May 1, 1928. 1,667,950

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AUTOMATIC TELEPHONE SYSTEM

Filed Aug. 18, 1926 2 Sheets-Sheet 1

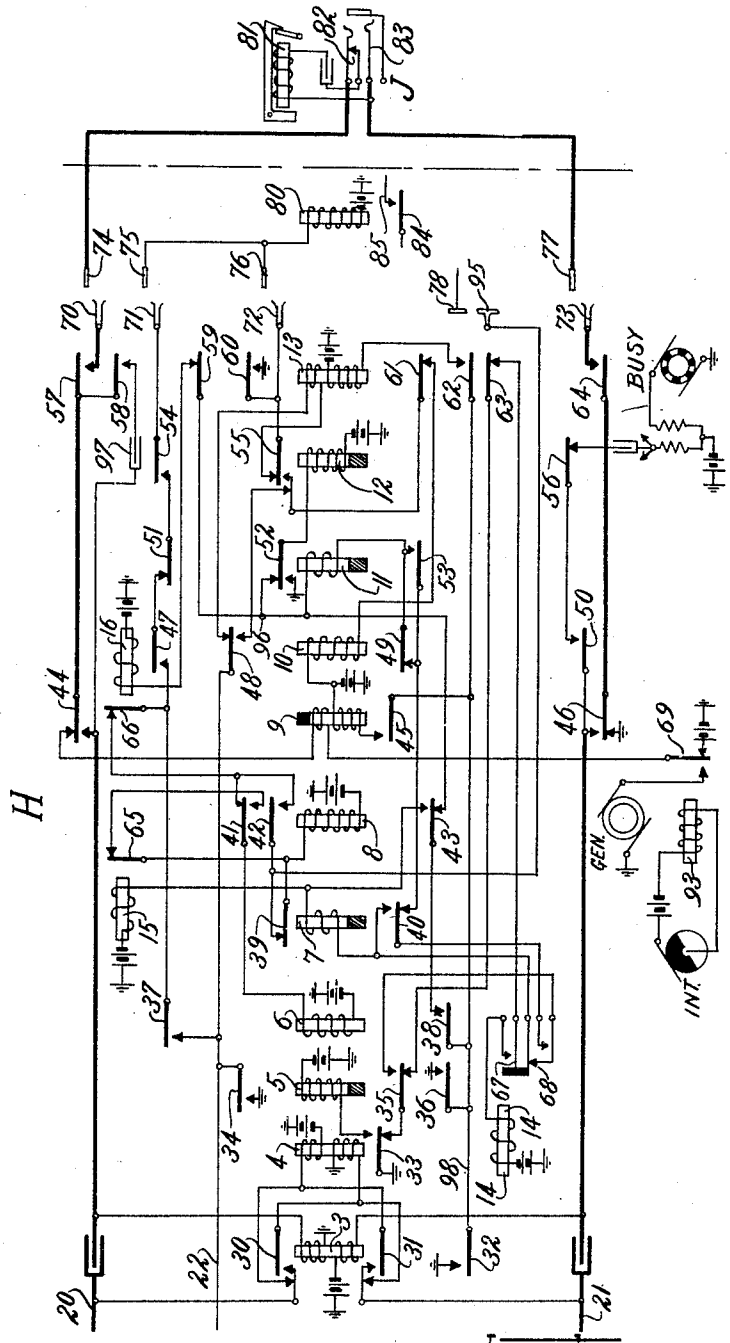


Fig. 1

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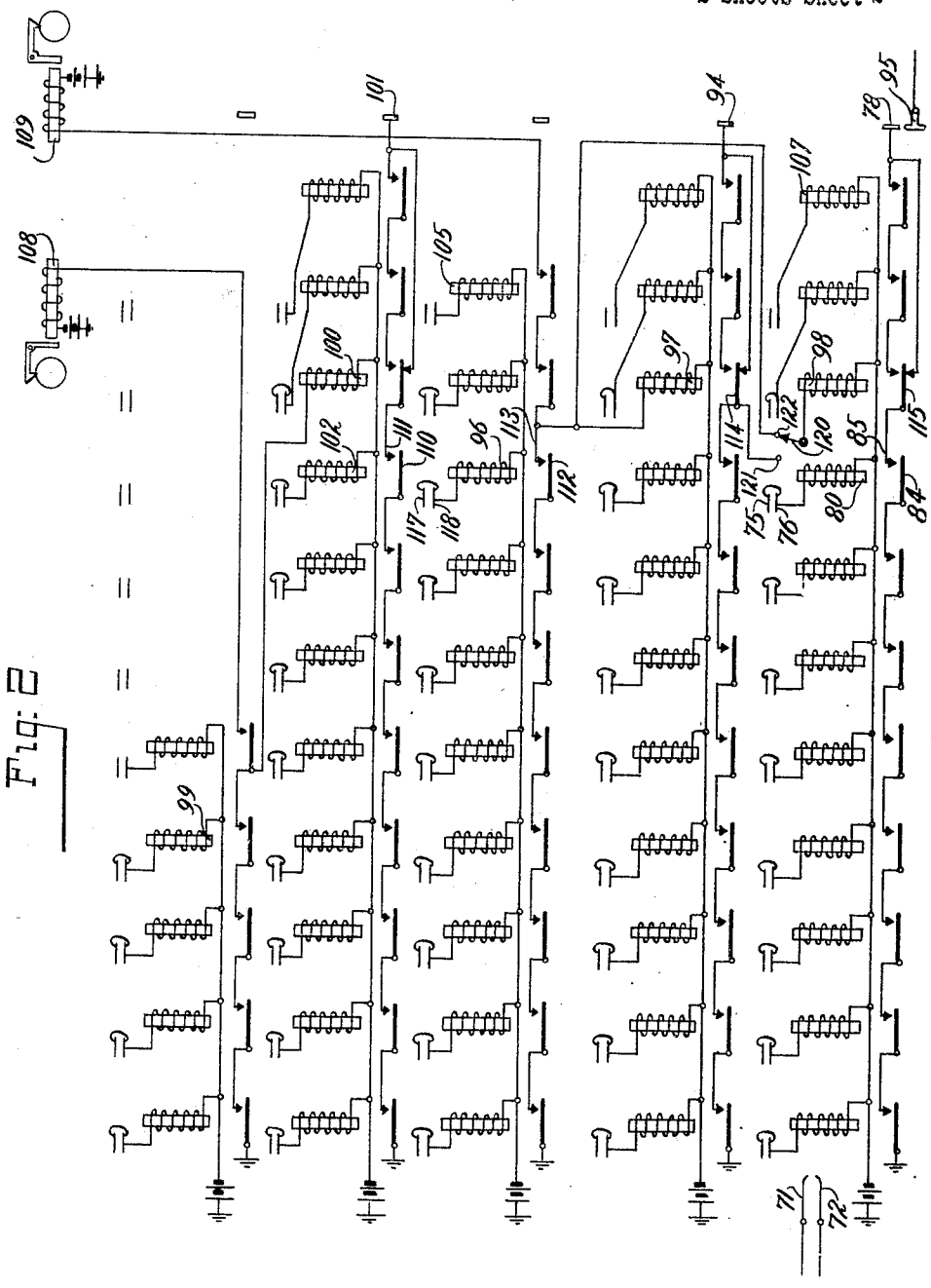


Fig. 2

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

Application filed August 18, 1926. Serial No. 129,899.

This invention relates in general to telephone systems, and more specifically to improvements in chain relay circuits for use with automatic rotary connector switches.

The object of the invention is to provide improvements in chain relay circuits now commonly in use.

The Wicks application Serial No. 571,947, filed June 30, 1922, and patented Oct. 19, 1926, No. 1,603,929, shows an automatic vertical and rotary connector having access to large groups of trunks, each of which groups may consist of trunks terminating in two or more levels of bank contacts in the connector switch bank. Chain relays are provided to close a circuit to cause the connector to automatically continue its primary movement to the next level when all the trunks in the preceding level are busy. Chain relay circuits of this type have proven unsatisfactory because during heavy traffic conditions two or more switches may be hunting on the same level at the same time when there is only one available trunk with the result that the switch which first seizes the trunk makes it busy to the other switches. The other switches will then stop on the last trunk bank contact in the level and transmit a busy tone to the calling subscriber, although there may still be idle trunks of the same group in other levels.

