April 3, 1928. 1,664,943

W. T. POWELL

AUTOMATIC TELEPHONE SYSTEM

Filed May 8, 1924 4 Sheets-Sheet 1

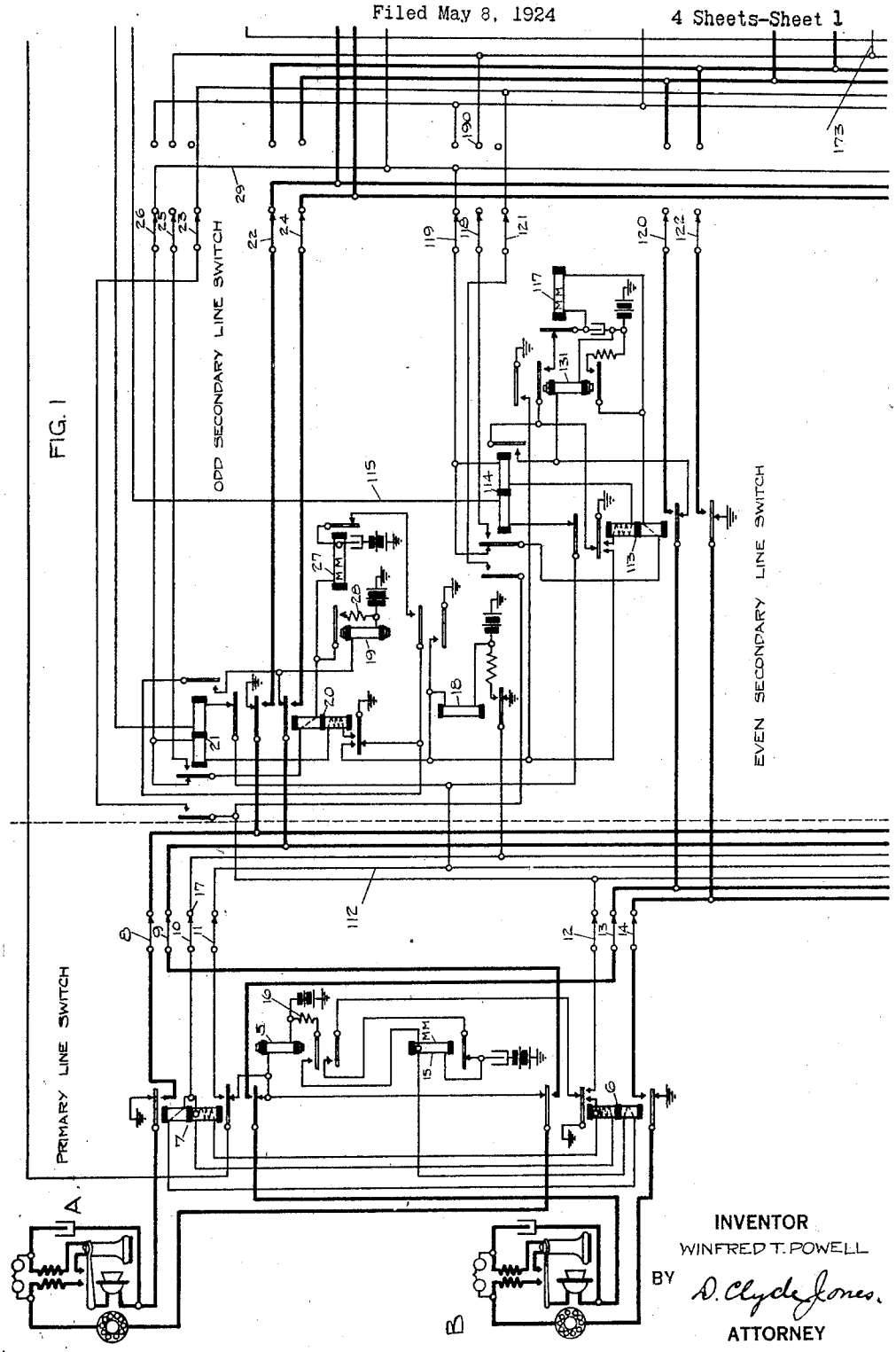

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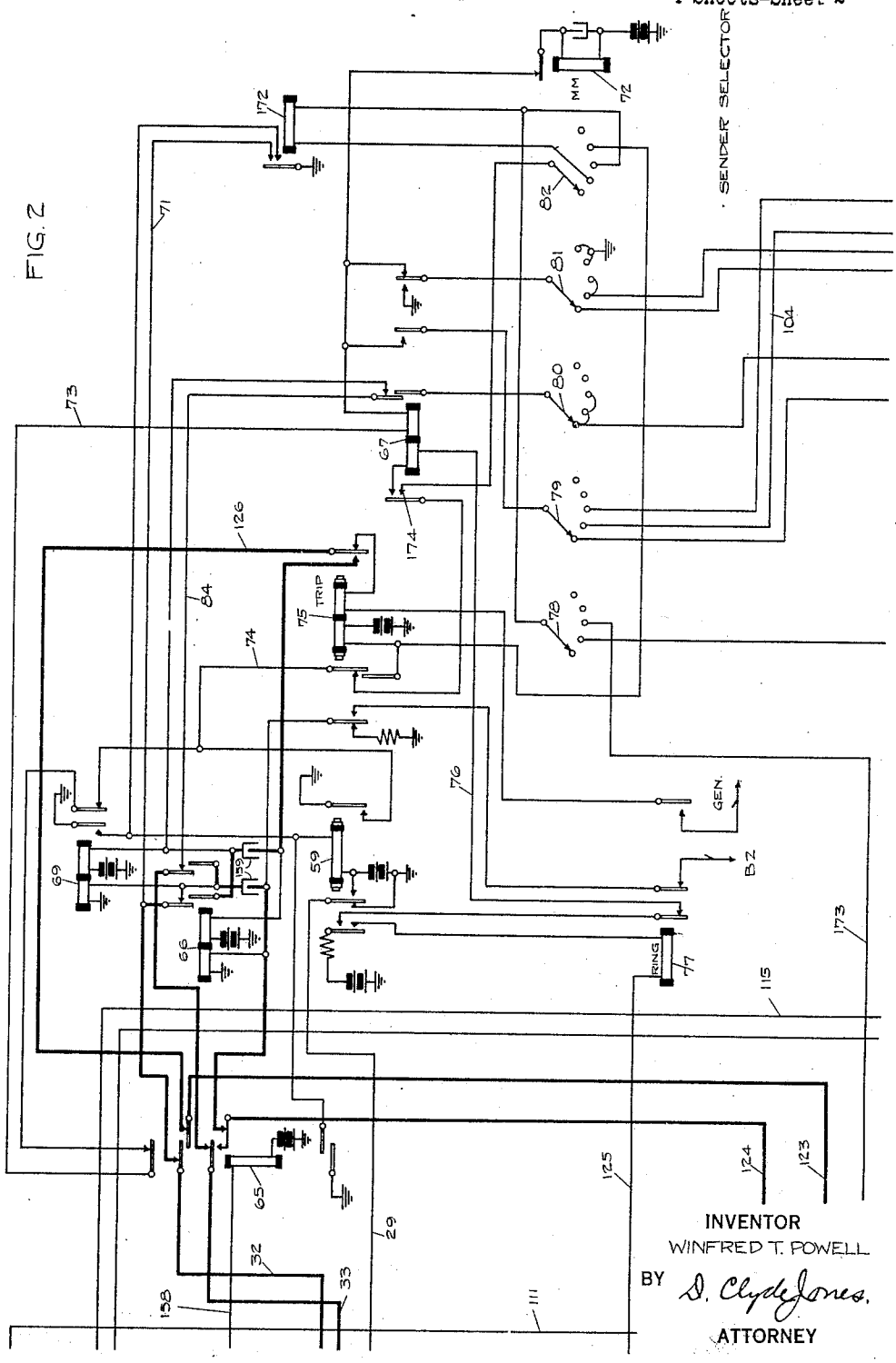
FIG. 2



