

**March 2 , 1926.**

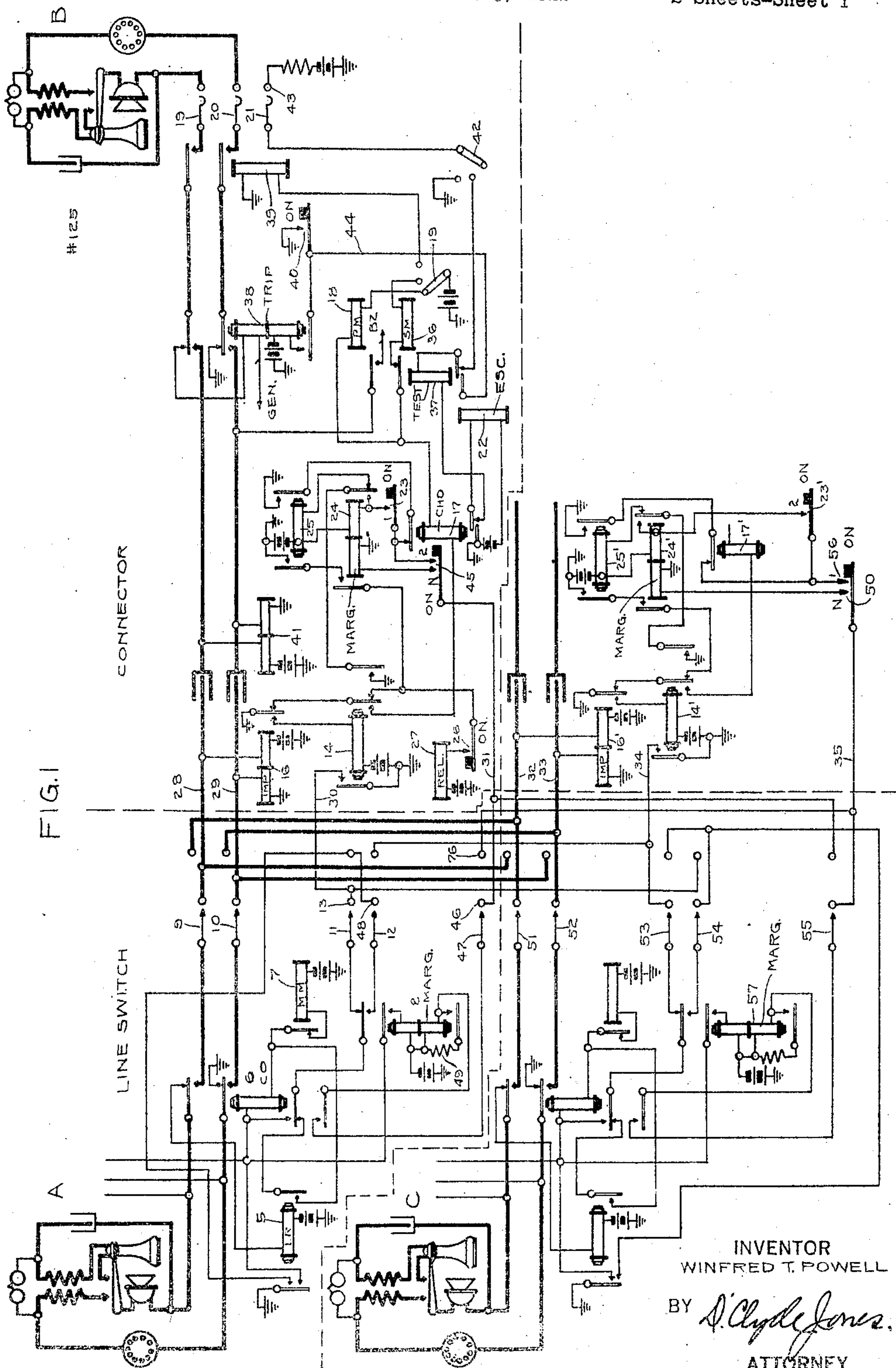
W. T. POWELL

**1,575,603**

# AUTOMATIC TELEPHONE SYSTEM

Filed Nov. 6, 1922

2 Sheets-Sheet 1





March 2, 1926.