In the present application, a chain circuit is closed to cause the automatic continuation of the primary movement when all but the last two trunks of the first level of the group are busy. This arrangement provides for the completion of connections to idle trunks by switches which were hunting on the same level at the time the chain relay circuit was closed. For instance, assume that the first seven trunks in the first level are busy and that a connector switch is hunting for the first idle trunk or the eighth trunk in the level and that two other connector switches have been operated to this level and have started to rotate just before the first switch seizes the eighth trunk. The first switch seizes the eighth or first idle trunk and causes the operation of the chain relay associated therewith to close the chain circuit. The other two switches continue to rotate and seize the ninth and tenth trunks or the reserve trunks thereby completing their connections. This arrangement, however, does not completely take care of an abnormally large number of simultaneous calls to a level but reduces the number of lost calls to a minimum. Provisions have also been made for taking into use the last two or reserve trunks in each level when all the other trunks in the group are busy.

The means by which the foregoing objects are accomplished will be fully set forth hereinafter, reference being had to the accompanying drawings, of which Fig. 1 is a circuit diagram of the connector switch such as described in the above mentioned Wicks application, while Fig. 2 shows the wiring of the improved chain relay circuits and the wiring of the test terminals of certain levels of the connector banks.

Referring to Fig. 1, the rotary connector is indicated by the reference character H, and is of the well known Strowger vertical and rotary type, having circuits such that it is controlled over the two sides of the incoming trunk in series. To the right of the connector H are shown the bank terminals of a trunk line, which may extend to a private branch exchange and terminate in the jack J. It is understood that the trunk line shown is one of a group of similar trunk lines all extending to the same point.

Fig. 2 shows the test contacts of the first five levels of the connector switch bank. The first three levels and their associated chain relays are assigned to one large group of trunks. The fourth and the first half of the fifth level are assigned to a second group of trunk lines. The last five test contacts in the fifth level represent individual lines. To the right of each level are shown the vertical test contacts which are engaged by the vertical test wiper of the connector in its primary movement.

The apparatus, having been described more or less in general, will now be described in connection with the detailed description of its operation. For this purpose, it will be assumed that an automatic subscriber desires to obtain connection with a subscriber at the private branch exchange served by the first large group of trunk lines. The customary subscriber's station, individual lineswitch, and selector switches used by an automatic subscriber in completing a connection, being well understood by those skilled in the art and forming no part of the present invention, it is therefore believed that it will suffice to say that in re-

sponse to the removal of the receiver by the calling subscriber, his individual lineswitch seizes an idle trunk line leading to an idle selector switch, and in response to the operation of the subscriber's calling device the selector switch is operated to select an idle trunk line leading to another idle selector switch, or to select an idle trunk leading to a connector switch, such as indicated by the reference character H. Let us assume that the calling subscriber has established his connnection now as far as the last selector, and that the selector has come to rest on its bank contacts which are connected to the conductors 20, 21, and 22, of the connector switch H, the connector switch H being the first idle connector accessible to said selector. When the selector switch comes to rest upon the contacts associated with the conductors 20, 21, and 22, the switching relay of the selector completes an energizing circuit for the line relay 4 of the connector as follows: From ground by way of lower winding of line relay 4, normally closed springs controlled by the armature 31, conductor 21, over the intervening switches and the subscriber's loop back to conductor 20, normally closed springs controlled by the armature 30, and through the upper winding of the line relay 4 to battery. Relay 4, at armature 33 and its working contact, completes an energizing circuit for the slow-to-release relay 5. Relay 5, upon energizing over the above traced circuit, connects ground to the release conductor 22 at armature 34 and its working contact; said ground completing a holding circuit for the switches back of the connector switch for maintaining the switches in an operated position, and in addition, makes the trunk lines leading to connector H busy to all other selectors having access thereto; at armature 35 and its working contact prepares the circuit for the vertical magnet 15, and at its resting contact opens a point in the release circuit; and at armature 36 and its working contact, prepares a circuit for relays 9 and 13.