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AUTOMATIC TELEPHONE SYSTEM

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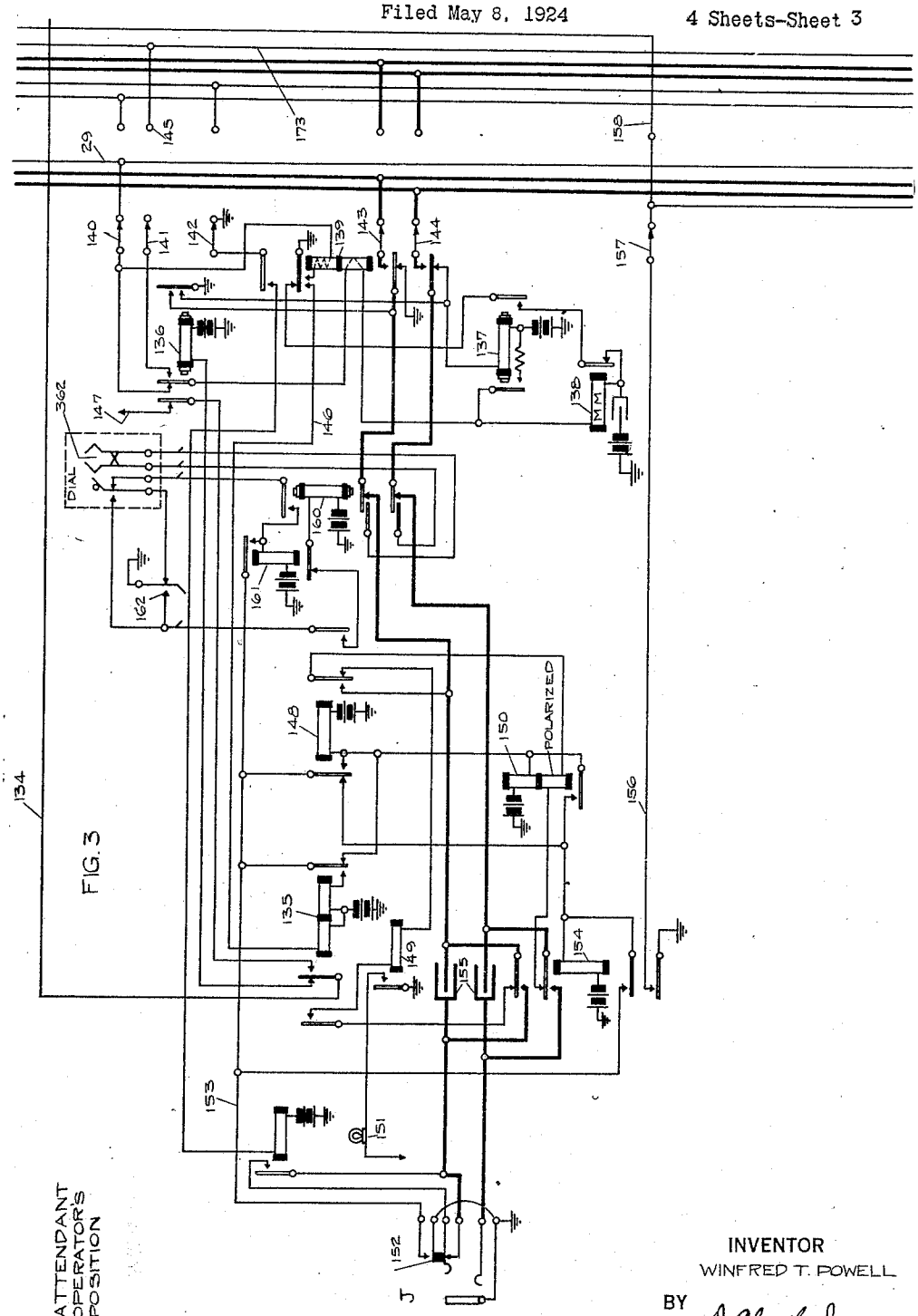

