower back contact of relay 32, uppermost front contact of relay 26, lower right winding of repeating coil 25, inner upper front contact of relay 26, conductor 22, brush 16 of switch SC1, middle brush of finder switch LF1, line L1 and station loop, upper brush of finder switch LF1, brush 15 of switch SC1, conductor 21, outer upper front contact of relay 24, upper right winding of repeating coil 25, inner upper front contact of relay 24, outer upper back contact and lower continuity back contact of relay 32, and lower winding of relay 31 to ground. The operation of relay 31 closes a circuit for operating relay 38 and closes a circuit for operating relay 51 of the trunk circuit TC2 at the distant end of trunk T1. The operation of relay 38 of trunk circuit TC1 closes a circuit for operating relay 37, and relay 37 connects ground to sleeve conductor 23 to hold relays 24 and 26 operated and to hold the selector connector SC1 and line finder LF1 operated after the ground temporarily connected to brush 17 of the selector-connector SC1 is disconnected therefrom. The circuit for operating relay 51 is traced from battery through the upper winding of relay 51, lower back contact of relay 50, lower conductor of trunk T1 and conductor 42 of trunk circuit TC1, lowermost front contact of relay 26, middle lower front contact of relay 31, outer lower continuity back contact of relay 28, inner lower front contact of relay 26, lower left winding of repeating coil 25, middle upper front contact of relay 26, lower winding of polarized relay 36, upper continuity back contact of relay 28, middle upper front contact of relay 24, upper left winding of repeating coil 25, lowermost front contact of relay 24, inner lower continuity back contact of relay 28, inner lower front contact of relay 31, next to the lowermost front contact of relay 24, conductor 41 and upper conductor of trunk T1, upper back contact of relay 50 and through the lower winding of relay 51 to ground. Relay 36 is polarized and the current through its lower winding is in the non-operating direction so that relay 36 is not operated at this time. The operation of relay 51 of trunk circuit TC2 closes a circuit for operating relay 84. The operation of relay 84 connects ground to the sleeve of multiple jacks 95 as a busy indication, closes a circuit for lighting the busy lamps 97, and closes a circuit including the inner lower front contact of relay 51 for operatively energizing the winding of relay 62. The operation of relay 62 closes a circuit including the lower back contact of relay 82 for lighting the trunk lamp 96; and disconnects ground from the lower outer transfer spring of relay 53 to prevent the operation of either of relays 54 and 58. At its upper front contact, relay 62 closes a circuit including the outer lower front contact of relay 51 for operating relay 50. The operation of relay 50 closes a locking circuit through its outer lower front contact to ground at the inner lower front contact of relay 84, relay 62 being locked through its upper front contact to the same ground. Relay 50 disconnects the conductors of trunk T1

from the windings of relay 51 and connects these conductors, through front contacts of relay 62 and back contacts of relay 63, to the windings of line relay 57. Relay 51 is thereby released; and relay 57 is operated in the circuit through the conductors of trunk T1 and the bridge across these conductors comprising the lower winding of relay 36 of trunk circuit TC1. Relay 84 is held operated, after relay 51 releases, under the control of relay 57. With relays 50, 62 and 84 operated, a connection is closed from the ringing current source 85, through condenser 87, lowermost front contact of relay 84, inner upper back contact of relay 82, inner lower front contact of relay 62 and inner lower front contact of relay 50, to the lower conductor of trunk T1, thereby to transmit an audible ringing tone to the calling subscriber at station A.