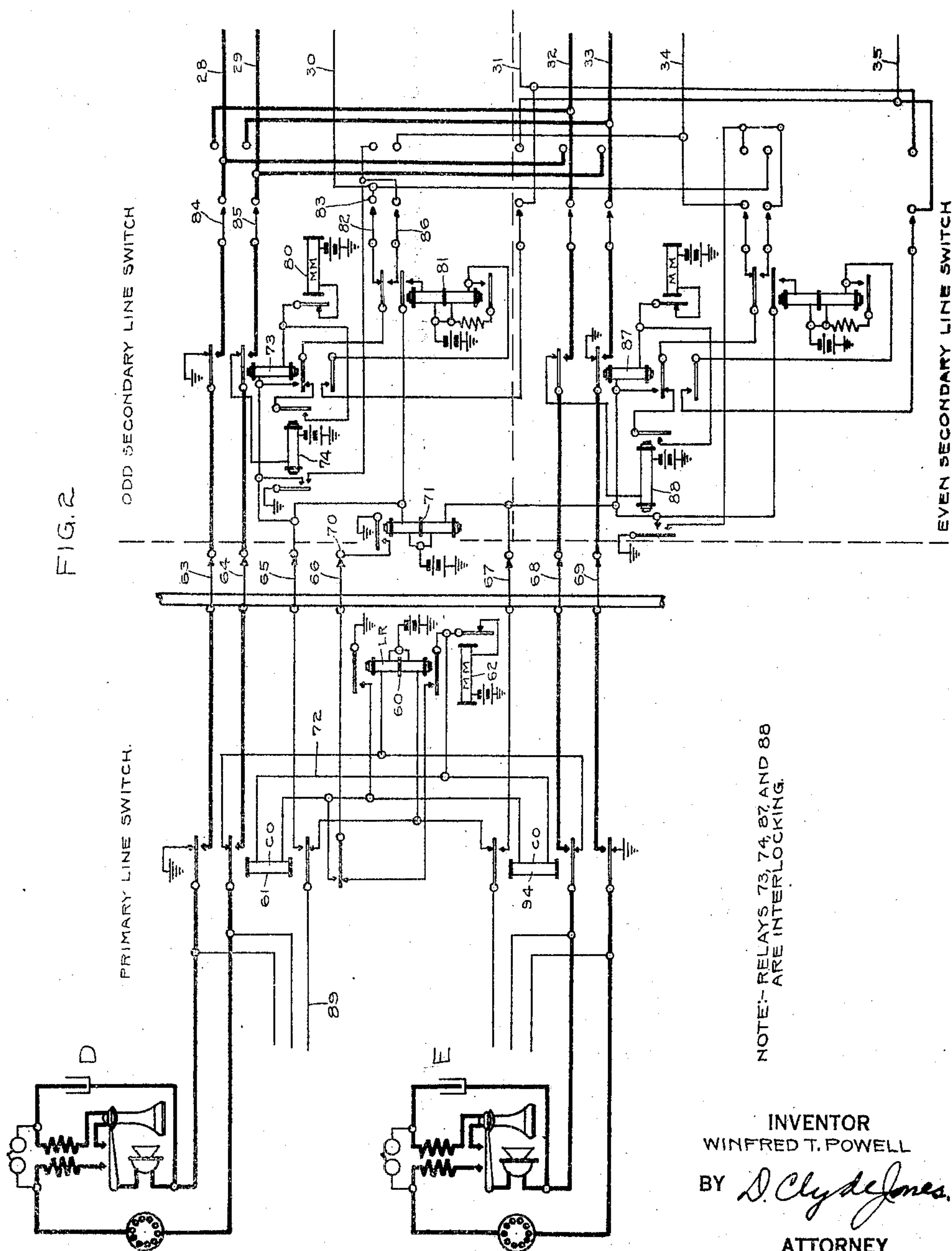
W. T. POWELL

1,575,603

AUTOMATIC TELEPHONE SYSTEM

Filed Nov. 6, 1922

2 Sheets-Sheet 2





## 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 6, 1922. Serial No. 599,202.

*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 particularly to telephone systems employing automatic switches in completing some portion of a telephone connection.

In all commercial step-by-step automatic telephone systems wherein the number of lines exceeds one hundred, it is customary to provide a trunk-hunting numerical switch or first selector in addition to the final connecting switch also known as a connector switch.

It is the purpose of the present invention to provide automatic telephone systems having a maximum capacity of two hundred telephone lines in which such first selector switches may be omitted.

Another feature of this invention is the arrangement by which two telephone lines may make use of the same line switch in a system of the above-mentioned character in which the first selector switches have been omitted.

Other features will appear from the detailed description and claims.

In the drawings Fig. 1 represents an automatic telephone system employing certain of the features of the present invention. At the extreme left of this figure there are diagrammatically represented two subscribers' substations and the lines extending therefrom to the main exchange. At the left of the dotted line of Fig. 1 there are also shown line switches, one of which is provided for each of said telephone lines. Above and to the right of the dotted line of Fig. 1 there are represented the circuits of a final connecting switch or connector in the terminals of which a called telephone line from a called substation shown in the upper right hand corner of this figure is terminated. Below and to the right of the dotted line of this figure there is shown a portion of a second connector switch by which it is in-

tended to show that the circuits of the various connector switches are identical.

Fig. 2 diagrammatically represents a modified form of the invention in which two subscribers' lines and substations are connected to the movable brushes of the primary line switch represented at the left of the dotted line of this figure. Above and to the right of the dotted line there is shown an odd secondary line switch while below and to the right of these lines there is represented an even secondary line switch. It will be understood that these primary and secondary line switches may replace the primary line switches of Fig. 1 by connecting the conductors 28 to 35 inclusive of Fig. 2 to corresponding conductors of Fig. 1 at the point where the vertical dotted line of Fig. 1 cuts these conductors.

