Nov. 11, 1924. 1,515,362

W. T. POWELL

AUTOMATIC TELEPHONE SYSTEM

Filed Nov. 23 1921 4 Sheets-Sheet 1

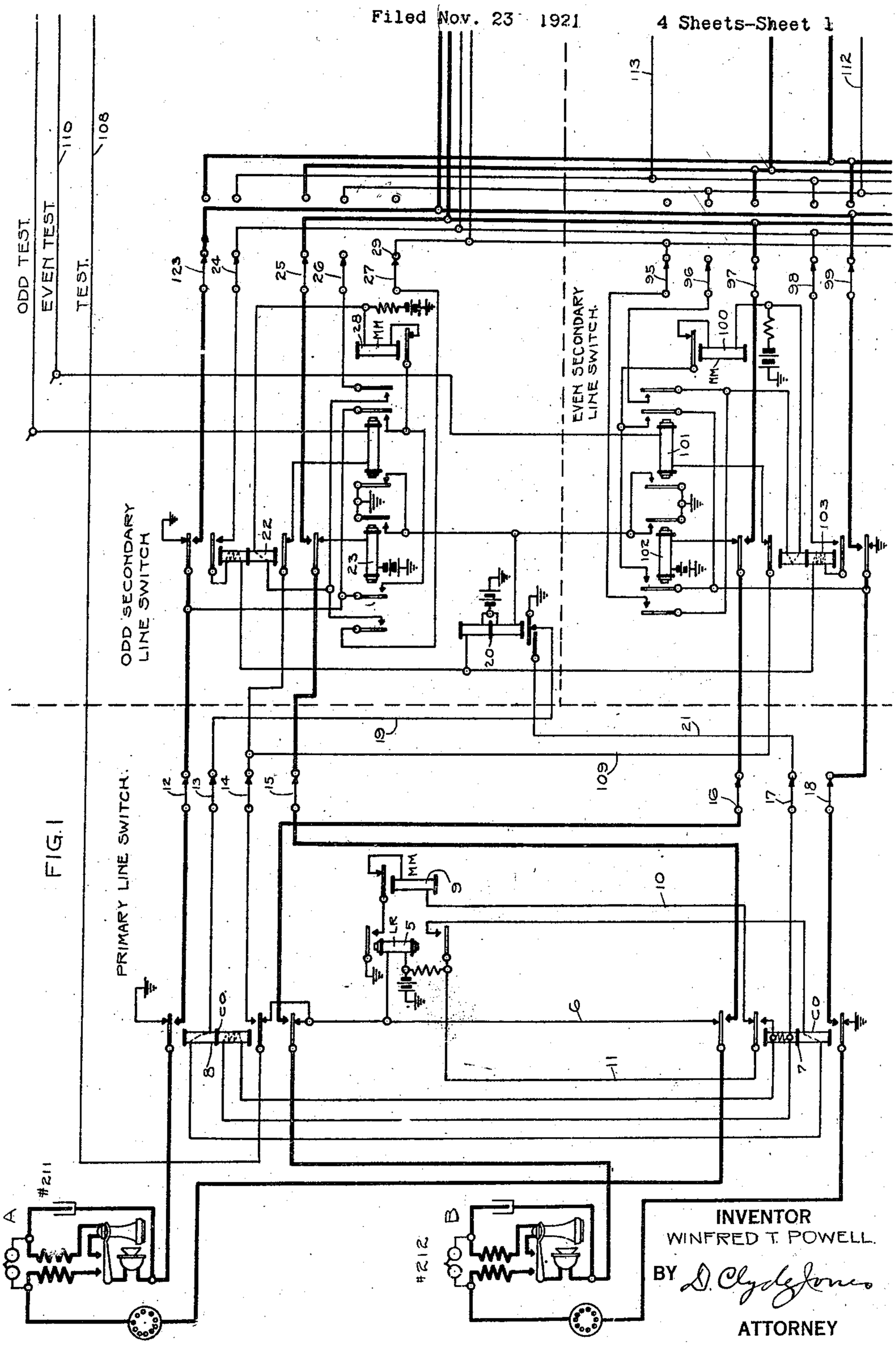

FIG. 1

INVENTOR
WINFRED T. POWELL.
BY D. Clyde Jones
ATTORNEY

Nov. 11, 1924. 1,515,362

W. T. POWELL

AUTOMATIC TELEPHONE SYSTEM

Filed Nov. 23 1921 4 Sheets-Sheet 2

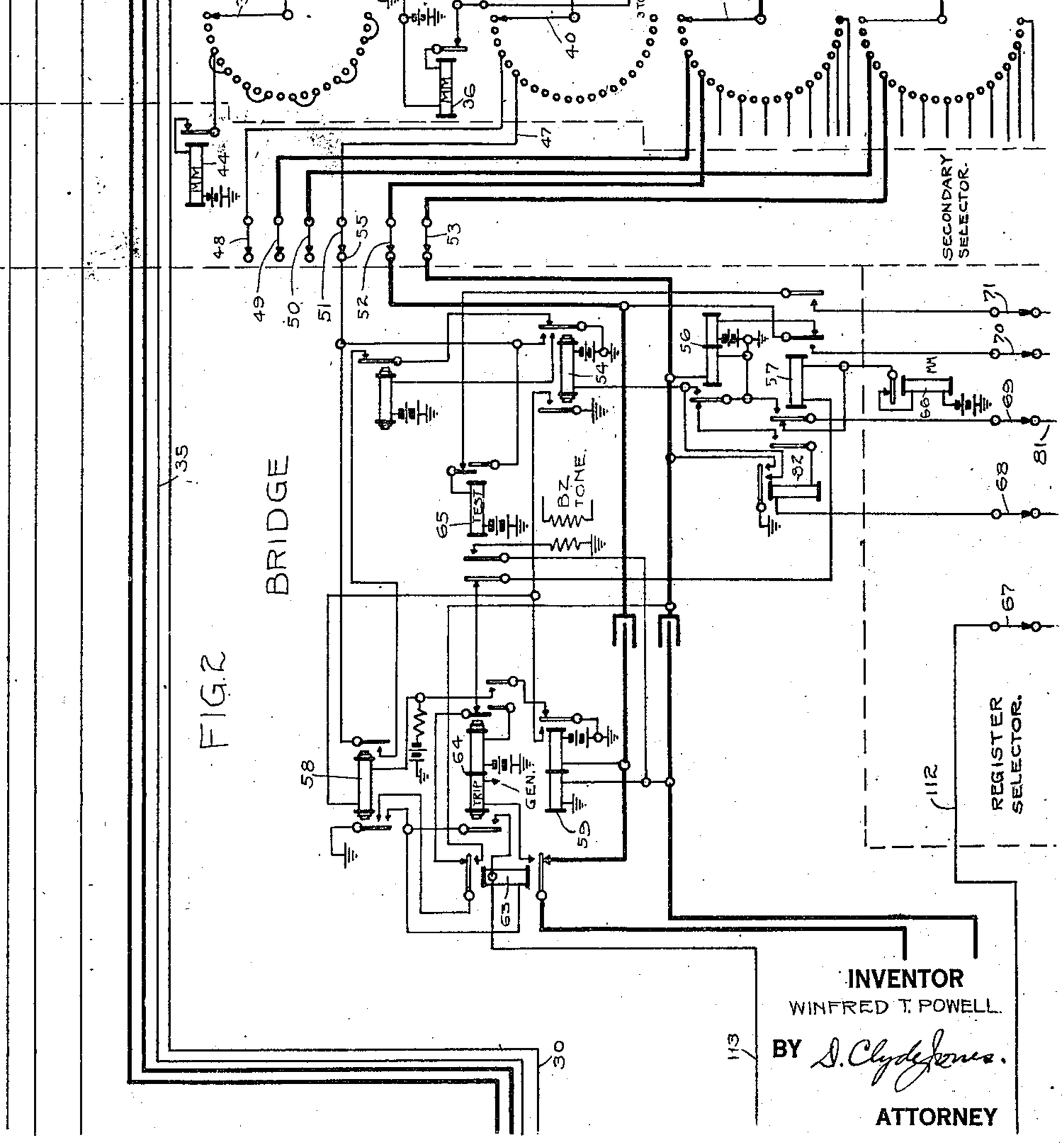

FIG. 2

INVENTOR
WINFRED T. POWELL.
BY D. Clyde Jones.
ATTORNEY

Nov. 11, 1924. 1,515,362

W. T. POWELL

AUTOMATIC TELEPHONE SYSTEM

Filed Nov. 23, 1921 4 Sheets-Sheet 3

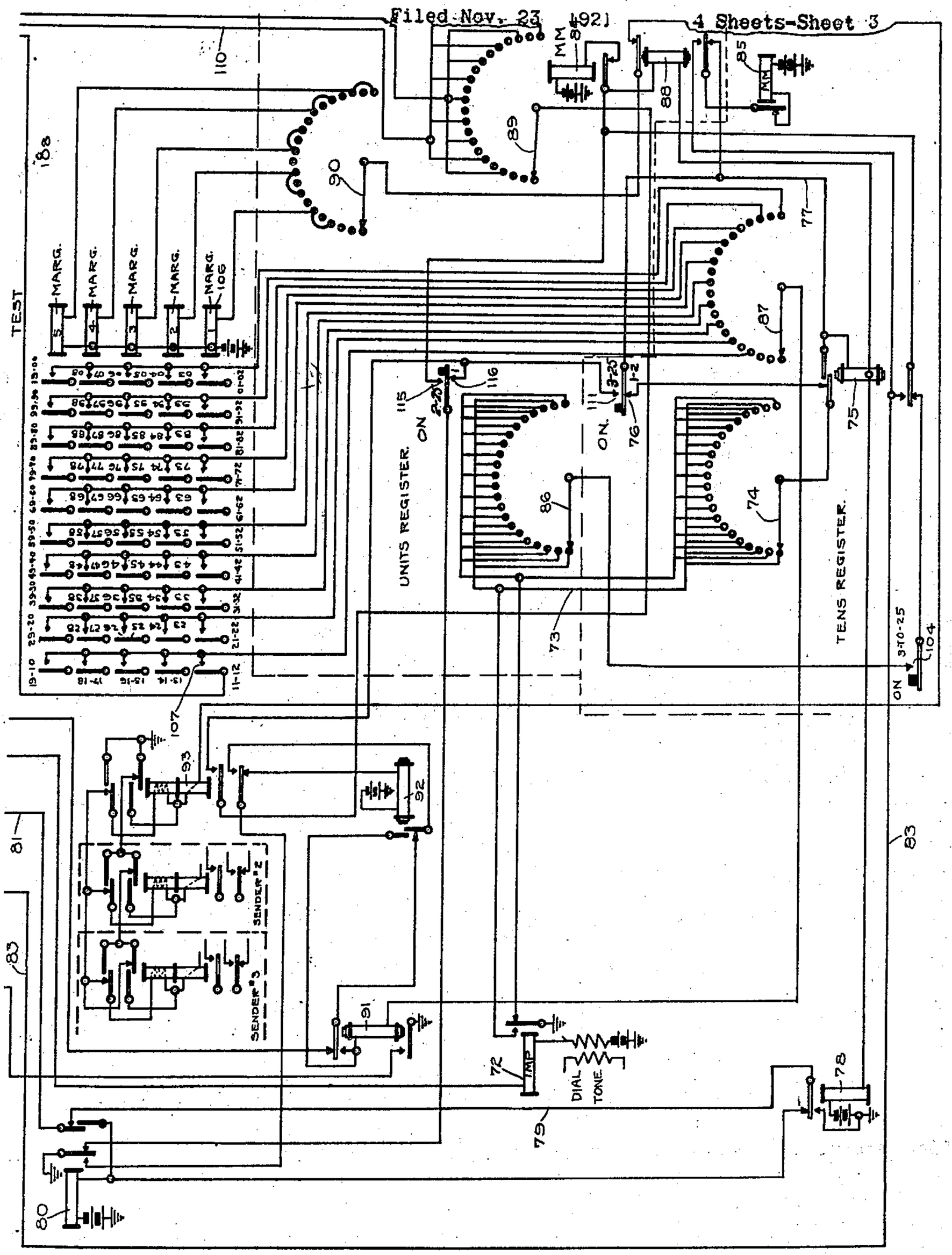

FIG.3

INVENTOR
WINFRED T. POWELL.
BY D. Clyde Jones.
ATTORNEY

Nov. 11, 1924. 1,515,362