The lighting of the trunk lamp 96 associated with jack 95 attracts an operator's attention and indicates that there is a call waiting to be answered. When an operator answers the call by inserting the plug 101 of a cord CD1 in jack 95, relay 106 is operated by the closure of a circuit from ground at the inner upper front contact of relay 84, sleeve conductors of jack 95 and plug 101, inner lower back contact of relay 113 of cord CD1 and the winding of relay 106, to battery. The operation of relay 106 closes a circuit from battery through the lower winding of retard coil 109, lower front contacts of relay 106, lower winding of relay 105, lower back contact of key 103, ring conductors of plug 101 and jack 95, conductor 92, windings of retard coil 80 and relay 81, a back contact of relay 63, conductor 91, tip conductors of jack 95 and plug 101, upper back contact of key 103, upper winding of relay 105, upper front contacts of relay 106, through the middle winding of retard coil 109 to ground. Relay 81 is thereby operated to close a circuit which includes the upper front contact of jack 95 for operating relay 63. Relay 63 locks to the ground at the contact of jack 95 independent of relay 81, closes a circuit for holding relay 84, closes a circuit for holding relay 50, closes a circuit for operatively energizing the lower winding of relay 82, closes a circuit including the outer lower front contact of relay 57 for operating relay 64, and interchanges the connections between the windings of relay 57 and the conductors of trunk T1 so as to reverse the direction of current through the lower winding of polarized relay 36 of trunk circuit TC1 and thereby cause the operation of relay 36. The operation of relay 82 closes a locking circuit through the upper winding of this relay to battery at the lowermost front contact of relay 62, opens the circuit path for lighting the trunk lamps 96, and opens the connection for transmitting an audible ringing signal to the calling station. The operation of relay 64 opens the short-circuit normally connected across conductors 65 and 66, which connect with the input side of one of the amplifiers of the telephone repeater, and closes a short-circuit across resistor 68 and condenser 69. The bridge, consisting of the winding of relay 81 and the windings of retard coil 80, across tip and ring conductors of jack 95 is opened by the operation of relay 63 and again closed by the operation of relay 64. The continued closure of this bridge effects the operation of supervisory relay 105 of the cord thereby extinguishing the rear cord supervisory lamp 102. The aforementioned operation of relay 82 connects the winding of relay 52 to conductor 91, whereby relay 52 is operatively

energized in series with the upper winding of relay 105 and middle winding of retard coil 109. The operation of relay 52 closes a circuit for operating relay 53; and the operation of relay 53 completes the talking connection between the calling station and the answering operator. This connection is traced from the conductors of trunk T1, through front contacts of relay 50, front contacts of relay 53, conductors 55 and 56, telephone repeater R1, conductors 77 and 78, the resistors of pad P1, front contact of relays 64 and 82, conductors 91 and 92, front contacts of relay 106 of cord CD1, condensers 107 and 108, back contacts of relay 113, front contacts of talking key 114, to the operator's telephone set. The aforementioned operation of relay 36 of trunk circuit TC1 closes a circuit for operating relay 32 and a circuit for operating relay 39. The operation of relay 32 interchanges the connection between the windings of relay 31 and the conductors of line L1 thereby to reverse the current through the conductors of line L1. Relay 39 locks under control of relays 37 and 38 and connects the upper high resistance winding of relay 36 in parallel with its low resistance winding.

The answering operator may further extend the connection by plugging the other end of the cord into a jack of a called extension, into the jack of another tie line or into the jack of a trunk to the central office.

If the receiver hook at the calling station is operated to recall the operator, relay 31 of trunk circuit TC1 is alternately released and reoperated, thereby alternately opening and closing the connection through the low resistance winding of relay 36. The operation of relay 36 is maintained by its upper, high resistance winding, but relay 57 of trunk circuit TC2 releases and reoperates each time the low resistance bridge across the conductors of trunk T1 is opened and closed by relay 31. The release and reoperation of relay 57 cause the release and reoperation of relay 64, whereby the bridge across conductors 91 and 92 is alternately opened and closed to release and reoperate supervisory relay 105 of cord CD1 and thereby flash the answering supervisory lamp 102. If the telephone instrument is replaced at the calling station, to release the connection, before the cord CD1 is disconnected from jack 95, relay 31 of trunk circuit TC1, relays 57 and 64 of trunk circuit TC2, and relay 105 of cord CD1 are released in succession, thereby causing the answering cord supervisory lamp 102 to be lighted as a disconnect signal. The continued release of relay 31 causes the release of relay 38; but relay 37 is held operated until the answering operator disconnects, the circuit for holding relay 37 being traced through the back contact of relay 38, a front contact of relay 39 and the front contact of relay 36. When the operator disconnects plug 101 from jack 95, relays 52 and 63 release; the release of relay 52 causes the release of relay 53; the release of relay 63 causes the release of relays 84, 62 and 50; and the release of relay 62 causes the release of relay 82. The release of relay 84 removes the busy indication from the sleeves of the trunk jacks 95 and extinguishes the busy lamps 97. The aforementioned release of relay 63 also interchanges the connections between the windings of relay 57 and the conductors of trunk T1, thereby reversing the current through these conductors to effect the release of relay 36 of trunk circuit TC1. The release of relay 36 causes the release of relays 32 and 37; and the release of relay 37 causes the release of relays

24, 26 and 39 whereby the trunk circuit TC1 is again normal.