In this system the two-hundred lines are divided into two groups of one hundred lines each, and the line switches and connectors are likewise divided into two groups. The line switches and connectors assigned to the first hundreds group of lines are so arranged that the line switches thereof make connection with an idle connector switch assigned to the same hundreds group. If the called line is in the same hundreds group as the calling line the selected connector switch is operated and released in response to the hundreds digit, but the connector switch is still retained and operates in response to the tens and units series of impulses. If, however, the called line is in a different hundreds group from the calling line, the line switch seizes a connector switch that is assigned to the same hundreds group as the called line. In response to the hundreds series of impulses, however this connector switch is advanced and released to control the line switch of the calling line so that it now operates to select an idle connector switch in the other hundreds group in which the called line is located. The original connector switch of this last mentioned connection reverts to common use.

The line switches employed in this system may be of the type similar to that disclosed in the patent to Clement #1,107,153 granted August 11, 1914, while the connector switch may be similar to the patent issued to Keith Erickson and Erickson #815,176, granted



March 13, 1906, when modified to operate in a so-called two-wire automatic system. The connector switches have off-normal contacts O. N. well known in this art. The letter N and numerals 1 and 2 adjacent certain of these contacts indicate that these are closed when the switches are in their normal position or are closed when the switch has taken two steps respectively.

With this brief description of the apparatus, 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 B, the numerical designation of which is assumed to be #125.

When the subscriber at A initiates a call by removing his receiver from its switch hook, a circuit is completed for the line relay 5 from grounded battery, winding of this relay, uppermost back contact and armature of cut-off relay 6, over the upper side of the calling line and through the substation circuits at A in series, over the lower side of the calling line, inner armature and back contact of cut-off relay 6 to ground. The line relay 5 is energized in this circuit and if the line switch of this line is not resting with its brushes in engagement with the terminals of an idle trunk the motor magnet 7 is energized from grounded battery, winding of the magnet 7, its back contact and armature, right hand front contact and armature of line relay 5, inner lower back contact and armature of cut-off relay 6, uppermost armature and back contact of switching relay 8, test brush 11, and test terminals such as 13 of busy trunks, left hand front contacts and armatures of relays similar to 14 associated with busy trunks to ground. Under the control of this circuit the motormagnet 7 advances the brushes 9, 10, 11, 12 and 47 of the line switch, over the terminals of such busy trunks. It will be noted that as soon as the line relay 5 is operated it closes a circuit for the cut-off relay 6 from grounded battery, winding of the motor magnet 7, its back contact and armature, winding of the relay 6, left hand front contact and armature of the line relay 5 to ground. This circuit is ineffective at this time to operate the cut-off relay 6 since it is short-circuited by the operating circuit of the motor magnet 7.

The idle condition of a trunk is indicated by the absence of potential at its test terminal such as 13. Let it be assumed that the first idle trunk tested by the line switch of Fig. 1 is the trunk terminating in the connector switch shown at the right in this figure. Under this assumption, when the test brush 11 encounters test terminal 13, the operating circuit of the motor magnet 7 is no longer completed, so that this magnet causes brushes 9 to 12 inclusive and 47 of

the line switch to remain in engagement with the terminals of this trunk. The circuit of the cut-off relay 6 previously described, is now effective to operate this relay, which operation extends the two sides of the calling line through the upper armatures and front contacts of this relay, line switch wipers 9 and 10 to ground and grounded battery respectively, through both windings of the impulse relay 16. The relay 16 is energized in this circuit and at its armature and front contact effects the operation of the slow-releasing relay 14 and this relay at its left hand armature and front contact applies a busy potential to the test terminal 13 of this trunk. At this time a holding circuit is closed for the cut-off relay 6 from grounded battery, winding of the motor magnet 7, its back contact and armature, winding of the relay 6, its inner, lower, front contact and armature, uppermost armature and back contact of switching relay 8, test brush 11, test terminal 13, left hand front contact and armature of relay 14 to ground. With relay 14 operated relay 25 is energized from grounded battery, its winding, armature and back contact of relay 24, right hand armature and front contact of relay 14 to ground.

The circuits are now in condition to receive the directive impulses from the dial sender at the calling sub-station A. It has been assumed that the numerical designation of the called substation B is #125. The subscriber at A then operates his dial sender to transmit one impulse corresponding to the hundreds digit of the wanted number. In response to each of these impulses, the impulse relay 16 of the connector retracts its armature once. In response to each retraction a circuit is closed from ground, armature and back contact of impulse relay 16, inner armature and front contact of relay 14, winding of change-over relay 17 and winding of primary motor magnet 18 in series and side switch wiper 19 to grounded battery. Under the control of this circuit, the primary motor magnet 18 advances the brushes 19, 20, and 21 of the connector switch one step in their primary movement. As soon as the change-over relay 17 is operated, it effects the energization of the escape magnet 22 from grounded battery, winding of this magnet, continuity spring and armature of change-over relay 17 to ground. At the close of this impulse, the impulse relay 16 holds its armatures attracted for a relatively long period, which permits the relay 17 to deenergize, whereupon the escape magnet 22 releases the side switch wipers into their second position. Since the impulse relay has been operated once to advance the connector switch brushes one step, the off normal contacts 23 which are closed only in position one, close an