W. T. POWELL

AUTOMATIC TELEPHONE SYSTEM

Filed Nov. 23 1921 4 Sheets-Sheet 4

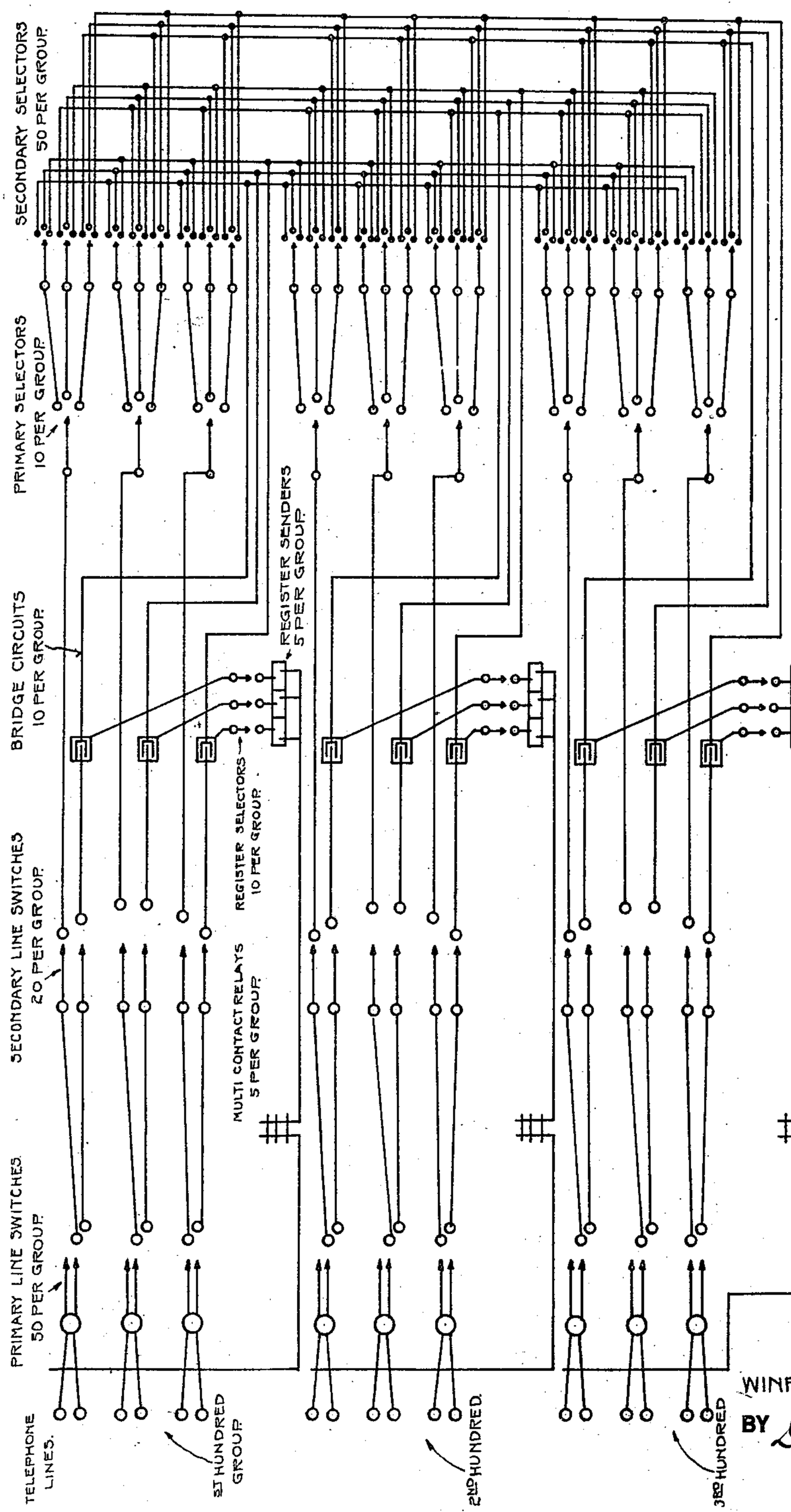

FIG. 4

INVENTOR
WINFRED T. POWELL
BY D. Clyde Jones.
ATTORNEY

Patented Nov. 11, 1924. 1,515,362

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.

AUTOMATIC TELEPHONE SYSTEM.

Application filed November 23, 1921. Serial No. 517,376.

To all whom it may concern:

Be it known that I, WINFRED T. POWELL, a citizen of the United States, residing at Rochester, in the county of Monroe and State of New York, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to telephone systems and more especially to telephone systems employing automatic switches in establishing telephone connections between calling and called subscribers.

One of the main features of this invention resides in the novel arrangement for testing telephone lines in a telephone system. Other features will appear from the detailed description and appended claims.

The drawings with Fig. 2 placed at the right of Fig. 1 and with Fig 3 placed below Fig 2, diagrammatically represent a portion of a telephone system incorporating the present invention. Fig. 4 is a schematic showing of the system arranged for a maximum capacity of 1000 telephone lines and also indicates the number of parts used in such a system.