FIG. 3

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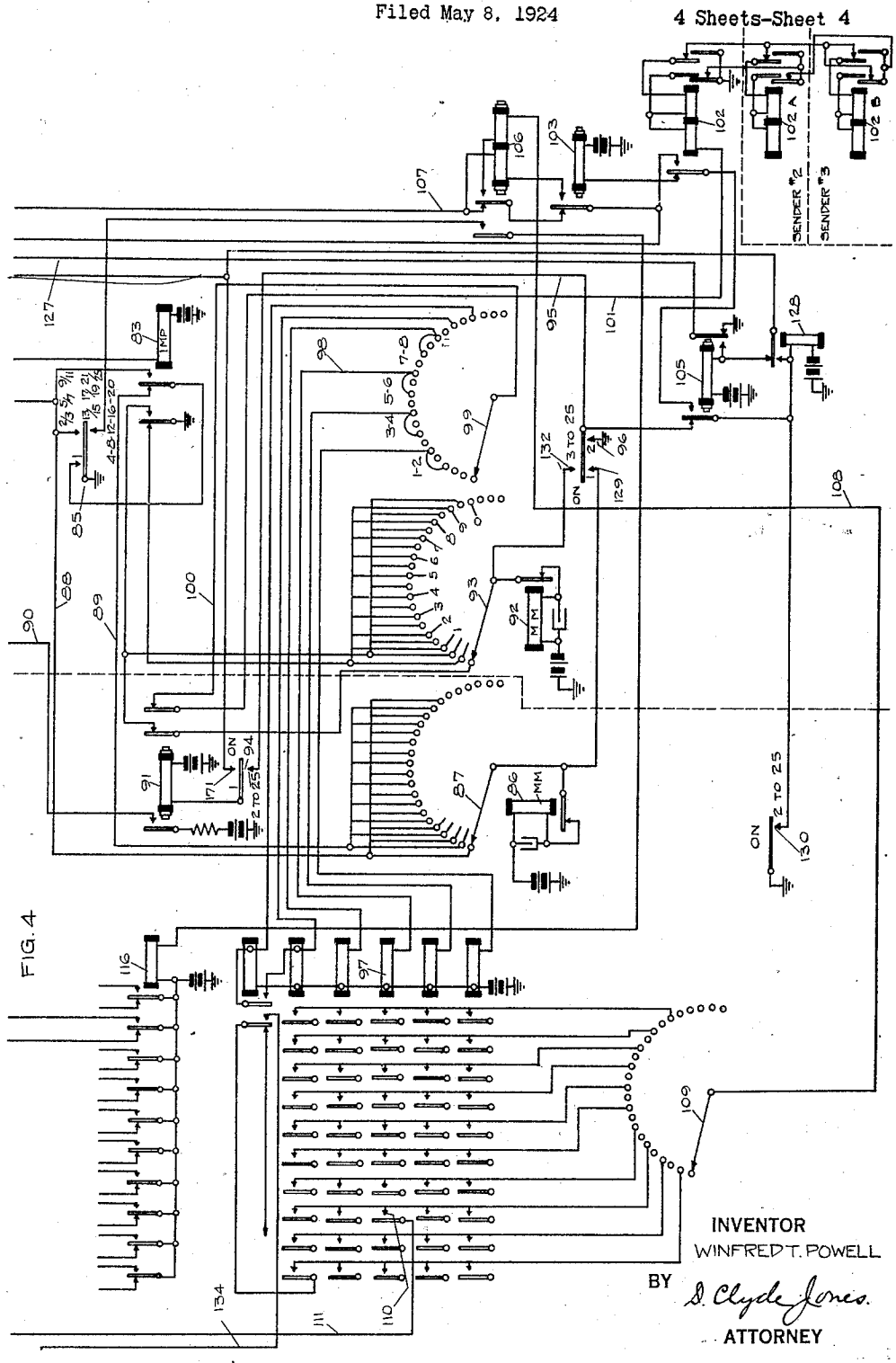

FIG. 4

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

Application filed May 8, 1924. Serial No. 711,750.

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

One of the principal features of this present invention resides in the arrangement by which calls from a main exchange may be extended through an attendant operator's position associated with a private automatic exchange to a subscriber's telephone line and the circuit thereby extended is provided with a minimum number of transmitter current dissipating devices such as impedances and condensers.

Another feature of the invention consists in the arrangement by which a register sender is not seized until the subscriber initiating the call starts to dial the number of a wanted subscriber.

The above mentioned features together with others will appear from the description and appended claims.

For a better understanding of the invention, reference is made to the drawings in which Figs. 1 and 2, when arranged in the order named and with Figs. 3 and 4 below 1 and 2, diagrammatically represent a portion of a telephone system employing the present invention.

The progressively movable switches herein disclosed, may be substantially similar to those disclosed in the patent to Clement, #1,107,153, patented August 11, 1914. It will be noted that certain of these switches, such as the units register, are provided with sets of contacts, such as 96, 129 and 132, which are referred to as off-normal contacts. It will be understood, however, that these contacts are the ordinary terminals or contacts in the contact bank of the register switch, whereas the spring shown intermediate these contacts is a switch brush such as that shown at 93 or 99. The small numerals such as 3 to 25 placed adjacent to contacts such as 132 indicate that the contacts 3 to 25 of the terminal bank engaged by the off-normal brush are connected together. Also at 85, 2/3 means that terminals 2 and 3 of the contact bank are connected together.

It is believed that the invention will best be understood by describing the method of establishing a telephone connection from a calling substation such as A to a called substation such as that designated B. When the subscriber at A removes his receiver from its switch-hook, the line relay 5 is energized in a circuit traceable from grounded battery, winding of this relay, uppermost back contact and armature of cut-off relay 6, lower side of the calling line and through the substation network at A in series, over the upper side of the calling line, uppermost armature and back contact of cut-off relay 7 to ground. In the event that the brushes 8, 9, 10, 11, 12, 13 and 14 of the primary switch are not standing in engagement with the terminals of an idle pair of trunks, the energization of the line relay 5 closes an operating circuit for the motor magnet 15 extending from ground at the upper armature and back contact of cut-off relay 6, lowermost armature and front contact of relay 5, winding, back contact and armature of the motor magnet 15, front contact and innermost armature of the line relay 5, and resistance 16 to grounded battery. Under the control of this circuit the motor magnet 15 advances the brushes 8 to 14 inclusive of the line switch until the test brush 10 encounters a test terminal associated with an idle pair of trunks.