operating circuit for the marginal relay 24 from grounded battery, right hand winding of this relay, off-normal contacts 23, uppermost back contact and armature of change-over relay 17, right hand armature and front contact of relay 25 to ground. The operation of relay 24 opens the energizing circuit of the relay 25, and since this last named relay is slow-releasing, before it retracts its armatures, a circuit is extended from ground, left hand front contact and armature of relay 24, off normal contacts 26, winding of the release magnet 27 to grounded battery. The energization of the release magnet 27 releases the connector switch to its normal position in the well-known manner. The operation of the relay 24 closes a locking circuit for itself from grounded battery, its right hand winding, front contact and armature, outermost armature and front contact of relay 14 to ground. It will be noted that the relay 24 remains operated until the deenergization of relay 14.

The connector switch is now in condition to receive the tens series of impulses, which in the present case are two in number. In response to each of these impulses, the impulse relay vibrates its armature and thereby closes a circuit from ground at the armature and back contact of relay 16, inner armature and front contact of relay 14, winding of the change-over relay 17, primary motor magnet 18, side switch wiper 19 in its first position to grounded battery. In response to each retraction of the armature 16, the circuit just described is completed and advances the brushes 19, 20, and 21 of the connector switch one step and since there are two impulses in this series, the connector switch brushes are advanced two steps. In the case of the tens series of impulses the connector switch is not released as in the case of the hundreds impulses due to the fact that the relay 24 is locked operated with the result that the energizing circuit of the relay 25 is open. When the change-over relay 17 is energized in series with the primary motor magnet as just described it completes an actuating circuit for the escape magnet 22. At the close of the tens series of impulses, the impulse relay 16 maintains its armature attracted for a relatively long interval to open the circuit of the slow releasing change-over relay 17, and after a brief period this relay opens the circuit of the escape magnet to cause it to move its side switch wipers into their second position. The subscriber at A now operates his dial sender to transmit the units series of impulses which in the case assumed are five in number. In response to each of these impulses the impulse relay 16 retracts its armatures to complete an operating circuit for the secondary motor magnet 36, traceable from

grounded battery, side switch wiper 19 in its second position, winding of the secondary motor magnet 36, inner back contact and armature of test relay 37, winding of the change-over relay 17, inner front contact and armature of slow-releasing relay 14, back contact and armature of relay 16 to ground. Under the control of this circuit, the change-over relay 17 is operated and completes the circuit already described for energizing the escape magnet 22. As is well known the slow-releasing change-over relay 17 maintains the escape magnet energized during this series of impulses, but in response to each of the five impulses of the units series of impulses the secondary motor magnet 36 advances the brushes 19, 20 and 21 of the connector switch one step in their secondary movement.

At the close of this series of impulses, if the called line is idle the escape magnet deenergizes and moves the side switch wipers into their third position, where signaling current is applied to the called line over a circuit traceable from the ringing generator GEN, upper winding of the trip relay 38, uppermost back contact and armature of this relay, uppermost armature and front contact of relay 39, connector brush 19, upper side of the called line, through the called substation circuits and bell, lower side of the called line, brush 20, inner front contact and armature of relay 39, inner armature and back contact of relay 38 to ground. Signaling current is applied over this circuit until the called party responds by removing his receiver from its switch hook, at which time the trip relay 38 receives sufficient current to be energized and thereby attracts its armatures. It should be pointed out that the lowermost armature and front contact of the trip relay are arranged to be closed before the upper armature and back contacts of this relay are opened. With the relay 38 energized it closes a locking circuit for itself from grounded battery, its lower winding, lower contact and armature, off-normal contact 40 to ground. At the upper armatures and front contacts of the trip relay, break points in the talking circuit are completed. Talking battery is supplied to the calling subscriber through the windings of the impulse relay 16, while talking battery is supplied to the called subscriber through the windings of the impedance coil 41.

In the event that the called line is engaged at the time when it is tested at the close of the units series of impulses, when the change-over relay 17 deenergizes the escape magnet is held operated in a circuit now extending from grounded battery, winding of this magnet, continuity spring and back contact of change-over relay 17, winding of test relay 37, its continuity spring and back contact, side switch wiper 42 in its second posi-



tion, test brush 21, through test terminal 43 and a test terminal in multiple therewith, through a test brush similar to 21 at the connector which has already seized the called  
 5 line through a side switch wiper similar to 42 in its third position to ground. Under the control of this circuit the escape magnet is held energized and the test relay 37 is  
 10 operated to close a locking circuit for itself, through its continuity spring and armature, conductor 44, off-normal contacts 40 to ground. This circuit maintains the escape magnet and the test relay 37 operated until the calling party releases the connection.  
 15 With the test relay actuated, a source of busy tone current "BZ" is connected through the upper front contact and armature of the test relay and over the extended connection to the sub-station at A to indicate by the  
 20 busy tone that the called subscriber can not be reached. It will be noted that the inner, upper armature and back contact of the test relay 37 interrupts the circuit previously described for the secondary motor magnet  
 25 37 to prevent the calling subscriber from now advancing the connector switch, in the event that he should attempt the transmission of an unnecessary series of impulses.