In a 1000 line system, the lines may be divided into groups of 100 lines each and the 100 lines of each group may be further sub-divided into sub-groups, each containing two telephone lines. A primary line switch is divided for each pair or sub-group of telephone lines and functions when either or both of its pair of telephone lines initiate a call or is called, to extend these lines to idle secondary line switches, which are herein designated odd and even secondary line switches. In the event that the odd line of the pair alone is calling, only the odd secondary line switch will function. It will, therefore, be seen that for each group of 100 lines there are provided fifty primary line switches which in turn have access to twenty secondary line switches, each group of secondary line switches has access to ten bridge circuits which are equivalent to cord circuits in a manual telephone system. These twenty secondary line switches also have access to a group of ten primary selectors which are entirely numerical in their operation, that is, they respond only to directive impulses. For each group of ten primary selectors, there are provided, fifty secondary selector switches which are non-numerical in their operation, that is, they operate independently of directive control from the calling substation to connect the calling line which has already been extended through the primary and secondary line switches and a primary selector, to an idle bridge circuit. A register selector is provided for each bridge circuit so that there are ten register selectors for the individual use of each group of one hundred telephone lines. These register selectors are also non-numerical in their operation and function to connect an idle register sender of which there are five per group, to the bridge circuit which has been extended to the calling line in the manner already described. There are also provided a group of five multi-contact relays for each group of telephone lines. The parts referred to in this brief description of Fig. 4 appears more in detail in Figs. 1, 2 and 3 as will now be pointed out.

At the left of the dotted line of Fig. 1 there appears a diagrammatic representation of the substation circuits of a subgroup or pair of telephone lines which terminate in the movable brushes of a primary line switch which appears just at the left of the mentioned dotted line. At the right of this dotted line and separated by a dotted horizontal line there are diagrammatically shown odd and even secondary line switches. At the extreme right of Fig. 2 and separated from the remainder of this figure by a dotted line, there is diagrammatically represented a primary selector switch which functions to further extend the calling line under substation control. A secondary selector switch is presented near the middle of Fig. 2 between the pair of dotted lines extended across this figure; this switch functions to select an idle bridge circuit shown at the left hand portion of Fig. 2, while the register selector shown at the bottom and to the left of Fig. 2 is effective to connect a bridge circuit to an idle register sender which is shown in Fig. 3. The register sender referred to and shown in Fig. 3 includes a tens register switch and a units register switch; the apparatus individual to

the tens and units register switches are separated by dotted lines and by the confines of the drawings.

The switches employed in this system may be substantially similar to that shown in the patent to Clement #1,107,153 patented August 11, 1914.

With this outline of the system, it is thought that the invention will best be understood by describing the method of establishing a telephone connection from the calling subscriber's line such as A designated #211 to a called subscriber's line designated #212 and whose substation is referred to by the character B. When the subscriber at A removes his receiver from its switch hook, a circuit is closed for the slow releasing line relay 5, extending from grounded battery, winding of this relay, conductor 6, the uppermost back contact and armature of the relay 7, over the lower side of the calling line and through its substation circuit in series, over the upper side of the calling line and through the upper armature and back contact of the cut-off relay 8 to ground. The line relay is actuated in this circuit and closes an operating circuit for the motor magnet 9 of the primary line switch, over conductor 10, inner back contact and upper armature of relay 7, conductor 11 and resistance, to grounded battery. In the event that brushes 12, 13, 14, 15, 16, 17 and 18 of the primary line switch are in engagement with the terminals of busy secondary trunk circuits, the motor magnet under the control of the circuit last described, continues to advance its brushes until the outgoing test brush 13 encounters a pair of idle trunk circuits which condition is indicated by ground potential on the test terminals of these trunks. At this time, a circuit is closed to shunt the motor magnet 9, extending from grounded battery, resistance, lower armature and front contact of line relay 5, through the low resistance windings of cut-off relays 7 and 8 in series, test brush 13, conductor 19, back contact and continuity spring of relay 20 to ground. This circuit is effective to stop the operation of the motor magnet 9 and to energize both of the cut-off relays 7 and 8. These cut-off relays when operated are locked in this condition in a circuit extending from grounded battery, resistance, conductor 11, inner armature and front contact of relay 7 and high resistance windings of cut-off relays 7 and 8 in multiple, holding brush 17, conductor 21, armature and continuity spring of relay 20 to ground which relay is operated at this time as will be described. As soon as the cut-off relays 7 and 8 are operated the calling line is extended through the armatures of these relays, through brush 12 and the uppermost armature and back contact of relay 22 to ground and through brush 15 and the lowermost armature and back contact of relay 22 and the winding of the slow releasing relay 23 to grounded battery. When slow releasing relay 23 is actuated in this circuit, at its inner right hand armature it completes a circuit for the lower winding of the relay 20 which immediately operates to close a break point in the holding conductor 21 previously mentioned. In the event that the brushes 123, 24, 25, 26 and 27 of the odd secondary line switch are in engagement with the terminals of a busy secondary trunk circuit, the motor magnet 28 will be actuated in a circuit from grounded battery, resistance, winding, back contact and armature of this motor magnet, inner left hand front contact and armature of relay 23, uppermost armature and back contact of 22 to ground. Under the control of this circuit, the brushes of the odd secondary line switch are advanced until an idle secondary trunk or primary selector circuit is located, which condition is indicated by the presence of ground potential on the test terminal 29. This is effective to shunt the motor magnet 28 which circuit extends from grounded battery, resistance, lower winding of relay 22, outer left hand contact and armature of relay 23, outgoing test brush 27, test terminal 29, conductor 30, left hand back contact and armature of slow releasing relay 31, back contact and upper armature of slow releasing relay 32 to ground. This circuit is effective to stop the operation of the motor magnet, causing the brushes of the odd secondary line switch to stop in engagement with an idle secondary trunk or primary selector and also operates relay 22. This relay when operated also extends the calling line over the trunk just seized to ground at the inner lower armature and back contact of relay 33, and through the inner upper armature and back contact of relay 33 and winding of the impulse relay 34 to grounded battery. As soon as the last mentioned circuit is complete a dial tone is transmitted to the calling line from the source of dial tone current, to indicate to the calling subscriber that the apparatus is in condition to receive impulses corresponding to the first digit of the wanted number. The impulse relay 34 is actuated in the last described circuit and at its inner armature and front contact effects the energization of the slow releasing relay 31, which relay at its left hand armature opens the testing conductor 30 to apply the busy condition to the test terminal 29 of the trunk just seized. Also at the middle armature and front contact of relay 31, the holding circuit for this trunk is complete from ground over conductor 35 holding brush 24, front contact, upper armature and high resistance winding of relay 22, upper winding of relay 20 to grounded battery. The hold-

ing circuit just described and the previously mentioned holding circuit of the primary line switch are effective to maintain this connection until the time of release.