Let it be assumed that the first pair of idle trunks is that shown in Fig. 1 so that when test brush 10 encounters the test terminal 17 of this idle pair of trunks, a circuit is closed from ground, back contact and armature of relay 18, test terminal 17, test brush 10, low resistance winding of cut-off relays 7 and 6 in series, inner front contact and armature of relay 5, resistance 16 to grounded battery. The motor magnet 15 is shunted and the cut-off relays 7 and 6 are thus operated. These relays at their armatures and front contacts, extend the two sides of the calling line in series to the odd trunk circuit of the selected pair. This extended circuit is traceable from grounded battery, winding of the slow releasing relay 19, inner back contact and armature of relay 20, line switch brush 9, uppermost front contact and armature of cut-off relay 6, over the lower side of the calling line and through the substation circuits at A in series, over the upper side of the calling line, uppermost front contact and armature of cut-off relay 7, line switch brush 8, middle armature and back contact of relay 20 to ground.

Relay 19 is operated in this circuit and at its lowermost armature and front contact, completes a circuit from ground through the winding of relay 18 to grounded battery. The operation of relay 18 extends a holding circuit from grounded battery, resistance, front contact and armature of relay 18, test terminal 17, line switch brush 10 and through the high resistance windings in multiple of the cut-off relays 6 and 7, inner front contact and armature of relay 6 to ground. As soon as the relay 19 is energized, it closes an operating circuit for the motor magnet 27 of the odd secondary line switch and in the event that the brushes 22 to 26 inclusive of this switch are not resting in engagement with the terminals of an idle secondary trunk circuit the motor magnet 27 advances its brushes 22 to 26 inclusive until the test brush 26 engages a test terminal which is characterized as idle by the presence of ground potential thereon.

When the test brush 26 locates an idle secondary trunk, a circuit is closed for operating the switching relay 20 and shunting the motor magnet 27. This circuit is traceable from grounded battery, resistance 28, front contact of relay 19, through the low resistance winding of relay 20, inner armature and back contact of relay 21, test brush 26, test conductor 29 of the idle trunk circuit, inner left hand armature and back contact of relay 59, to ground. The magnet 27 is thus disabled and the switching relay 20 is operated to extend through its armatures and front contacts the calling line and the primary trunk to which it is connected through the secondary line switch brushes 22 and 24, to conductors 32 and 33. This circuit is continued from conductor 33 through the inner upper armature and back contact of relay 65, outer continuity spring and back contact of relay 66, continuity spring and back contact of relay 67, right hand winding of relay 69 to grounded battery and from conductor 32 through the middle armature and back contact of relay 65, inner continuity spring and back contact of relay 66, left hand winding of relay 69 to ground. The relay 69 is thereby operated and closes an actuating circuit for the slow releasing relay 59. This last named relay at its inner front contact and armature completes the holding circuit for the secondary line switch from grounded battery at relay 59, front contact and armature of this relay, conductor 29, test brush 26, left hand winding of relay 21 and through the high resistance winding of relay 20, front contact and armature of this relay to ground. The operation of the relay 20 disconnects the relay 19, which, in turn, opens the operating circuit of the motor magnet 27.

The apparatus is now in condition to receive the tens series of impulses and in response to the first impulse, which is transmitted over the two sides of the calling line to the relay 69, over conductors 32 and 33, this last named relay retracts its armatures. This is effective to operate the relay 67, over a circuit from grounded battery, winding of the motor magnet 72, right hand winding of relay 67, conductor 73, uppermost armature and back contact of relay 65, armature and back contact of relay 69, front contact and armature of relay 59 to ground. As soon as the relay 67 is operated in the manner just described, it is locked in this condition over a circuit from ground, right hand armature and front contact of relay 59, conductor 74, continuity spring and back contact of the relay 75, left hand armature and front contact of relay 67, conductor 76, inner back contact and armature of relay 77, outer front contact and armature of relay 59, resistance to grounded battery. With the relay 67 operated the slow releasing relay 91 of Fig. 4, is operated through the off-normal contacts 171, sender selector brush 81 in its first position, outermost armature and front contact of relay 67 to ground.

When the impulse springs of the dial sender are closed at the end of the first impulse of the tens series, the impulse relay 83 of Fig. 4 is operated in a circuit from grounded battery, winding of this relay, sender selector brush 80, innermost armature and continuity spring of relay 67, conductor 84, and thence through the back contact and continuity spring of relay 66, inner back contact and armature of relay 65, over conductor 33 to the calling line and thence over the other side of the calling line and the extended connection through conductor 32 and to ground through the middle continuity spring and back contact of relay 65, continuity spring and back contact of relay 66, left hand winding of relay 69 to ground. The relay 83 is energized in this circuit and effects the operation of the motor magnet 72 of the sender selector in a circuit traceable from grounded battery winding of the magnet 72, its armature and back contact, middle contact and armature of relay 67, selector brush 79, front contact and armature of relay 83, off-normal contact 85 closed in its first position, to ground. Under the control of this circuit the motor magnet advances its brushes 78 to 82 inclusive into their second position. At this time relay 172 is operated from grounded battery at the left hand armature and front contact of relay 91, conductor 90, brush 78 in position two, winding of relay 172, brush 82, contact 174 and armature of relay 67, back contact and continuity spring of relay 75, conductor 74, front contact and armature of relay 59 to ground. Relay 172 when operated extends conductor 71 of the impulse circuit to ground independent of the left winding of

relay 69. The energization of the impulse relay causes the motor magnet 86 of the tens register to be energized from grounded battery, winding of this magnet, its back contact and armature, tens register brush 87 in its first position, conductor 88, inner front contact and armature of the impulse relay 83, off-normal contacts 85 to ground. Under the control of this circuit the tens register is moved from position one into position two. The relay 91 is now held operated through off-normal contacts 94, conductor 95, off-normal contacts 129 in multiple with magnet 86. In response to the second impulse of the tens series of impulses, the impulse relay 83 retracts its armatures and thereby closes a circuit from ground, through off-normal contacts 85, inner armature and back contact of the impulse relay 83, conductor 89, register brush 87 in its second position, armature back contact and winding of the motor magnet 86 to grounded battery to move the tens register into position three. When the impulse relay 83 is energized at the close of this series of impulses, the motor magnet 86 is operated from ground at the off-normal contacts 85, armature and front contacts of relay 83, conductor 88, brush 87 in its third position, armature, back contact and winding of the motor magnet 86 to grounded battery. Under the control of this circuit the brush 87 is advanced into position four. In response to the third and last impulse of this series the impulse 83 retracts its armature and again completes a circuit for the motor magnet 86, causing the same to advance its brushes into their fifth position.