Assume next that an operator has answered a call with plug 101 of cord CD1, that the call is for a station in the dial branch exchange and that the operator inserts the plug 119 in jack 95 to extend the connection over trunk T1 and that the talking and dialing key 114 of cord CD1 is in operated position. Relay 81 of trunk circuit TC2 is thereby operated by the current in a circuit from battery through the lower winding of relay 111, outer lower back contact of relay 113, a front contact of talking key 114, conductor 154, a back contact of relay 157 of the operator's position, conductor 152, a front contact of key 114, lower back contact of ringing key 115, ring conductors of plug 119 and jack 95, conductor 92, windings of retard coil 80 and relay 81, back contact of relay 63, conductor 91, tip conductors of jack 95 and plug 119, upper back contact of ringing key 115, a front contact of key 114, conductor 151, a back contact of relay 157 of the operator's position, conductor 153, a front contact of key 114, outer upper back contact of relay 113, upper winding of relay 111, and inner upper back contact of relay 113, to ground. The operation of relay 81 closes the circuit, including the upper front contact of jack 95, for operating relay 63. Relay 63 locks to ground at the upper front contact of jack 95, opens the circuit for operating relay 81, and closes circuits for operating relays 84, 50 and 82. The operation of relay 84 connects ground to the sleeve of jacks 95 and lights the busy lamps 97. The operation of relay 50 disconnects the windings of relay 51 from the conductors of trunk T1 to prevent the operation of relay 51. The operation of relay 82 closes a circuit from battery through the winding of relay 52, outer upper front contact of relay 82, conductor 91, tip conductors of jack 95 and plug 119, upper back contact of ringing key 115, a front contact of talking and dialing key 114, conductor 151, upper back contact of relay 157 of the operator's position, conductor 153, another front contact of key 114, outer upper back contact of relay 113, upper winding of relay 111 and inner upper back contact of relay 113 to ground. The resistance of relay 52 is high so that the current in this circuit effects the operation of relay 52 without effecting the operation of relay 111. The operation of relay 52 closes a circuit for operating relay 53. The operation of relay 53 closes a circuit for operating relay 54, connects the conductors of trunk T1 to conductors 55 and 56 leading to the telephone repeater, and also bridges the winding of retard coil 60 and winding of relay 61 in series across these conductors to cause the operation of relay 31 of trunk circuit TC1 in the dial private branch exchange. The circuit for operating relay 31 is traced from battery through its upper winding, upper continuity back contact of relay 32, outer lower back contact of relay 32, middle lower back contact of relay 26, lower left winding of repeating coil 25, inner lower back contact of relay 26, conductor 42, lower conductor of trunk T1, inner lower front contact of relay 50, inner upper back contact of relay 62, lower continuity back contact of relay 53, winding of retard coil 60, winding of relay 61, upper continuity back contact of relay 58, upper front contact of relay 53, upper front contact of relay 50, upper conductor of trunk T1, conductor 41, lowermost back contact of relay 24, upper left winding of repeating coil 25, inner

upper back contact of relay 24, outer upper back contact of relay 32, lower continuity back contact of relay 32, and lower winding of relay 31, to ground. The operation of relay 31 causes the successive operations of relays 38 and 37, the operation of relay 37 connecting ground to conductor 23 to mark the trunk circuit TC1 busy in the banks of selector-connectors having access thereto. The operation of relay 31 also closes a circuit for operating the line relay 45 of the incoming connector IC1. This circuit is traced from battery through the right winding of relay 45, right back contact of relay 47, conductor 43, inner lower back contact of relay 24, inner front contact of relay 31, inner lower back contact of relay 28, outer upper back contact of relay 24, upper right winding of repeating coil 25, middle upper back contact of relay 24, upper back contact of relay 28, lower winding of relay 36, outer upper back contact of relay 26, lower right winding of repeating coil 25, inner upper back contact of relay 26, outer lower back contact of relay 28, middle lower front contact of relay 31, lowermost back contact of relay 26, conductor 44, left back contact of relay 47, and left winding of relay 45, to ground. The incoming connector IC1 is thereby prepared for response to dial impulses.