As soon as the impulse relay 34 is actuated it closes a circuit for the motor magnet 36 of the primary selector from ground, through the lowermost armature and front contact of this relay, conductor 43, primary selector brush 37, continuity spring and back contact of the change over relay 32, off-normal contacts 38, back contact, armature and winding of motor magnet 36 to grounded battery. The slow releasing relay 32 is engaged in a circuit in multiple of that just described. The operation of the motor magnet 36 advances the brushes 37, 39, 40, 41 and 42 on the primary selector one step. This selective switch is now in condition to receive directive impulses from the calling subscriber's impulse sender. Since the hundreds digit of the wanted station is 2, the calling subscriber will actuate his impulse sender to transmit two impulses and in response to the first of these impulses the impulse relay 34 will retract its armatures and thereby close a circuit from ground through its lowermost armature and back contact, brush 37 in its second position to battery, through the continuity spring and back contact of relay 32 and the winding of the motor magnet 36. The motor magnet thus advances the brushes of the primary selector into their third position and when the impulse relay 34 is again energized a circuit will be closed from ground through the lowermost armature and front contact of this relay, conductor 43, brush 37 in its third position, continuity spring and armature of relay 32 back contact, armature and winding of motor magnet 36 to grounded battery to move the primary selector into position four. In response to the second impulse of the hundreds series, the impulse relay retracts its armature to close an operating circuit from ground through the lower armature and back contact of the impulse relay 34, brush 37 in its fourth position, continuity spring and armature of relay 32, back contact, armature and winding of the motor magnet 36 to grounded battery, to move the primary selector into its fifth position. When the impulse relay 34 energizes at the close of this impulse, the motor magnet 36 will advance the primary selector to its sixth position, by means of the circuit completed over conductor 43. It will be seen that during the time that relay 34 is in its operated position a circuit exists for relay 31 and during the time that relay 34 is deenergized a circuit is established to operate the motor magnet 36 and relay 32 in parallel. The operation of the relay 32 closes a locking circuit for relay 31 and this circuit together with the one closed through the front contact of relay 34 enables a much slower or faster series of impulses than normal to maintain operated the relay 31 which controls the holding circuit.

At the close of this series of impulses the slow releasing change-over relay 32 retracts its armatures and thereby disconnects the motor magnet 36 from any further control of the impulse sender. At the upper armature and back contact of the change-over relay 32 a circuit is completed from ground through the left hand armature and front contact of relay 31, the uppermost armature and back contact of relay 33, winding of slow releasing relay 45, brush 39, armature, back contact and winding of motor magnet 44 to grounded battery. In the event that the bridge circuit with which the secondary selector is in engagement happens to be busy, the relay 45 at the primary selector is not operated at this time because it is short circuited by the operating circuit of the motor magnet 44 extending from grounded battery, winding, back contact and armature of the motor magnet 44, selector brush 39 in its sixth position, lowermost back contact and armature of relay 33, outer armature and front contact of relay 31, conductor 46, lowermost back contact and armature of relay 32, primary selector brush 40 in its sixth position, conductor 47, secondary selector brush 51 right hand front contact and armature of relay 54 to ground. Under the control of this operating circuit, the motor magnet 44 advances the brushes of the secondary selector switch until an idle bridge circuit is reached which condition is indicated by the absence of ground potential on its test terminal 55. When the idle bridge circuit is reached relay 45 which has previously been short circuited by the presence of ground potential on the various busy test terminals such as 55, is now operated and completes an actuating circuit for the relay 33 at its armature and front contact. Relay 33 when operated extends the calling line through the primary selector brushes 41 and 42 and to the secondary selector brushes 52 and 53, to ground through the left hand winding of relay 56 and to grounded battery through the inner back contact and armature of relay 57 and right hand winding of relay 56. Relay 56 is operated in this circuit and at its armature and front contact closes an energizing circuit for the slow releasing relay 54 and this relay at its right hand armature and front contact applies a guarding potential to the test terminal 55. At this time the relay 33 is locked operated in a circuit extending from grounded battery, its winding, lowermost front contact and armature, outer armature and front contact of relay 31, conductor 46 lowermost contact and armature of relay 32, primary selector brush 40 in its sixth position, con-

ductor 47 to ground at the test terminal 55. The relay 31 is also maintained operated in multiple with relay 33.

The register selector which is individual to the bridge circuit just seized, is standing with its brushes in engagement with terminals of an idle register sender since all the register selector switches of this group of bridge circuits are normally in engagement with an idle register sender. As soon as relay 54 is operated, it also effects the actuation of the relay 58 by the closure of a circuit from grounded battery, resistance, winding of this relay, left hand front contact and armature of relay 54 to ground.

When the relay 58 is operated it closes a circuit from ground through its left hand armature and front contact, upper armature and back contact of relay 63, continuity spring and back contact of the trip relay 64, back contact and armature of relay 65, winding of relay 57, armature, back contact and winding of the motor magnet 66 to grounded battery. The operation of relay 57 effects the actuation of relay 80, over conductors 79 and 81 and when operated it is locked in this condition through its armature and continuity spring. The operation of relay 57 also opens the conductor to the right hand winding of relay 56 and extends the ring side of the calling line through the inner right hand armature and front contact of relay 57, register selector brush 70, winding of the impulse relay 72 and winding of the induction coil to grounded battery. This circuit energizes the impulse relay 72 and also transmits a tone to the calling subscriber to indicate that the apparatus is in condition to receive the tens series of impulses. At the armature and front contact of the impulse relay 72, a circuit is closed from ground over conductor 73, the tens register brush 74 in its first position, continuity spring and back contact of slow releasing relay 75, off normal contacts 76, conductor 77, winding of relay 75, winding of relay 78 to grounded battery.