When the subscriber at A terminates the  
 30 connection by replacing his receiver on its switch hook, impulse relay 16 deenergizes to open the circuit of slow-releasing relay 14 which shortly afterwards retracts its armatures. At its left hand armature and front  
 35 contact it opens the holding circuit of the line switch which has been maintaining the cut-off relay 6 operated. This last named relay thereupon retracts its armatures to re-  
 40 connect the line relay 5 to the calling line, and since the line switch is of the type that remains in engagement with the trunk last used, the line switch is in condition to establish a second connection. Also, when the  
 45 slow releasing relay 14 deenergizes it completes an energizing circuit for the release magnet 27, from grounded battery, winding of this magnet, off-normal contacts 26, inner  
 50 back contact and armature of relay 14, back contact and armature of impulse relay 16 to ground. The release magnet 27 is energized in this circuit and effects the release of the  
 connector switch and its side switch into their normal positions.

Let it now be assumed that the calling  
 55 subscriber at substation A desires a connection with the called substation of the second hundreds group. The hundreds designation of this substation is, therefore, "2". When  
 60 the subscriber at A initiates a call by removing his receiver from its switch hook, the motor magnet 7 advances its brushes 9 to 12 inclusive and 47 of its line switch into engagement with the terminals of a trunk  
 65 leading to an idle connector switch of the first hundreds group.

Let it be assumed that the first idle connector located in this group is that shown in the upper right hand corner of Fig. 1. On the seizure of this connector switch the  
 70 impulse relay 16 and slow releasing relay 14 thereof are operated in the manner already described. The operation of relay 14 likewise closes an actuating circuit for the slow-releasing relay 25 from grounded battery,  
 75 winding of this relay, right hand back contact of relay 24, outer armature and front contact of relay 14 to ground.

The connector switch is now in condition to receive directive impulses corresponding to the hundreds digit of the wanted num-  
 80 ber, which in the present case are two in number. In response to each of these impulses the impulse relay 16 retracts its armatures to close a circuit from ground, its  
 85 armature and back contact, inner armature and front contact of relay 14, winding of change-over relay 17, primary motor magnet 18, side switch wiper 19 to grounded  
 90 battery. Each energization of the primary motor magnet 18 advances the brushes 19, 20, and 21 in their primary movements. This is effective to close the off-normal con-  
 95 tacts 45. At the close of this series of impulses the change-over relay 17 which was energized in series with the primary motor magnet 18 deenergizes to effect the release  
 100 of the escape magnet 22. This magnet then deenergizes and advances the side-switch wipers into their second position. When the change-over relay 17 deenergizes, a circuit  
 105 is extended from ground, right hand front contact and armature of relay 25, upper armature and back contact of relay 17, off normal contacts 45, conductor 31, contact  
 110 46 and brush 47 of the calling line switch, lowermost front contact and armature of cut-off relay 6, lower winding of slow releasing relay 8 to grounded battery. The  
 115 relay 8 is actuated in this circuit and thereby opens the circuit of cut-off relay 6 causing it to reconnect the line relay 5 to the line whereby it is operated. Relay 8 since  
 it is slow-releasing holds itself operated while these operations are taking place and  
 then closes a locking circuit for itself from grounded battery, its upper winding, front  
 contact and armature and left hand make contact of relay 5 to ground.

It will be noted that the operation of relay 8 places the calling line switch under  
 120 the control of test brush 12, instead of test brush 11 as in the case previously described, with the result that the calling line switch now operates to seize only idle trunks lead-  
 125 ing to connector switches of the second hundreds group. A portion of the circuits of a second connector is indicated in the lower right hand corner of Fig. 1. The circuits  
 of this last mentioned connector have been very much abbreviated but it will be under- 130



stood that they are in all respects similar to the connector switch shown in the upper right hand corner of this figure. When the idle connector of the second hundreds group is reached, the cut-off relay 6 and subsequently the relays 16', 14' and 25' operate in the manner already described. Since the relay 8 is operated at this time, a circuit is closed from grounded battery, through low resistance 49, lower armature and front contact of relay 8, lowermost armature and front contact of relay 6, line switch brush 47, terminal 76, conductor 35, off-normal contacts 50 which are closed until the connector switch takes one step, left hand winding of relay 24' to ground. The relay 24' operates in series with the mentioned low resistance 49 and locks itself operated from grounded battery, through its right hand winding, front contact and armature to ground at the outermost armature and front contact of relay 14'. The operation of relay 24' opens the energizing circuit of relay 25' to prevent its operation and therefore the connector switch of the second hundreds group is prevented from releasing. The tens and units series of impulses are now transmitted to cause the connector switch to connect with and signal a called line in the manner already described.