The aforementioned operation of relay 54 closes circuits for maintaining the operation of relays 84 and 59, and closes a circuit from ground at the inner upper back contact of relay 64, through a front contact of relay 54, resistor 67, conductor 92, ring conductors of jack 95 and plug 119, lower back contact of ringing key 115, a front contact of key 114, conductor 152, lower back contact of relay 157 of the operator's position, conductor 154, another front contact of key 114, lowermost back contact of relay 113 and through the lower winding of relay 111 to battery. Resistor 67 limits the current to prevent operation of relay 111. When the operator dials each of the digits of the number of the called station in the dial branch exchange, the off-normal contacts of dial 150 are actuated to effect the operation of relay 156 and to effect the operation of relay 157, the circuit for operating relay 157 not being shown. With relays 156 and 157 operated, the windings of relay 111 are disconnected from the tip and ring conductors of plug 119 so as to place relay 52 under the control of the impulse contacts of the dial 150. The circuit for operating relay 52 is now traced from battery through the winding of relay 52, outer upper front contact of relay 62, conductor 91, tip conductors of jack 95 and plug 119, upper back contact of ringing key 115, a front contact of talking and dialing key 114, conductor 151, impulse contacts of dial 150, front contact of relay 156, conductor 152, a front contact of key 114, a back contact of key 115, ring conductors of plug 119 and jack 95, conductor 92, resistor 67, a front contact of relay 54, and a back contact of relay 64, to ground. Relay 52 is alternately released and reoperated responsive to each impulse created by the operation of dial 150, the alternate release and reoperation of relay 52 causing a like release and reoperation of relay 53. The release of relay 53 in response to the first dial impulse of each digit closes a circuit for operating relay 58 and opens the circuit over trunk T1 to cause the release of relay 31 of trunk circuit TC1. When relay 53 reoperates at the end of the first dial impulse, separate grounded circuits are closed over the conductors of trunk T1 for effecting the reoperation of relay 31 of trunk circuit

TC1. The circuit for energizing the upper winding of relay 31 includes the lower conductor of trunk T1, inner lower front contacts of relays 50, 53 and 58; and the circuit for energizing the lower winding of relay 31 includes the upper conductor of trunk T1 and upper front contacts of relays 50, 53 and 58. Relay 58 is slow-to-release and remains operated until relay 53 has reoperated after the last impulse of a train. Relay 31 of trunk circuit TC1 is thereby released and reoperated in response to the dial impulses created by the dialing of the digits of the called number in the dial private branch exchange with which connection is desired. The release of relay 31, in response to the first dial impulse of each digit, opens the bridge across conductors 43 and 44 to release the line relay 45 of connector IC1 and closes a circuit from ground at its lower back contact, through a back contact of relay 39 and a front contact of relay 38, for operating relay 28. Relay 28 is a slow-to-release relay which remains operated during the receipt of each train of impulses by relay 31. When relay 31 reoperates at the end of the first dial impulse, the windings of line relay 45 of the connector are energized in separate grounded circuits. The circuit for energizing the right winding of relay 45 includes conductor 43, inner front contact of relay 31 and inner lower front contact of relay 28; and the circuit for energizing the left winding of relay 45 includes conductor 44, the middle lower front contact of relay 31 and the outer lower front contact of relay 28. The release and reoperation of relay 31 responsive to the succeeding dial impulses in each train causes the alternate release and reoperation of relay 45. At the end of each of these trains of dial impulses relays 31 and 45 remain operated and relay 28 releases to connect the lower winding of relay 36 in series with the windings of relay 45. The response of relay 45 to the dialing of the digits of the number of the called station operates connector IC1 to select and test the terminals connected to the called line; and, if the line is idle, ringing current is transmitted to the called station. When the called subscriber answers, relay 47 is operated, thereby effecting a reversal of the current through the lower winding of relay 36 to operatively energize this winding. The operation of relay 36 closes a circuit for operating relay 32 and a circuit for operating relay 39. Relay 39 locks under control of relays 37 and 38 and connects the upper winding of relay 36 in parallel with its lower winding. The operation of relay 32 interchanges the connections between the windings of relay 31 and the conductors of trunk T1 thereby to reverse the current through the winding of relay 61 of trunk circuit TC2 to cause the operation of relay 61, and relay 61 closes a circuit for operating relay 64. The operation of relay 64 short-circuits resistor 68 and condenser 69, opens the short circuit across conductors 65 and 66, closes the talking circuit, opens the connection of conductor 92 to ground through resistor 67 to improve the transmission balance, and connects the winding of relay 31 and retard coil 80 across the tip and ring conductors of the jack 95 and plug 119. When the talking and dialing key of cord CD1 is restored to normal, relay 52 is held operated in series with the upper winding of relay 111 and relay 81 is operated in series with both windings of relay 111. Relay 52 is thereby held operated and relay 111 is operated to extinguish the supervisory lamp 118. Relay