At the same time that relay 75 is operated the motor magnet 85 is operated in a circuit in multiple with that of the relay 75 and this magnet advances its brushes 74 and 87 into their second position. When relay 72 retracts its armature in response to the single tens impulse, the tens register is advanced to its third position, and when impulse relay 72 is energized after this impulse, the tens register is moved in to position four.

After relay 75 is energized and when relay 56 deenergizes in response to the first tens impulse, relay 82 is operated in a circuit from ground at the armature and back contact of relay 56, left hand front contact and outer armature of relay 57, winding of relay 82, brush 68, conductor 83, front contact and armature of relay 75, armature, back contact and winding of the motor magnet 84 to grounded battery. Relay 82 at its armature and front contact completes a holding circuit for the slow releasing relay 54. This last mentioned relay has been guarding the bridge circuit against interruption. It will of course be understood that the interval between the deenergization of the relay 56 and the energization of relay 82 is not long enough to permit the relay 54 to release, so that the bridge circuit is guarded during this interval.

At the close of the tens series of impulses the change-over relay 75 deenergizes and removes the tens motor magnet 85 from further control of the impulse sender during this call. This release of relay 75, however, completes an actuating circuit for the motor magnet 84 of the units register which circuit extends from grounded battery, winding, back contact and armature of this magnet, lower back contact and armature of relay 75, off-normal contacts 104, units register brush 86 in its first position, front contact and armature of relay 72 to ground. A multiple circuit of that just described is completed for the change-over relay 88 of the units register extending from grounded battery, winding of relay 78, winding of relay 88 and through contacts 104 and brush 86 to ground at the armature and front contact of the impulse relay. The motor magnet 84 is energized in the circuit described and advances its brushes 86, 90 and 89 into their second position, wherein the units register is now in readiness to receive impulses from the impulse sender in accordance with the units designation of the wanted line. In response to the first of these impulses relay 72 retracts its armature to complete a circuit from ground, brush 86 in its second position and through the remainder of the circuit previously described for the motor magnet 84 to grounded battery. Under the control of this circuit the motor magnet 84 advances the units register into its third position at which time the impulse relay 72 will be operated. The original operating circuit for the motor magnet 84 is now closed from ground at the armature and front contact of relay 72 through brush 86 in its third position and through the winding of the motor magnet 84 to grounded battery to advance the brushes to their fourth position. In response to the second and last impulse of this series the motor magnet 84 will advance the brushes of the units register into their fifth position and the operation of the impulse relay 72 at the close of this series of impulses causes the motor magnet 84 to advance the units register into its sixth position.

At the close of the units series of impulses the units change-over relay 88 deenergizes. At this time, if no other register sender of this one hundred group of lines

is making a test, the multi-contact relay 106 is actuated in a circuit closed from grounded battery, its winding, brush 90 in its sixth position, uppermost back contact and armature of relay 88, through the low resistance and high resistance windings in series of the relay 93, continuity spring and back contact of this relay and through the inner back contacts and continuity springs of all the other relays similar to 93 of the senders assigned to this one hundred group of lines, to ground.

Relay 106 is marginal and will not operate in series with the high-resistance winding of relay 93, but this last named relay is energized in this circuit and short circuits its high resistance winding so that the relay 106 will thus be operated. When relay 93 is operated, it opens at its lowermost armature and back contract, the energizing circuit of the relay 92 but since this last mentioned relay is slow releasing it will hold its armature attracted for a relatively long interval so that the circuit for testing the called line will be closed from ground, inner armature and front contact of relay 80, lowermost armature and front contact of relay 93, continuity spring and armature of relay 92, winding of relay 91, brush 87 in its fourth position, contact 107 of the multi-contact relay 106, conductor 108, but since the called line 212 terminates at the same primary line switch as line 211, its conductor 108 is extended through the inner armature and front contact of cut off relay 8, test brush 14, conductor 109, inner upper armature and back contact of relay 103, winding of relay 101, conductor 110, units register brush 89, inner lower armature and front contact of relay 93, off-normal contacts 111, conductor 77, windings of relays 75 and 78 to grounded battery also winding of motor magnet 85 to grounded battery.

Since the primary line switch associated with the lines 211 and 212 has been operated, the even secondary line switch which has been seized by the primary line switch will operate to find the terminating end of the selected bridge circuit to which the calling line has been extended. The secondary line switch is operated by the completion of an operating circuit for its motor magnet extending from grounded battery, resistance, winding of this magnet, its back contact and armature, inner right hand front contact contact and armature of relay 101, lowermost armature and back contact of relay 103 to ground. The motor magnet will thus continue to advance the secondary line switch brushes over the circuit just described until a preselected bridge is located, which will be indicated by the presence of ground potential on its test terminal applied over conductor 112. When this pre-selected bridge is reached the motor magnet 100 will be shunted by a circuit extending from grounded battery, resistance, upper low resistance winding of relay 103, outer armature and front contact of relay 101, terminating test brush 96, test conductor 112, brush 67, lower front contact and armature of relay 91 to ground. This last mentioned relay, it will be remembered, is energized due to its inclusion in the test circuit previously mentioned. The operation of the relay 103 extends the called line conductors over the brushes 16 and 18 of the primary line switch, and the brushes 97 and 99 of the secondary line switch through both windings in series of relay 59 to ground and grounded battery respectively.