If a line of the second hundreds group such as that terminating at substation C originates a call for another line in the second hundreds group the removal of the receiver at substation C causes the line switch whose brushes are designated 51, 52, 53, 54, and 55 to seize an idle connector switch of the second hundreds group such as that shown in the lower right hand corner of Fig. 1. In response to the hundreds series of impulses, the connector switch is advanced two steps, but in this instance off-normal contacts 56 corresponding to 45 of the first described connector switch are closed in position 1, so that at the time when this last mentioned connector releases in response to the hundreds series of impulses, the relay 57 of the calling line switch is not operated so that the calling line switch remains in connection with this connector of the second hundreds group and the tens and units series of impulses operate this connector in the manner already described.

If the calling line of substation C which is in the second hundred group is to establish a connection with a line such as that terminating at B in the first hundreds group, this line switch operates in the manner already described to seize a connector switch of the second hundreds group similar to that shown in the lower right hand corner of Fig. 1. In response to the hundreds series of impulses this connector switch is advanced one step which serves to close the off-

normal contacts 56 so that the switching relay 57 is operated in the manner similar to the operation of relay 8, so that the line switch of the line from substation C now operates to seize a connector switch of the hundreds group similar to that shown in the upper right hand corner of Fig. 1. The tens and units series of impulses are now transmitted to cause the connector switch of the first hundreds group to operate in the manner already described. The signaling of the called line and the releasing operations are effected in the manner already mentioned.

In Fig. 2 there is shown a modified form of the invention, which in principle is similar to the arrangement shown in Fig. 1 except that instead of providing one line switch for each subscriber's line, one line switch together with a common group of odd and even secondary line switches serves to extend two subscribers' lines to idle connector switches. It is believed that this modification will best be understood by describing the method of extending a calling telephone line from a substation such as D to a called station such as B. When the subscriber at D initiates a call by removing his receiver from its switch-hook, the line relay 60 is energized in a circuit traceable from grounded battery, upper winding of this relay, inner armature and back contact of cut-off relay 61, over the lower side of the calling line and substation circuits in series, over the upper side of the calling line, uppermost armature and back contact of cut-off relay 61 to ground. The line relay 60 is thus energized and in the event that the primary line switch is standing with one of its sets of brushes in engagement with the terminals of a busy trunk, the motor magnet 62 is operated in a circuit extending from grounded battery, winding of this motor magnet 62, its back contact and armature, lower armature and front contact of relay 60, lowermost back contact and armature of relay 61, test brush 66, test terminal 70, front contact and armature of relay 71 to ground. Under the control of this circuit the motor magnet 62 advances the brushes 63 to 69 inclusive over the terminals of the busy trunk circuits. When, however, a pair of idle trunks are located, a condition indicated by the absence of ground potential on the test terminal such as 70, the motor magnet 62 ceases to operate and the cut-off relay 61 is energized in a circuit now completed from grounded battery, winding of the motor magnet 62, its back contact and armature, conductor 72, winding of cut-off relay 61 upper front contact and armature of relay 60 to ground.

The relay 61 when thus operated extends the calling line through the line switch brushes 63 and 64 and the conductors of the



selected primary trunk to ground at the upper armature and back contact of relay 73 and to grounded battery, through the upper inner armature and back contact of relay 73, winding of relay 74. Relay 74 is actuated and closes an energizing circuit for the relay 71 through its upper winding and through the left hand front contact and armature of relay 74 to ground. It should be stated that relay 71 is slower in releasing than relays 73 and 87. With relay 71 operated a holding circuit is closed for the cut-off relay 61 extending from ground at its upper armature and front contact, test terminal 70, test brush 66, lowermost armature and front contact of relay 61, winding of this relay, conductor 72, armature, back contact and winding of motor magnet 62 to grounded battery. It will be understood, of course, that the motor magnet 62 is marginal and will not operate in series with the cut-off relay 61. Also at this time the cut-off relay 94 is energized and held operated in multiple with the circuits just described for the cut-off relay 61.

As soon as the relay 74 is energized, it closes an operating circuit for the motor magnet 80 of the odd secondary line switch which circuit is completed from grounded battery, winding of this magnet, its back contact and armature, right hand front contact and armature of relay 74, inner lower back contact and armature of relay 73, uppermost armature and back contact of switching relay 81, test brush 82, test terminal 83, conductor 30 associated with a busy trunk to ground through a front contact and armature of a relay similar to 14 of Fig. 1. It will be noted that as soon as the relay 74 is energized, a circuit is also completed for the relay 73 extending from grounded battery, winding of the motor magnet 80, its back contact and armature, winding of relay 73, left hand front contact and armature of relay 74 to ground. This circuit is ineffective, however, to operate relay 73 at this time since it is short circuited by the operating circuit just described for the motor magnet. When, however, an idle trunk is located, a condition indicated by the absence of ground potential on its test terminal such as 83, the operating circuit of the motor magnet 80 is no longer completed, but the previously described circuit for the relay 73 is effective to energize it.