The calling subscriber may now manipulate the calling device in accordance with the remaining digits in the number of the private branch exchange, which in this case are 1 and 1. Due to the operation of the calling device by the calling subscriber, the circuit of the line relay 4 is interrupted in the well known manner and the line relay in response to this circuit interruption, deenergizes for a short interval and at this time a circuit may be traced for the vertical magnet 15 as follows: From ground by way of armature 33 and its resting contact, armature 35 and its working contact, normally closed off-normal springs controlled by spring 68 and said springs, slow-acting relay 7, and vertical magnet 15 to battery. The vertical magnet 15 and relay 7 energize in series, and by the operation of the vertical magnet 15, the switch shaft and wipers are raised until the wipers 70–73, inclusive, are opposite the first level and the vertical test wiper 95 in engagement with vertical test contact 78, which is opposite the first level. Relay 7 energizes and maintains its own circuit and that of the vertical magnet intact after the off-normal springs have shifted, which they do on the first vertical step.

After the first impulse, the line relay 4 energizes and opens the circuit for relay 7 and vertical magnet 15 at armature 33. Relay 7, upon deenergizing, which it does after a short interval, switches the impulsing circuit from the vertical magnet to the rotary magnet at armature 40, and at armature 39 completes a testing circuit for the vertical wiper relay 8.

Assuming that only the first seven trunk lines in the first level are busy, the vertical wiper relay 8 will not energize because there is no ground potential on the vertical test terminals 78.

The subscriber may now dial the remaining or last digit of the called number or the digit 1. In response to the operation of the calling device by the calling subscriber, the circuit of the line relay 4 is again interrupted. The line relay 4 upon deenergizing completes a circuit for the rotary magnet 16 in series with relay 11 as follows: From ground by way of armature 33 and its resting contact, armature 35 and its working contact, normally open off-normal springs controlled by springs 68, armature 40 and its resting contact of armature 40 and said armature, winding of relay 11, armature 59 and its resting contact, and winding of rotary magnet 16 to battery. The rotary magnet 16 and relay 11 energize in series. The rotary magnet 16 steps the wipers 70–73, inclusive, into engagement with the bank terminals of the first trunk in the first level, and moves the vertical test wiper 95 out of engagement with the first vertical test terminal 78. Relay 11 upon energizing at armature 53 and its working contact maintains the impulsing circuit for the rotary magnet closed, so that the impulsing circuit will not be opened at armature 49 when the wipers are passing over busy trunks, at armature 51 and its resting contacts opens the circuit for relay 6 so that this relay will not energize when wiper 71 is passing over busy trunks, and at armature 52 and its working contact, completes an energizing circuit for relay 12. Relay 12, upon energizing, at armature 54 and its working contact prepares a circuit for relay 6, at armature 56 disconnects the busy machine, at armature 55 and its resting contact opens the circuit of the switching relay 13, and at its working contact prepares the testing cir-

cuit for relay 10. As before stated, assuming that the first seven trunks of the first level to be busy, there will be ground potential on the test terminal which wiper 72 comes into engagement with; said ground extending from the connector switch occupying a multiple of that particular trunk line. The first trunk line in the first level being busy, ground from the lower test terminal of the said trunk line energizes relay 10 by way of wiper 72, armature 55 and its working contact, armature 61 and its resting contact, and winding of relay 10 to battery. Relay 10, upon energizing, at armature 49 opens a point in the rotary impulsing circuit, at armature 48 prepares a locking circuit for itself, and at armature 47 prepares a circuit for relay 6. A short interval after the final digit is received, the series relay 11 deenergizes and at armature 52 opens the circuit of the slow acting relay 12. Relay 12, however, does not immediately deenergize and since the first trunk line in the first level is busy, a circuit for relay 6 may be traced as follows: From ground potential on the test terminal of the busy trunk line, over the conductor connecting the bottom test terminal with the top test terminal and from there by way of test wiper 71, armature 54 and its working contact, armature 51 and its resting contact, armature 47 and its working contact, interrupter springs 66 of the rotary magnet, resting contact of armature 41 and said armature, and winding of relay 6 to battery. Relay 6, upon energizing, completes a locking circuit for itself as follows: From ground on release conductor 22 by way of working contact of armature 37 and said armature, interrupter springs 66 of the rotary magnet, resting contacts of armature 41 and said armature, and winding of relay 6 to battery. Relay 6, in addition to completing a locking circuit for itself, closes a circuit for energizing rotary magnet 16 and slow-to-release relay 12 in multiple as follows: From ground by way of working contacts of armature 36 and said armature, armature 38 and its working contact, armature 43 and its resting contact, through the junction point 96 where the circuit divides, one branch going over the resting contact of armature 52 and said armature to relay 12, and the other branch extending from the junction point 96 by the way of armature 59 and its resting contact, and through the winding of rotary magnet 16 to battery. The above traced circuit for relay 12 maintains said relay in an operated position, it being remembered that relay 12 is slow to deenergize, and, therefore, does not have time to fully deenergize before relay 6 is energized. The rotary magnet energizing over the above traced circuit, steps the wipers 70 to 73, inclusive, into engagement with the next or second set of bank terminals in the first level, and at its interrupter springs 66 opens the locking circuit for the testing relay 6, whereupon said relay deenergizes. Relay 6, upon deenergizing opens at armature 37 the circuit of the rotary magnet 16 and the slow-to-release relay 12. Before relay 12 is inclined to deenergize, the testing circuit for relay 10 is again completed and if the trunk line is busy, relay 10 will be maintained energized from ground on the test terminal associated with the busy trunk line, and a circuit may also be traced from ground at the test terminal of the busy trunk line for again energizing the stepping relay 6. Relay 6 again energizes and completes a locking circuit for itself as well as again completing the circuit for the rotary magnet and maintaining relay 12 in an operated position. The rotary magnet operates and steps the test wipers into engagement with the next set of bank contacts and in addition opens the locking circuit of relay 6 at its interrupter springs 66. Relay 6, upon deenergizing again opens the circuit for the rotary magnet 16 and relay 12. Relay 10 again tests for busy ground potential and if the next trunk line is busy, the sequence of operation just explained continues until the wipers are rotated into engagement with the eighth or the first idle trunk line in the level.