81 is operated but performs no useful function at this time.

If the subscriber at the called station alternately restores and removes the telephone, relay 47 is alternately released and reoperated, thereby causing the alternate release and reoperation of relay 36. Relay 39 remains operated, but relay 32 is alternately released and reoperated to reverse the current over the conductors of trunk T1, thereby effecting the alternate release and reoperation of relay 61 of trunk circuit TC2. The alternate release and reoperation of relay 61 causes the alternate release and reoperation of relay 64, thereby to open and close the bridge across conductors 91 and 92, relay 52 being held operated during flashing in series with the upper winding of relay 111. The energization of the upper winding of relay 111 in series with relay 52 and the energization of the lower winding of relay 111 in series with resistor 67 are ineffective to hold relay 111 operated and relay 111 is alternately released and reoperated under the control of relay 64, to flash supervisory lamp 118 in the cord circuit. When the telephone is restored to normal at the called station, relay 47 releases and the reversal of the current through conductors 43 and 44 causes the release of relays 36 and 32 of trunk circuit TC1. The release of relay 32 reverses the current in the conductors of trunk T1 to cause the successive release of relays 61 and 64 of trunk circuit TC2. The release of relay 64 opens the bridge across the conductors 91 and 92 to cause the release of relay 111 to light the supervisory lamp 118. Relay 52 remains operated to ground in the cord circuit until the cord is disconnected from jack 95. When the operator disconnects plug 119 from jack 95, relays 63, 52 and 81 release. The release of relay 63 causes the release of relay 82; and the release of relay 52 causes the release of relay 53. The release of relay 53 causes the release of relay 54 and opens the bridge across conductors of trunk T1 thereby to release relay 31 of trunk circuit TC1. The release of relay 54 also causes the release of relay 84, whereby the busy indication is disconnected from the sleeve conductor of jacks 95 and the busy lamps 97 are deenergized; and causes the release of relay 50 whereby the trunk circuit TC2 is restored to normal. The release of relay 31 of trunk circuit TC1 causes the successive release of relays 38, 37 and 39 and causes the release of relay 47 of connector IC1. The release of relay 37 disconnects ground from conductor 23 to terminate the busy indication in the banks of the selectors having access to the trunk circuit TC1. The release of relay 47 causes the release of relay 46 and the connector is restored to normal in usual manner.

If, on a call initiated by the operator to a called subscriber in the dial branch exchange, a busy condition is encountered, busy tone from the connector is transmitted through repeating coil 25, trunk T1 and trunk circuit TC2 to the calling operator. Since the called station has not answered, relays 61 and 64 are not operated so that the talking connection is open at the lower front contact of relay 64; but the condenser 69 and resistor 68 constitute a path suitable for the transmission of the busy tone from the conductors of trunk T1, through the repeater of Fig. 3 to conductors 91 and 92, thence to the operator. Audible ringing tone from the connector is also transmitted to the operator in like manner.