At the close of this series of impulses, the impulse relay 83 again attracts its armatures, thereby closing a circuit over conductor 88 to energize the motor magnet 86 which advances the brushes of the tens register into their sixth position. Since the impulse relay 83 is now held operated for a relatively long interval, the change-over relay 91 deenergizes and thereby completes an operating circuit for the motor magnet 92, which circuit is traceable from grounded battery, winding back contact and armature of this magnet, units register brush 93 in its first position, inner armature and back contact of relay 91, front contact and armature of relay 83 to ground. Under the control of this circuit the units register brushes are advanced into their second position. In this position the change-over relay 91 is now operated from grounded battery, winding of this relay, off-normal contacts 94, conductor 95, off-normal contacts 96 closed in the second position of the units register to ground. This enables the change-over relay 91 to be operated before the impulse relay responds to the units impulses. In response to each of the six impulses of the units series of impulses relay 83 vibrates its armature and on the first retraction of its armatures a circuit is closed from ground, outer armature and back contact of relay 83, units register brush 93 in its second position, armature back contact and winding of the motor magnet 92 to grounded battery. Under the control of this circuit, the motor magnet advances the brushes of the units register into their third position to close the off-normal contacts 132 so that the change-over relay 91 is held operated in multiple with the motor magnet 92. When the impulse relay 83 is energized at the close of its first impulse, the motor magnet 92 is again operated from grounded battery, winding of the motor magnet 92, its back contact and armature, register brush 93 in its third position, outer front contact and armature of relay 83 to ground so that the motor magnet advances the units register brushes into their fourth position. In response to each of the succeeding impulses of the units series, the motor magnet is likewise operated to cause the brushes of the units register to be advanced two steps.

At the close of the units series of impulses, the impulse relay 83 holds its armatures attracted for a relatively long period, causing the change-over relay 91 to retract its armatures. This is effective to close a circuit from grounded battery, winding of the relay 97, conductor 98, brush 99 in its fourteenth position, conductor 100, outer back contact and armature of relay 91, conductor 101, through both windings in series of relay 102 and its continuity spring and back contact, through the outer continuity springs and back contacts of other relays such as 102^a and 102^b similar to 102, associated with the other register senders of this group and through the inner back contacts and continuity springs of these relays to ground at the inner continuity spring of relay 102. Relays 97 and 102 are operated in this circuit and the relay 102 locks itself operated through its inner armature and continuity spring to ground. The motor magnet 72 of the sender selector is now operated to advance the register selector brushes from position two to position three. This is accomplished by a circuit closed from grounded battery, winding, back contact and armature of this magnet, middle front contact and armature of relay 67, brush 79 in its second position, conductor 104, left hand front contact and armature of relay 102, left hand front contact and armature of relay 105, off-normal contacts 130 to ground. The energization of relay 102 also opens the operating circuit for the slow-releasing relay 103 but before this relay retracts its armature, the slow releasing relay 106 is energized in a circuit now extended from grounded battery, winding of the motor magnet 72, its armature and back contact, middle front contact and armature

of relay 67, selector brush 79 in its third position, conductor 107, left hand winding of relay 106, front contacts and armatures of relay 103, 102 and 105, through off-normal contacts 130 to ground. When under the control of this circuit the relay 106 is energized and after relay 103 retracts its armature, relay 106 temporarily locks itself energized over a so-called test circuit from ground through off-normal contacts 130, left hand armature and front contacts of relays 105 and 102, armature and back contact of relay 103, inner armature, front contact and winding of relay 106, conductor 108, tens register brush 109 in its sixth position, through the contact 110 and armature of relay 97, conductor 111 and since the called line is one of the same pair of lines as the calling line its test conductor is now extended through the lower inner armature and front contact of the cut-off relay 7 and the operated primary line switch brush 11, conductor 112, armature and back contact of relay 113, left hand winding of the relay 114, conductor 115, armature and contact of relay 116 to grounded battery. Relay 114 is thus energized and relay 131 is operated from grounded battery, winding of this relay, front contact and armature of relay 114, inner back contact and armature of relay 113 to ground. Relay 131 then closes an operating circuit for the motor magnet 117 of the even secondary line switch from grounded battery, resistance, lower front contact and armature of relay 131, winding of the motor magnet, its armature and back contact, inner front contact and armature of relay 131, inner back contact and armature of relay 113 to ground. At the inner left hand front contact and armature of relay 114 the test brush 118 which is used only on a terminating call is rendered effective while the test brush 119 which is used when line B originates a call is ineffective at this time. Under the control of the circuit for the motor magnet 117, previously described, the brushes 118, 119, 120, 121 and 122 of the even secondary line switch are advanced until the test brush 118 encounters the incoming terminals of the bridge circuit which have previously been connected to the calling line. At this time the relay 113 is operated to disable the motor magnet 117 and stop the brushes of the even secondary line switch in engagement with the terminating end of the mentioned bridge circuit. The operating circuit of the relay 113 is traceable from grounded battery, resistance, lower front contact and armature of relay 131, through the low resistance winding of relay 113, inner left hand armature and front contact of relay 114, test brush 118, test terminal 190, conductor 173, sender selector brush 78 in its third position, sender selector brush 82 in its third position, contact 174 and armature of relay 67, back contact and continuity spring of relay 75, conductor 74, right hand front contact and armature of relay 59 to ground. As soon as the relay 113 is operated, it extends the called line through the brushes 13 and 14 of the primary line switch and through the brushes 120 and 122 of the secondary line switch to the conductors 123 and 124 of the terminating end of the bridge circuit. Also when the relay 113 is operated it closes a locking circuit for itself from ground, through its upper armature and front contact, its high resistance winding, winding of relay 114, brush 119 of the secondary line switch, conductor 125, winding of the ringing relay 77, left hand front contact and armature of relay 59 to grounded battery.