Relay 59 will not be operated at this time since the called party has not yet answered. Also when relay 103 is operated, it closes a locking circuit for itself from grounded battery, upper winding of relay 20, high resistance winding, armature and front contact of relay 103, holding brush 98, holding conductor 113, winding of the ringing relay 63, left hand front contact and armature of relay 58 to ground. Ringing relay 63 is operated in this circuit and ringing current is supplied from the generator designated Gen, left hand winding of the trip relay 64, lower contact and armature of the ringing relay 63 and through the extended connection to the called substation and through the signal thereon over the lower side of the called line and the extended connection to ground through the winding of relay 59. Relay 64 does not operate at this time but when the called party answers, the trip relay 64 is operated and at its left hand armature and front contact short circuits the ringing relay 63 which deenergizes.

When the ringing relay 63 was operated it opened the circuit which has been maintaining relay 57 operated and this relay on its release opens the circuit of relay 82 and also opens the circuit which has been maintaining the holding relay 80 operated. Relay 80 thereupon releases and effects the restoration of the register sender including the tens and units registers to normal position. This is effected by the closure of a circuit from ground, armature and back contact of the relay 80, off normal contacts 115, armature, back contact and winding of the motor magnet 84 to grounded battery. The motor magnet 84 continues to interrupt its own circuit and thereby advances the brushes of the units register until the brushes are in their normal position, whereupon the tens register is also restored. The circuit for effecting the restoration of the mentioned tens register switch is from ground, armature and back contact of relay 80, off normal contacts 115 and 111, back contact and armature of relay 88, armature,

back contact and winding of the motor magnet 85 to grounded battery. Under the control of this circuit the motor magnet 85 advances the brushes of the tens register until they reach their normal position when the operation of the motor magnet is stopped due to the interruption of its operating circuit at the contacts 111.

The release of relay 57 also disconnects the impulse relay 72 from a circuit connected to the calling line and connects the right hand winding of the relay 56 to the ring conductor of the connection so that talking battery is supplied to the calling line through the windings of relay 56 while talking battery is supplied to the called subscriber through the windings of relay 59.

Thus far in this description it has been assumed that the called line is idle at the time that it was tested by the register sender. In the event that the called line is busy at the time that the test is made, its relay such as 103 will be operated so that the test circuit which, it will be remembered, included the winding of relay 101, will be opened at the inner armature and back contact of the relay 103, also relay 91 at the left of Fig. 3 will not be operated so that the test relay 65 of Fig. 2 will be operated in a circuit completed from grounded battery, winding, continuity spring and back contact of this relay, outer armature and front contact of relay 57, brush 71, back contact and armature of relay 91, back contact and continuity spring of relay 92, lowermost front contact and armature of relay 93, front contact and armature of relay 80 to ground. The test relay 65 is operated in this circuit and closes a locking circuit for itself extending from its continuity spring and armature, front contact and armature of relay 54 to ground. With the relay 65 thus locked operated, the busy tone current is transmitted to the calling line over a circuit which may be partially described as extending from ground, through the secondary winding of the induction coil, inner front contact and armature of the relay 65 and over the extended connection to the calling substation. This tone informs the calling subscriber that the call cannot be completed.

The ringing current is not supplied to the called line under this condition due to the fact that the secondary line switch does not seize the terminating end of the bridge connected to the calling line with the result that the ringing relay 63 is not operated. Also the operation of the test relay 65 interrupts the circuit which has been holding relay 57 and this relay in turn effects the restoration of the register sender just used in the manner previously described.

In this system, the called and calling subscriber each controls the release of a portion of the telephone connection. When the calling subscriber terminates the call by replacing his receiver on its switch hook, the battery feed relay which has been held operated during the connection releases and shortly afterwards the slow releasing relay 54 controlled thereby, is deenergized. The holding circuit including the conductor 47 and secondary selector brush 51 is opened at the right hand front contact and armature of relay 54 which causes the release of the relays 31 and 33 associated with the primary selector switch. The release of relay 31 causes the motor magnet 36 to restore the primary selector to its normal position over a circuit traceable from grounded battery, winding of motor magnet 36, its armature and back contact, off normal contacts 117, middle contact and armature of relay 31 to ground. As soon as the primary selector reaches its normal position this last described circuit is opened at the contacts 117, also the deenergization of relay 31 opens the circuit including conductor 35 which has been holding the odd secondary line switch. This line switch, it will be recalled, is of the type which remains with its brushes in engagement with the terminals of the circuit last used. The opening of the holding circuit effects the release of the relay 22 so that the brushes of the secondary line switch are electrically disconnected from its primary trunk circuit. It will be recalled that the holding circuit also includes the upper winding of the relay 20 and if the calling line 211 had called any other line except that designated 212 which terminates on the same primary line switch, the relay 20 would have deenergized at this time to effect the release of the primary line switch by the deenergization of its cutoff relay 8. In the present instance, however, the relay 20 is maintained energized in series with the lower winding of relay 103. If at this time the called subscriber replaces his receiver on its switch hook, the relay 59 will deenergize and thereby short circuit relay 58 which has been maintaining the holding circuit for this even secondary line switch which included conductor 113. With this holding circuit interrupted, the relays 20 and 103 deenergize, and relay 103 disconnects the brushes of the even secondary line switch from its primary trunk circuit while the deenergization of the relay 20 effects the release of the cutoff relays 7 and 8 of the lines #211 and #212 respectively.

Although this invention is shown in a thousand line system, it is not limited to systems of any particular size, and it will be understood that there may be variations from this disclosure without departing from the spirit of the invention as defined in the claims.

What I claim is:—

1. In a telephone system, a plurality of

telephone lines, arranged in pairs, a group of bridge circuits for interconnecting said telephone lines, means for connecting a bridge circuit to a telephone line when said telephone line is calling, a group of multi-contact relays common to said telephone lines arranged to be variably operated from a distant point in accordance with the designation of the wanted telephone line, said group of multi-contact relays having a single set of contacts for each pair of telephone lines, a test circuit, means including the operated set of relay contacts for extending said circuit to the wanted telephone line, and means responsive to the completion of said test circuit for connecting the called telephone line to the selected bridge circuit.