If the above described call from a station in the dial private branch exchange is a toll call re-

quiring higher grade transmission, or if the above described call to a station in the dial private branch exchange is of such a character, the pad control 70 relay of trunk circuit TC2 is operated by application of ringing voltage to conductors 91 and 92. If plug 101 is connected to jack 95 ringing key 103 is operated and if plug 119 is connected to jack 95 ringing key 115 is operated. In either case the ringing source 104 is bridged across conductors 91 and 92 and the voltage applied to conductor 92, through the elements of gas-filled tube 83 and the winding of relay 70 causes the break-down of the tube and the operative energization of the relay. Relay 70 locks through conductor 94 to ground at the upper contact of jack 95 as long as the plug of the cord connected to jack 95 at the same time opening the connection through tube 83 to conductor 92. The operation of relay 70 short circuits the series resistors of pad P1 and opens the bridge across these resistors to decrease the attenuation of the talking currents. While the specific arrangement shows a gas-filled tube as being the high impedance element normally connecting the winding of relay 70 to the talking conductor 92, a thermistor may be used in place of the tube.

What is claimed is:

1. In combination in a telephone system, a trunk circuit including an attenuation pad comprising resistors normally connected in series with the talking conductors of said trunk circuit, an operator's cord connected to said trunk circuit, a pad control relay for short circuiting said resistors, means including a normally high impedance element connecting said relay to one of said talking conductors, a direct current source connected to the talking conductors of said cord, a ringing current source, and a ringing key in said cord for connecting said ringing current source to the talking conductors of said cord in place of said direct current source, the voltage of said direct current source being insufficient and the voltage of said ringing current source being sufficient to effect the operative energization of the winding of said relay.

2. In combination in a telephone system, a trunk circuit including an attenuation pad comprising resistors normally connected in series with the talking conductors of said trunk circuit, an operator's cord connected to said trunk circuit, a pad control relay for short circuiting said resistors, means including a normally high impedance element connecting said relay to one of said talking conductors, a direct current source connected to the talking conductors of said cord, a ringing current source, a ringing key in said cord for connecting said ringing current source to the talking conductors of said cord in place of said direct current source, the voltage of said direct current source being insufficient and the voltage of said ringing current source being sufficient to effect the operative energization of the winding of said relay, contacts actuated by the operative energization of the winding of said relay for disconnecting the winding from said one talking conductor, and means for locking said relay operated as long as said cord is connected to said trunk circuit.

3. In combination in a telephone system, a trunk circuit including an attenuation pad comprising resistors normally connected in series with the talking conductors of said trunk circuit, an operator's cord connected to said trunk circuit, a pad control relay for short circuiting said re-

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sistors, means including a normally high impedance element connecting said relay to one of said talking conductors, a direct current source connected to the talking conductors of said cord, a ringing current source, a ringing key in said cord for connecting said ringing current source to the talking conductors of said cord in place of said direct current source, the voltage of said direct current source being insufficient and the voltage of said ringing current source being sufficient to effect the operative energization of the winding of said relay and means rendered effective by the operation of said relay for maintaining the short circuit across the resistors of said pad while said cord is connected to said trunk circuit.

4. In a telephone system comprising subscribers' lines, trunk lines, and an operator's link for use in establishing connections between said lines, said trunk including a source of direct current, a source of ringing current and means for connecting the source of ringing current to a connected line in place of the source of direct current, a trunk circuit individually terminating one of said trunk lines, an amplifying repeater in the talking connection through said trunk circuit, an attenuation pad connected in series with the talking conductors of said trunk circuit, a relay in said trunk circuit, a variable impedance element connecting the winding of said relay to a talking conductor of said trunk circuit, said element normally having a high impedance, the connection of the direct current source in said link to the talking conductors of said trunk circuit being ineffective to decrease the impedance of said element and the connection of the source of ringing current in said link to the talking conductors of said trunk circuit being effective to decrease the impedance of said element to effect the operation of said relay, and means including contacts of said relay for rendering said pad ineffective to attenuate current transmitted through the talking conductors of said trunk circuit.

5. In a telephone system comprising subscribers' lines, trunk lines, and an operator's link for use in establishing connections between said lines, said link including a source of direct current, a source of ringing current and means for connecting the source of ringing current to a connected line in place of the source of direct current, a trunk circuit individually terminating one of said trunk lines, an amplifying repeater in the talking connection through said trunk circuit, an attenuation pad connected in series with the talking conductors of said trunk circuit, a relay in said trunk circuit, a variable impedance element connecting the winding of said relay to a talking conductor of said trunk circuit, said element normally having a high impedance, the connection of the direct current source in said link to the talking conductors of said trunk circuit being ineffective to decrease the impedance of said element and the connection of the source of ringing current in said link to the talking conductors of said trunk circuit being effective to decrease the impedance of said element to effect the operation of said relay, and means including contacts of said relay for rendering said pad ineffective to attenuate current transmitted through the talking conductors of said trunk circuit and for disconnecting said relay from the talking conductor of said trunk circuit.