The ringing relay is operated in this circuit and through its outermost armature and front contact, connects a source of ringing current through the right hand winding of the trip relay 75, right hand back contact and armature of this relay, conductor 126, middle back contact and continuity spring of relay 65, conductor 123 of the selected bridge and thence through the extended circuit to substation B and through the signal thereat, over the other side of the called line and the extended connection to conductor 124, innermost continuity spring and back contact of relay 65, left hand winding of the relay 66 to ground. Ringing current is supplied over the last described circuit until the subscriber at substation B removes his receiver from its switch hook, at which time the trip relay 75 is operated in the well known manner to disconnect the ringing current. Trip relay 75 as soon as it is operated closes a locking circuit for itself through its left hand winding, inner armature and continuity spring to ground through the right hand front contact and armature of the relay 59. It should be stated that the right hand contacts of trip relay 75 are so arranged that the front contacts are closed before the back contacts are opened.

The connection is now completed between substations A and B and talking battery for the calling subscriber is supplied through windings of relay 69 in series, while talking battery for the called subscriber is supplied through both windings in series of the relay 66.

As soon as the trip relay 75 is operated it interrupts the locking circuit for the relay 67 which has been maintained operated at the inner back contact and continuity spring of the relay 75. In this way the relay 67 is deenergized, which interrupts at its outermost armature and front contact the locking circuit of the holding relay 105. After a brief interval relay 105 deenergizes and thereby completes a circuit from ground, its back contact and armature, conductor 127,

sender selector brush 81 in its third position, outermost armature and back contact of relay 67, back contact, armature and winding of the motor magnet 72 to grounded battery. This circuit operates the motor magnet 72, which in turn advances the brushes of the sender selector into their fourth position where the operating circuit of the motor magnet 72 is continued through the brush 81 of the sender selector, so that the brushes of this switch are advanced into engagement with the terminals associated with the next idle register sender. When the relay 105 releases, the units register is advanced to its normal position by a circuit extending from grounded battery, through motor magnet 92, its back contact and armature, off-normal contacts 132, left hand back contact and armature of relay 105, off-normal contacts 130 to ground. The motor magnet 92 intermittently interrupts the circuit just described and thereby advances the brushes of the units register into their normal position, at which time off-normal contacts 129 are closed. This is effective to close the operating circuit for the motor magnet 86 of the tens register from grounded battery, winding, back contact and armature of this magnet, off-normal contacts 129, back contact and armature of relay 105, off-normal contacts 130 to ground. When the tens register has reached its normal position, off-normal contacts 130 are opened to cause the relay 128 to deenergize. This register sender is now in readiness for use on a succeeeding call.

It will be understood that the sender selector, individual to the bridge circuit such as shown in Fig. 2 is provided with a set of contacts similar to those shown for each register sender provided in the system. In the foregoing description it has been pointed out that when the register sender employed in establishing a connection is released, the brushes of the sender selector are advanced into engagement with the terminals associated with the next idle register sender. When this last mentioned sender is seized by some other sender selector, individual to another bridge circuit the sender selector of Fig. 2 advances its brushes into engagement with the terminals of an idle register sender so that a register sender is always preselected for use. The arrangement by which the sender selector of Fig. 2 preselects another idle register sender when the preselected sender is seized at some other bridge circuit is as follows: At the time when the second bridge circuit is connected to the preselected register sender, a relay such as 67, associated therewith, is operated in the manner previously described so that a circuit is closed from the ground, outer right hand front contact and armature of that relay 67 through a brush such as 81 of the sender selector associated with the second bridge circuit and through the multiple connected contacts of the sender selectors, brush 81 of the sender selector, Fig. 2, armature and back contact of the relay 67 of Fig. 2, back contact, armature and winding of motor magnet 72, to ground battery. Under the control of this circuit the motor magnet 72 advances its brushes, 78 to 82 inclusive, into their second position where an operated circuit for the motor magnet is completed in the second and third position of the switch, traced from grounded battery, winding, armature and back contact of motor 72, back contact and armature of relay 67, brush 81, second and third position contacts of the selector switch, conductor 127, armature and back contact of a relay 103 of the preselected register sender shown in Fig. 4 to ground. Under the control of this circuit the sender selector is advanced into its fourth position where the fourth and fifth contacts of the switch are grounded to close an operating circuit of motor magnet 72 to advance the sender selector switch into engagement with the first set of contacts associated with the next register sender. The sender selector thus continues to operate until it locates or preselects an idle register sender for use.

Call to a busy line.

Let it be assumed that at the conclusion of the setting of the register sender, the called line is busy, under this assumption the test circuit including the conductor 111 is not completed at the relay 106 of Fig. 4. The motor magnet 72 of the sender selector is thereupon operated in a circuit closed from grounded battery, winding of this magnet, its armature and back contact, middle front contact and armature of relay 67, brush 79 in its third position, conductor 107, inner back contact and armature of relay 106, back contact and armature of relay 103, front contact and armature of relay 102, left hand front contact and armature of relay 105, off-normal contacts 130 to ground. Under the control of this circuit, the sender selector advances its brushes 78 to 82 inclusive into their fourth position. In this position, the trip relay 75 is operated in a circuit closed from grounded battery, its left hand winding, selector brush 82 in its fourth position, contact 174 and armature of relay 67, inner back contact and continuity spring of relay 75, conductor 74, front contact and armature of relay 59 to ground. The trip relay 75 on operation locks itself in this condition through its armature and continuity spring. The locking circuit of the relay 67 is thus opened permitting this relay to deenergize, whereupon the sender selector is operated from grounded battery, winding of its motor magnet 72, its armature and back contact, outermost back contact and armature of re-

lay 67, selector brush 81 in positions 4 and 5 to ground. Under the control of this and similar circuits the motor magnet 72 advances the brushes of its sender selector into engagement with the first position connected to an idle register sender. Also as soon as the trip relay is operated, the busy tone is applied from the source B. Z. through the armature of ringing relay 77, front contact and armature of the trip relay 75, thence over the extended connection to the calling substation to indicate to the calling subscriber that the wanted connection can not be established. The calling subscriber may then release the connection in the manner already described by placing his receiver on its switch hook. Also when the relay 67 of Fig. 2 deenergizes the holding relay 105 of Fig. 4 of the register sender deenergizes permitting the restoration of the tens and units registers of this sender to their normal position.

Call from a private automatic exchange subscriber to a subscriber at a manual exchange.