2. In a telephone system, a plurality of telephone lines arranged in groups, groups of bridge circuits for interconnecting said telephone lines, means for connecting a bridge circuit to a telephone line when said telephone line is calling, a test circuit associated with said bridge circuit including a portion common to all the telephone lines of a group, conductors arranged to be included in said test circuit, one of said conductors being common to a certain telephone line of said group and the other conductor being common to a certain other telephone line of said group, means variably controlled from a distant point for completing a test circuit of the called telephone line including one of said conductors, and means responsive to the completion of said test circuit for connecting the called telephone line to a selected bridge circuit.

3. In a telephone system, a plurality of telephone lines arranged in groups, groups of bridge circuits for interconnecting said telephone lines, means for connecting a bridge circuit to a telephone line when said telephone line is calling, a test circuit associated with said bridge circuit, said test circuit including a conductor common to all of the telephone lines in said group, branches for said test circuit including one conductor common to a portion of said telephone lines and a second conductor common to the other telephone lines, a register sender arranged to be variably operated over said calling telephone line in accordance with the designation of the wanted telephone line, means responsive to the setting of said register sender for completing the test circuit of a wanted telephone line through said conductor and a certain one of said branches, and means controlled by said test circuit for controlling the connection of the wanted telephone line to the selected bridge circuit.

4. In a telephone system, a plurality of telephone lines, a primary line switch for each pair of telephone lines, secondary line switches, trunk circuits extending from said primary line switch and terminating in said secondary line switches, groups of bridge circuits terminating in said secondary line switches, means operating subsequent to the initiation of a call on any of said telephone lines for extending the calling line through the primary and secondary line switches to an idle bridge circuit, a register sender, means for connecting said register sender to said selected bridge circuit, means controlled over a calling telephone line for variably setting said sender in accordance with the designation of a wanted telephone line, a test circuit individual to the groups of bridge circuits including the selected bridge circuit extending through said register sender and arranged to be normally completed at the primary line switch individual to a pair of telephone lines including the wanted telephone line and arranged to be subsequently completed through the secondary line switch selected by said primary line switch, and means responsive to the completion of the second mentioned test circuit for interconnecting the called telephone line and the selected bridge circuit.

5. In a telephone system, a plurality of telephone lines, a primary line switch individual to each pair of telephone lines, primary trunk circuits terminating in said primary switches, a secondary line switch in which each primary trunk circuit terminates, numerical switches, secondary trunk circuits terminating in said secondary switches and in said numerical switches, groups of bridge circuit, means responsive to the initiation of a call for extending a calling telephone line through said primary and secondary switches to an idle numerical switch, means for directively operating said numerical switch to select a wanted group of bridge circuits, means for connecting said numerical switch to an idle bridge circuit in the selected group, a register sender arranged to be variably adjusted over the calling telephone line, and means responsive to the adjustment of said register sender for extending the called telephone line to the selected bridge circuit through primary and secondary line switches.

6. In a telephone system, a plurality of telephone lines divided into groups, a primary line switch for each pair of telephone lines, secondary line switches, means including a primary trunk circuit and a primary line switch for extending a calling telephone line to a secondary line switch, trunk circuits each terminating at one end in said secondary line switches and at its other end in a numerical switch, means including said secondary line switch for selecting a numerical switch, a group of bridge circuits for each group of telephone lines, means for directively operating said numerical switches

for selecting the group of bridge circuits common to the called telephone line, means for extending said operated numerical switch to an idle bridge circuit in the selected group, a register sender common to said bridge circuits of the selected group, means for operating said register sender over said calling telephone line, and means responsive to the operation of said register sender for causing other primary and secondary line switches to connect the wanted telephone line to the selected bridge circuit.

7. In a telephone system, a plurality of telephone lines arranged in pairs, groups of bridge circuits for interconnecting said telephone lines, means for connecting a bridge circuit to a telephone line when calling, a test circuit associated with said bridge circuit having a branch for testing each pair of telephone lines, means for extending the test circuit to the pair of telephone lines including the called telephone line, and means responsive to the completion of said test circuit for extending the bridge circuit to the called telephone line.

8. In a telephone system, a plurality of telephone lines arranged in groups, a group of bridge circuits for interconnecting said telephone lines, means including primary and secondary line switches for connecting a bridge circuit to a telephone line when said telephone line is calling, a group of multi-contact relays common to said telephone lines arranged to be variably operated from a distant point in accordance with the designation of the wanted telephone line, said group of multi-contact relays having a single set of contacts for each pair of telephone lines, a test circuit, means including the operated set of relay contacts for extending said test circuit to the wanted telephone line, and means responsive to the completion of said test circuit for connecting the called telephone line to the selected bridge circuit.

9. In a telephone system, a plurality of telephone lines arranged in groups, a group of bridge circuits for interconnecting said telephone lines, means including primary and secondary line switches for connecting a bridge circuit to a telephone line when said telephone line is calling, a group of multi-contact relays common to said telephone lines arranged to be variably operated from a distant point in accordance with the designation of the wanted telephone line. said group of multi-contact relays having a single set of contacts for each pair of telephone lines. a test circuit, means including the operated set of relay contacts for extending said test circuit to the wanted telephone line, means responsive to the completion of said test circuit for connecting the called telephone line to the selected bridge circuit, and means for completing but a single test circuit at a time for a group of said telephone lines.

10. In a telephone system, a plurality of telephone lines arranged in pairs, a group of bridge circuits for interconnecting said telephone lines, means for connecting a bridge circuit to a telephone line when calling a single test conductor individual to each pair of telephone lines, a test circuit including said test conductor for testing each pair of telephone lines, means for completing the test circuit of a pair of telephone lines including the calling telephone line, and means responsive to the completion of said test circuit for extending the bridge circuit to the called telephone line.

In witness whereof, I hereunto subscribe my name this 22nd day of November, A. D. 1921.

WINFRED T. POWELL.