Assuming the eighth trunk line in the first level to be the first idle trunk line, the test wipers 71 and 72 will come to rest in engagement with the test terminals 75 and 76, respectively. As the test relay 10 no longer finds a ground potential on the test terminal 76 with which it is now in engagement, said relay deenergizes and prepares a circuit for the switching relay 13 at armature 48, and at armature 47 opens the circuit for the testing relay 6 so said relay will not energize and operate the rotary magnet when this trunk line is made busy to other connector switches having access thereto. At armature 50 relay 10 also opens a portion of the busy circuit. A short interval after relay 6 deenergizes the slow acting relay 12 deenergizes and completes a circuit for the switching relay 13 as follows: From grounded release conductor 22 by the way of armature 48 and its resting contacts, upper winding of switching relay 13, resting contact of armature 55 and said armature, wiper 72, test terminal 76, and winding of chain relay 80 to battery. The switching relay 13 and the chain relay 80 energize in series. The chain relay 80 upon energizing closes its contacts 84 and 85, thereby completing a chain circuit for grounding the vertical test contact 78. The circuit may be traced as follows: From ground by way of the working contacts of the first seven relays, armature 84 and its working contact, armature 115 and its resting contact to vertical test contact 78. As a result of the energization

of the switching relay 13, said relay closes at armature 58 a circuit through the low capacity condenser 97 for transmitting the well known ring-back tone when ringing current is applied to the called line. Switching relay 13, at armature 59 opens the circuit for the rotary magnet, at armature 60 short circuits its upper winding, completes a holding circuit for chain relay 80, and places ground potential on the test terminal 76, thereby making the trunk line busy to other switches having access thereto; at armature 61 opens the circuit for the testing relay 10 so said relay cannot again energize, at armature 62 completes a locking circuit for itself from ground at armature 36, at armature 63 opens a point in the release circuit so as to prevent the premature release of the switch, and at armatures 57 and 64 connects ringing current to the trunk line, which current operates a signal at the operator's position in the private bank exchange. The circuit for operating the visual signal or drop 81 at the private bank exchange may be traced as follows: By the operation of the interrupter relay 93, grounded generator and booster battery is alternately placed on armature 69, and from thence the circuit may be traced through the upper winding of the ringing cut-off relay 9, resting contacts of armature 44 and said armature, armature 57 and its working contact, wiper 70, line bank terminal 74, tip spring 82 of jack J and its resting contact, condenser C, winding of drop 81, line bank terminal 77, wiper 73, working contact of armature 64 of said armature, armature 46 and its working contact to ground. The ring cut-off relay 9 due to its construction, condenser C, and the high resistance of drop 81, will not energize over the above traced circuit, drop 81, however, is operated over the above traced circuit to display to the operator at the branch exchange the visual signal by means of which the operator is informed that a connection is desired. The operator, in response to the operation of the visual signal, inserts an answering plug of her cord circuit (not shown) into jack J, thereby disconnecting drop 81 at springs 82 and its resting contact, and completes a circuit for the ring cut-off relay as follows: from grounded generator of booster battery, at armatures 69, over the circuit previously traced to spring 82 and from thence to the operator's cord circuit back to spring 83 and ground at armature 46. Ring cut-off relay 9, upon energizing completes a locking circuit for itself at armature 45, and at armatures 44 and 46 disconnects ringing current from the called line and completes the talking circuit between the calling subscriber and the operator, and in addition, completes a circuit for the back bridge relay 3 as follows: From ground, upper winding of said relay, by the way of working contact