Let it be assumed that the subscriber at A desires a telephone connection to a telephone line terminating at a main exchange (not shown). Under this assumption the calling line is extended to the attendant operator's position of Fig. 3, where the operator is provided with apparatus (not shown) to extend the connection to the main exchange where the connection is completed to the called line. In the case of such a connection the calling subscriber initiates the call by removing his receiver from its switch hook, and thereupon operates his dial sender to seize a register sender in the manner already described. Thereafter this register sender switch such as that shown in Fig. 4 is associated with the bridge in the manner already described and the calling party dials "00" to set the tens and units registers of this associated sender. After the adjusting of these registers the testing of the attendant operator's position is effected over a test circuit including the conductor 134, inner armature and back contact of relay 135, winding of relay 136 to grounded battery. Slow releasing relay 136 is thereby operated and at its right hand armature and front contact effects the operation of the slow releasing relay 137. The motor magnet 138 is now energized from grounded battery, resistance, left hand contact and armature of relay 137, winding, back contact and armature of motor magnet 138, front contact and armature of relay 137, inner back contact and armature of relay 139 to ground. Under the control of this circuit the brushes 140, 141, 142, 143, 144 and 157 of the operator's line switch are automatically advanced until the test brush 141 encounters the test terminal 145 of the terminating end of the bridge circuit to which the calling line has been connected. Then relay 139 is operated from grounded battery, front contact and armature of relay 137, winding of relay 139, armature and contact of relay 136, brush 141, conductor 173, sender selector brush 78 in its third position, sender selector brush 82 in its third position, left hand front contact and armature of relay 67, back contact and continuity spring of relay 75, right hand front contact and armature of relay 59 to ground. The relay 139 is energized in this circuit and locks itself operated from ground, through its upper armature, front contact and upper winding, line switch brush 140, conductor 125, winding of relay 77, outer left hand make contact of a relay 59 and resistance to grounded battery. The relay 139 also effects the operation of the relay 135 from grounded battery, left hand winding of this relay, conductor 146, front contact and armature of relay 139 to ground. The operation of the relay 135 extends the test conductor 134 to the conductor 147 leading to the second operator's trunk, thereby assigning this second trunk for use in the case of a second call. The relay 135 on operation disables the relay 148 and at its outer left hand armature and front contact connects relay 149 and the polarized relay 150 in bridge of the selected bridge circuit. This is effective to trip the ringing by the operation of the trip relay 75. Also the operation of the relay 149 of Fig. 3 lights the lamp signal 151 whereupon the operator inserts the answering plug of her cord circuit (not shown) into the jack J. The inserting of this plug into the jack J closes the connecting springs 152 and thereby completes a circuit from ground over conductor 153, left hand armature and back contact of relay 148, winding of the relay 154 to grounded battery.

The relay 154 when operated, closes a locking circuit for itself, through its inner lower armature and front contact, and holding conductor 153. Also the operation of the relay 154 short circuits the condensers 155 and completes a circuit from ground at its lowermost armature and front contact, conductor 156, line switch brush 157, conductor 158, winding of relay 65 to grounded battery. Relay 65 is thus operated and disconnects the bridging relays 66 and 69 as well as the condensers 159. In this way the calling line from substation A is connected directly to the spring terminals of the jack J independently of any condensers and without having bridging relays connected thereto.

It will be noted that the operation of the relay 65 also closes a circuit for the holding relay 59, so that the release of the connection is controlled entirely from the attendant operator's position simply by removing the answering plug from the jack J.

Supervision of the connection will take place in the manual cord circuits, (not shown) in the manner now well known.

To resume the description at the point where the attendant operator plugs into jack J the operator requests the designation of the wanted exchange and then connects the other end of the cord to that exchange where the connection to the called line is completed in the well known manner.

A call from a manual subscriber to a subscriber in the private automatic exchange.

When a subscriber at a manual exchange desires to make connection with a subscriber, whose line terminates at a private automatic exchange, the manual subscriber's line is extended through one or more manual offices to the attendant operator's position of Fig. 3, which thereby operates a signal lamp (not shown) to indicate to the attendant operator that a call is awaiting attention. This operator then inserts the answering end of her cord circuit (not shown) into the trunk leading from the manual office and inserts the calling end of this circuit into the jack J. This last operation is effective to close the jack springs 152, which completes a circuit from ground, over conductor 153, right hand armature and back contact of relay 135, winding of relay 148 to grounded battery. The relay 148 is thus operated and closes a locking circuit for itself through its left hand front contact and armature to the holding conductor 153. Relay 148, which is faster to operate than relay 154 connects the polarized relay 150 through the lower winding thereof across the talking conductors of the selected trunk. The operator then presses the dial key and effects the operation of the slow releasing relay 160 from grounded battery, winding of this relay, lower armature and back contact of relay 161, front contact and armature of relay 148, contacts 162 of the dial key to ground. The operation of the relay 160 connects the dial sender of Fig. 3 to the conductors now connected to the line switch brushes 143 and 144.

The operator then actuates the dial sender 362 in accordance with the tens digit of the wanted number. In response to the first impulse the sender selector, whose brushes are designated 78 to 82 inclusive is arranged to connect the selected bridge circuit to an idle register sender. The tens register of this sender such as that shown in Fig. 4 is then directively operated to adjust its brushes. Thereafter the operator again actuates the dial sender 362 to directively set the units register in the manner already described. At the conclusion of the setting of the tens and units registers, a test circuit such as that including the conductor 111 of the called line is completed and this test circuit actuates the primary line switch of the called line to seize a primary trunk and thereafter causes the secondary line switch of this trunk circuit to seize the terminating end of the bridge circuit to which the operator's trunk has been connected.

When the calling line is thus extended to the bridge circuit, the ringing relay such as 77 of Fig. 2 is operated in the manner already described, so that ringing current is supplied to the called line through right hand winding of the trip relay 75 and over the two sides of the called line in series. On the response of the called party the trip relay is actuated to disconnect the ringing current after which conversation takes place in accordance with the method already described.