Let it be assumed that the first idle trunk tested is that leading to the connector of Fig. 1, so that when the relay 73 is operated it extends the calling line through the brushes 84 and 85 to the conductors 28 and 29 and thence to ground and grounded battery through windings of relay 16 of Fig. 1. Relay 16 is thus operated and as previously described effects the energization of relay 14, which in turn applies busy potential and

completes a holding circuit for the relay 73, over the conductor 30. It will of course, be understood that the odd secondary line switch operates in the manner similar to the individual line switches of Fig. 1, and if the wanted line is in the first hundreds group, the connector switch in the upper corner of Fig. 1 is advanced one step in response to the hundreds impulse and then releases, whereupon it is directly advanced in response to the tens and units impulses in the manner already described.

It has been mentioned that the cut-off relay 94 is energized in multiple with the cut-off relay 61 so that the line from substation E is extended through the primary line switch brushes 68 and 69 and the uppermost armatures of relay 87 to ground and through the winding of relay 88 to grounded battery. Relay 88 is not energized at this time since the mentioned circuit including the calling line is open at the contacts of the substation hook switch. The even secondary line switch is therefore not operated, but it is in readiness to extend a call from substation E.

If either of the substations of the pair D or E are called a circuit is closed at the connector switch that seizes this line, from ground through a side switch wiper such as 42 of Fig. 1, a test brush similar to 21 of the connector, test terminal 43, conductor 89, inner lower armature and back contact of cut-off relay 61, lower winding of line relay 60 to grounded battery. The line relay 60 is thus energized and causes the motor magnet 62 of the primary line switch to advance its brushes 63 to 69 inclusive into engagement with a pair of idle trunks.

The seizure of these idle trunks operates cut-off relays 61 and 94 so that the relay 73 or 87 as the case may be is operated over conductor 89. The relays 73 and 74 are of the so-called interlocking type, that is, if the relay 74 is energized before the relay 73, a mechanical device is effective to permit the complete attraction of the armatures of relay 73. If, however, the relay 73 is energized before the relay 74 this mentioned mechanical device permits only a partial attraction of the armatures of relay 73 which partial operation is effective to disconnect the relay 74 from the calling lines, but is not effective to extend these lines and the primary trunk connected thereto to the brushes 84 and 85 of the odd secondary line switch.

What is claimed is:—

1. In an automatic telephone system, two groups of telephone lines, a group of numerical switches individual to each group of telephone lines, means including a non-numerical switch for extending a calling telephone line to an idle numerical switch, means for operating and releasing said



numerical switch in response to a series of impulses, means responsive to such operation for causing said non-numerical switch to select a numerical switch in the group of switches common to the group of telephone lines in which the wanted telephone line is located, and means for directly operating said last mentioned numerical switch.

2. In an automatic telephone system, two groups of telephone lines, a group of numerical switches individual to each group of telephone lines, means including a trunk-hunting switch for extending a calling telephone line to an idle numerical switch, means for operating and releasing said numerical switch in response to a series of impulses, means responsive to such operation for causing said trunk-hunting switch to select a numerical switch in the group common to the group of telephone lines in which the wanted telephone line is located, and means for directly operating said last-mentioned numerical switch.

3. In a telephone system, groups of telephone lines, two groups of numerical switches, a plurality of trunks leading to said numerical switches, two groups of non-numerical switches for seizing an idle trunk leading to a numerical switch in a predetermined one of said groups of trunks, means for directly operating and releasing the numerical switch of the selected trunk, means responsive to said operation for causing the first operated non-numerical switch to operate a second time to select an idle trunk in the group indicated by the operation of said numerical switch, and means for directly operating the numerical switch of the selected trunk.

4. In an automatic telephone system, telephone lines arranged in two groups, a non-numerical switch for the use of each telephone line, two groups of trunks terminating at one end in said non-numerical switches, a numerical switch in which the other end of each trunk terminates, means responsive to the initiation of a call by one of said telephone lines for causing its associated non-numerical switch to seize a trunk in one of said groups, means for then operating the non-numerical switch of the calling line to seize a trunk in the desired group, and means for then directly operating the numerical switch of the trunk last selected.

5. In an automatic telephone system, a plurality of telephone lines, two groups of numerical switches in which said telephone lines terminate, means responsive to the initiation of a call on one of said telephone lines for connecting said telephone line to an idle numerical switch in one of said groups, an impulse sender associated with the calling line for causing the selected numerical switch to be directly advanced, means

responsive to said operation for releasing the operated numerical switch, and means associated with the actuated non-numerical switch for causing the same to select a numerical switch of the group through which the called line may be reached and means for preventing the release of said last selected numerical switch.

6. In a telephone system, a plurality of telephone lines divided into groups, groups of trunks, a group of non-numerical switches for each group of telephone lines for extending the same to said groups of trunks, a numerical switch in which each trunk terminates, each non-numerical switch being arranged to seize an idle trunk in a predetermined group, and means responsive to a predetermined operation of the selected numerical switch for preventing said non-numerical switch from operating in said first selected group and for causing it to seize a trunk in said second group.