6. In a telephone system comprising subscribers' lines, trunk lines, and an operator's link for

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use in establishing connections between said lines, said link including a source of direct current, a source of ringing current and means for connecting the source of ringing current to a connected line in place of the source of direct current, a trunk circuit individually terminating one of said trunk lines, an amplifying repeater in the talking connection through said trunk circuit, an attenuation pad connected in series with the talking conductors of said trunk circuit, a relay in said trunk circuit, a variable impedance element connecting the winding of said relay to a talking conductor of said trunk circuit, said element normally having a high impedance, the connection of the direct current source in said link to the talking conductors of said trunk circuit being ineffective to decrease the impedance of said element and the connection of the source of ringing current in said link to the talking conductors of said trunk circuit being effective to decrease the impedance of said element to effect the operation of said relay, means including contacts of said relay for rendering said pad ineffective to attenuate current transmitted through the talking conductor of said trunk circuit, and means for locking said relay operated as long as said link is connected to said trunk circuit.

7. In a telephone system, a trunk circuit, an amplifying repeater in the talking connection through said trunk circuit, an attenuation pad included in said talking connection, a relay in said trunk circuit, a gas-filled tube connecting the winding of said relay to a talking conductor of said trunk circuit, a source of direct current connected to said talking conductor during the existence of a talking connection through said trunk circuit, the connection of said direct current source to said talking conductor being ineffective to energize said tube, a ringing current source and means for connecting said ringing source to said conductor in place of said direct current source to effect the energization of said tube and operation of said relay, and means including contacts of said relay for rendering said pad ineffective to attenuate current transmitted through said talking connection.

8. In a telephone system, a trunk circuit, an amplifying repeater in the talking connection through said trunk circuit, an attenuation pad included in said talking connection, a relay in said trunk circuit, a gas-filled tube connecting the winding of said relay to a talking conductor of said trunk circuit, the impedance of said tube being high enough to prevent interference with the transmission of talking current through the trunk circuit, to prevent interference with the transmission of dial impulses and to prevent the operation of said relay while talking current is being transmitted through the trunk circuit, means for applying a ringing voltage to said talking conductor to effect the breakdown of the tube and operation of said relay, and means including contacts of said relay for disconnecting the winding of said relay from said tube and talking conductor and for rendering said pad ineffective to attenuate current transmitted through said talking connection.

9. In a telephone system, a trunk circuit, an amplifying repeater in the talking connection through said trunk circuit, an attenuation pad included in said talking connection, a relay in said trunk circuit, a gas-filled tube connecting the winding of said relay to a talking conductor of said trunk circuit, the impedance of said tube being high enough to prevent interference with

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the transmission of talking current through the trunk circuit, to prevent interference with the transmission of dial impulses and to prevent the operation of said relay while talking current is being transmitted through the trunk circuit, means for applying a ringing voltage to said talking conductor to effect the breakdown of the tube and operation of said relay, means including contacts of said relay for rendering said pad ineffective to attenuate current transmitted through said talking connection, and means for locking said relay while said talking connection is maintained.

10. In a telephone system, a trunk circuit, an amplifying repeater in the talking connection through said trunk circuit, an attenuation pad included in said talking connection, a relay in said trunk circuit, a gas-filled tube connecting the winding of said relay to a talking conductor of

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said trunk circuit, the impedance of said tube being high enough to prevent interference with the transmission of talking current through the trunk circuit, to prevent interference with the transmission of dial impulses and to prevent the operation of said relay while talking current is being transmitted through the trunk circuit, means for applying a ringing voltage to said talking conductor to effect the breakdown of the tube and the operation of said relay, means including contacts of said relay for rendering said pad ineffective to attenuate current transmitted through said talking connection and for disconnecting the winding of said relay from said tube and talking conductor, and means for locking said relay while said talking connection is maintained.

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