Also when the called party responds, the battery feed relay 66 is energized and by this operation reverses the connection of the battery feed relay 69 to the calling end of the connection. It will be recalled that when the spring contact 152 of the jack is closed the upper winding of relay 150 has a circuit closed in multiple with the winding of relay 148, but since the relay 150 is polarized it does not attract its armature at that time. It has also been mentioned that the lower winding of the relay 150 is included in a bridge of the operator's trunk circuit which has been connected to the terminating end of the bridge circuit of Fig. 2 but the direction of current in this circuit was ineffective to energize the polarized relay 150. When, however, the direction of current flow in the operator's trunk and the bridge circuit is reversed by the operation of relay 66, the polarized relay 150 attracts its armature. This is effective to operate the relay 154 in a circuit now closed from grounded battery, winding of this relay, front contact and armature of relay 150, front contact and armature of relay 148 and thence to holding ground, over conductor 153. At the upper armatures and front contacts of relay 154 the condensers 155 are short circuited; also at the lowermost armature and front contact of relay 154 a circuit is closed from ground, over conductor 156, operator's line switch brush 157, conductor 158, winding of relay 65 to grounded battery. The operation of relay 65 also disconnects the bridging relays 66 and 69 and short circuits the condensers 159 from the connection.

It will thus be seen that the called line which we assumed is that terminating at substation B is extended to the primary and secondary trunks and thence through a bridge circuit to the operator's trunk without passing through condensers and without the impedance of bridging relays. In this instance certain relays for maintaining the connection are controlled from the attendant operator's position. At the time of

disconnection, supervisory signals associated with this position and with the position at the mentioned manual office indicate to the operators the termination of the connection and they then proceed to disestablish the connection by disconnecting the cord circuits. When the cord circuit is disconnected from the jack J, holding ground is removed at the springs 152 and conductor 153. This terminates the holding of relays 148, 150 and 154 and when relay 154 deenergizes, relay 65 releases. Relay 59 of Fig. 2 has its holding circuit open at the relay 65 and relay 59 on retraction of its armatures opens the holding conductor 125 of the secondary line switch of the called line. The release of this line switch effects the release of the primary line switch of the called line in the well known manner.

What I claim is:

1. In a telephone system, a plurality of telephone lines, means including non-numerical automatic switches and link circuits for interconnecting said telephone lines, impedance devices normally connected to certain of said link circuits while the connection is maintained between said telephone lines, an operator's position, means including only non-numerical automatic switches and link circuits for interconnecting any of said telephone lines with said operator's position, and means responsive to said last mentioned interconnection for disabling certain of the impedance devices of the link circuit included in said last mentioned connection.

2. In a telephone system, a plurality of telephone lines, a bridge circuit, the ends of which are inductively connected together, but conductively separated, impedance devices connected to each end of said bridge circuit, means including non-numerical automatic switches for interconnecting said telephone lines through said bridge circuit, an operator's position, means including non-numerical automatic switches and said bridge circuit for interconnecting said operator's position and any one of said telephone lines, and means responsive to said last mentioned interconnection for disabling said impedance devices.

3. In a telephone system, a plurality of telephone lines, a bridge circuit, the ends of which are inductively connected together, but conductively separated, impedance devices connected to each end of said bridge circuit, means including non-numerical automatic switches for interconnecting said telephone lines through said bridge circuit, an operator's position, means including non-numerical automatic switches and said bridge circuit for interconnecting said operator's position and any one of said telephone lines, and means responsive to said last mentioned interconnection for disabling said impedance devices and for conductively connecting the ends of said bridge circuit.

4. In a telephone system, a plurality of telephone lines, grouped in pairs, a non-numerical switch having two sets of brushes and terminals, a pair of telephone lines terminating in the brushes of each non-numerical switch, secondary switches, link circuits including the fixed terminals of said first mentioned line switches and brushes of said secondary line switches, means including bridge circuits for interconnecting the several secondary line switches, each of said bridge circuits being provided with impedance devices, means including said non-numerical switches only for extending a connection between two telephone lines through link circuits and a bridge circuit, an operator's telephone position, means including said non-numerical switches only, for completing a telephone connection between said operator's position and a telephone line through certain of said link circuits and a bridge circuit, and means responsive to the completion of said last mentioned connection for disabling said impedance devices.

5. In a telephone system, a plurality of telephone lines, each provided with an impulse sender, a plurality of link circuits, register senders common to said link circuits, means for preselecting a register sender for use, means responsive to the initiation of a call on one of said telephone lines for extending said telephone line to a link circuit, and means responsive to the first operation of the impulse sender of said telephone line after the extension of said telephone line to said link circuit for seizing and connecting a preselected one of said register senders to said last mentioned link circuit.

6. In a telephone system, a plurality of telephone lines, each provided with an impulse sender, a plurality of link circuits, register senders common to said link circuits, means for preselecting an idle register sender for use, means responsive to the initiation of a call on one of said telephone lines for extending a telephone line to a link circuit, means responsive to the first operation of the impulse sender of said telephone line after the extension of said telephone line to said link circuit for seizing and connecting the preselected one of said register senders to said last mentioned link circuit, and means for releasing said last mentioned register when it has completed its operation.

7. In a telephone system, a plurality of telephone lines, each telephone line being provided with an impulse sender, line switches provided with brushes, two telephone lines terminating in the brushes of each line switch, link circuits terminating in the contacts of said line switches, a plurality of bridge circuits, means including a non-

numerical switch for extending a selected link circuit to a bridge circuit on the initiation of a call on one of said telephone lines, a plurality of register senders, and means responsive to the operation of the impulse sender of the calling telephone line for connecting an idle register sender to the selected bridge circuit.

8. In a telephone system, a plurality of telephone lines, each telephone line being provided with an impulse sender, line switches provided with brushes, two telephone lines terminating in the brushes of each line switch, link circuits terminating in the contacts of said line switches, a plurality of bridge circuits, means including a non-numerical switch for extending a selected link circuit to a bridge circuit on the initiation of a call on one of said telephone lines, a plurality of register senders, means responsive to the operation of the impulse sender of the calling telephone line for connecting an idle register sender to the selected bridge circuit, and means for releasing said register sender when it has completed its operation.

9. In a telephone system, a plurality of telephone lines, each provided with an impulse sender, a plurality of link circuits, register senders common to said link circuits, means for preselecting register senders for use, means responsive to the initiation of a call on one of said telephone lines for extending said telephone line to a link circuit, a relay controlled over said last mentioned link circuit, and means including said relay responsive to the operation of the impulse sender of said telephone line after the initiation of a call for seizing and connecting a preselected one of said register senders to said last mentioned link circuit.

In witness whereof, I hereunto subscribe my name this 6th day of May A. D. 1924.

WINFRED T. POWELL.