7. In a telephone system, a plurality of telephone lines arranged in groups, means including line switches and numerical switches for interconnecting said telephone lines, said numerical switches being arranged in two groups, each group being individual to one of said groups of telephone lines, each line switch being provided with a test brush individual to each group of numerical switches, a test circuit arranged to include either one of said test brushes therein, a relay individual to each switch for rendering one test brush operative and for rendering the other inoperative, and means controlled by an operated numerical switch for controlling said relay.

8. In an automatic telephone system, telephone lines arranged in two groups, a group of connector switches for each group of telephone lines, a trunk circuit terminating in each connector switch, non-numerical switches for extending a calling telephone line on the initiation of a call through one of said trunks to a connector switch, contacts in each connector switch arranged to be variably operated in accordance with the first directive operation thereof, means responsive to said operation for releasing said connector switch, and means controlled by said contacts of the connector switch for causing said non-numerical switch to seize a connector switch in one of the groups in accordance with the closure of said contacts.

9. In an automatic telephone system, a plurality of telephone lines, a plurality of numerical switches, a trunk circuit terminating in each numerical switch, non-numerical switches for extending a calling telephone line through a trunk circuit to an idle numerical switch, means controlled over the calling telephone line for directly operating said numerical switch, and means for causing said non-numerical switch to make



a second selection of an idle trunk in accordance with the movement of said first mentioned numerical switch.

10. In a telephone system, a plurality of 5 telephone lines, non-numerical switches for the use of said telephone lines, two groups of trunks terminating in said non-numerical switches, a connector switch for each trunk, means controlled over a calling tele- 10 phone line for causing a non-numerical switch to connect the calling line to an idle trunk, means controlled over the calling line for directly advancing the connector switch of the selected trunk through a prede- 15 termined movement, and means controlled by the degree of movement of said connector switch for causing said non-numerical switch to seize a trunk in the desired one of said groups.

20 11. In a telephone system, a plurality of telephone lines, two groups of trunks, a non-numerical switch for the use of each telephone line for extending it on the initi- 25 ation of a call to an idle trunk in one of said groups, a numerical switch for each trunk having movements in intersecting planes to select a wanted telephone line, means responsive to the control of said call- 30 ing line for operating the selected numerical switch in one plane, means controlled by said operation of the selected numerical switch for causing said non-numerical switch of the calling line to seize a trunk and its numerical switch in a desired 35 group, and means for then advancing the last selected numerical switch through movements in two planes to select the wanted telephone line.

40 12. In a telephone system, telephone lines divided into groups and sub-groups, inter- connecting means including non-numerical and final numerical switches operating through group, sub-group and line select- 45 ing movements, means controlled over a calling telephone line for causing one of said non-numerical switches to connect said call- ing telephone line to an idle numerical switch and for causing said last mentioned 50 switch to effect group selecting and releasing movements, and means including said last mentioned non-numerical switch and some one of said numerical switches con- 55 trolled by said movements for subsequently selecting a sub-group of telephone lines and then the telephone line in the selected sub-group.

60 13. In an automatic telephone system, a plurality of telephone lines divided into groups, an impulse transmitter for each telephone line, means including a group of connector switches for each group of lines

to interconnect the same, two release cir- 65 cuits for each connector switch, two pairs of relays at each connector switch for controlling each release circuit, one of said pairs of relays being operated responsive 70 to the connection of a calling telephone line to an idle connector switch, said second pair of relays being operated as a result of a series of impulses transmitted by said im- 75 pulse transmitter, and means responsive to the closure of said second release circuit for extending the calling telephone line to an idle connector switch of a group through which the wanted line may be reached.

14. In a telephone system, a plurality of 80 telephone lines, a line switch individual to each pair of telephone lines, primary trunks terminating in each line switch, a secondary line switch for each primary trunk, two 85 groups of secondary trunks terminating in said secondary line switches, a connector switch for each secondary trunk, means responsive to the initiation of a call on one of said telephone lines for extending the 90 same through a primary trunk to an idle secondary trunk of a predetermined group by the operation of a primary switch and a secondary switch, means controlled over 95 said calling telephone line for directly operating the connector switch of the se- lected secondary trunk, means responsive to such operation for causing said secondary switch to effect the seizure of a trunk of a 100 group designated by the operation of the first selected connector switch, and means for directly operating the connector 105 switch of the last-selected trunk.

15. In a telephone system, a plurality of 110 telephone lines, a primary switch for each pair of telephone lines, primary trunks terminating in said primary switches, a sec- 115 ondary line switch for each primary trunk, secondary trunks terminating in said sec- ondary line switches, numerical switches reached over said secondary trunks, means 120 responsive to the initiation of a call on one of said telephone lines for causing said pri- mary and secondary switches to extend said calling line through said primary and said 125 secondary trunks to an idle numerical switch, means controlled over said calling telephone line for directly operating said selected numerical switch, and means as- 130 sociated with certain of said line switches for subsequently controlling the character of selection at said numerical switches.

In witness whereof, I hereunto subscribe my name this 4th day of November A. D. 1922.

WINFRED T. POWELL.