of armature 44 of said armature, through the operator's cord circuit and back to the lower winding of said relay to battery. The back bridge relay, upon energizing, reverses the flow of current to the calling subscriber at armatures 30 and 31, and at armature 32 connects ground to the conductor 98 so that the switch cannot release until the subscriber hangs up. The operator, upon ascertaining the wants of the calling subscriber completes the desired connection and the conversation is carried on in the usual manner. After conversation is finished both parties replace their receivers. When the calling subscriber hangs up, he opens the circuit of the line relay 4 whereupon said relay deenergizes and opens the circuit of relay 5. After a short interval relay 5 deenergizes and removes ground from the release conductor 22, thereby allowing all the switches back of the connector H to release and restore to normal. In addition, at armature 36, relay 5 opens the locking circuit for relays 9 and 13, and at armature 35 completes a circuit for the release magnet 14 to allow the switch to return to normal. Relays 9 and 13 deenergize and relay 13 opens the circuit of the chain relay 80. Relay 80 deenergizes and opens the chain circuit at armature 84 and its working contact 85. The release magnet 14 is energized over the following path: From ground at armature 33 and its resting contact, armature 35 and its resting contact, armature 63 and its resting contact, off-normal springs 67, and release magnet 14 to battery. The release magnet is maintained energized over the above traced circuit until the shaft and wipers are returned to their normal position, thereupon the circuit of the release magnet is opened by the separation of the off-normal springs. The connector switch has now been returned to its normal position and can now be used for other calls.

Having described the operations of the connector switch in establishing a connection with the eight trunks in the first level and the establishments of the chain circuit as a result thereof, a detailed description will now be given showing how the connector switch completes connections to idle trunks in other levels of the same group of trunks.

Assuming that the connector switch H is again seized and operated opposite the first level as previously explained and that the first eight trunk lines in the first and second levels are busy, the vertical wiper relay will energize due to there being a ground potential on the vertical contact 78. It being remembered that when relay 7 deenergized it completed a testing circuit for the vertical wiper relay 8 at armature 39.

If the first eight trunk lines in the first

and second levels are busy, there will be a ground potential on the vertical test contacts 78 and 94 caused by the energization of the chain relays shown just below the first and seconds levels, (Fig. 2). Each chain relay, upon energizing when its associated trunk is seized completes its portion of a chain of contacts by means of which ground is connected to the vertical test contacts. Assuming, therefore that the first eight trunk lines in the first and second levels are busy, the relay 7, upon deenergizing completes an energizing circuit for the vertical wiper relay 8 as follows: From ground by way of chain relay contacts, vertical test contact 78, vertical wiper 95, resting contacts of armature 39 and said armature, and winding of relay 8 to battery. Relay 8, upon energizing prepares a circuit for vertical magnet 15 at armature 43 and its working contact, and at armature 41 and its working contact completes an energizing circuit stepping relay 6 as follows: From ground by way of vertical test wiper 95, resting contact of armature 39 and said armature, interrupter springs 65 and its resting contact, working contact of armature 41 and said armature, and the winding of stepping relay 6 to battery. Stepping relay 6 energizes and completes a locking circuit for itself as follows: From ground by way of working contact and armature 34 and said armature, working contacts of armature 37 and said armature, armature 66 and its resting contact, working contact of armature 42 and said armature, resting contact of armature 39 and said armature, interrupter spring 65 and its resting contact of the vertical magnet, working contact of armature 41 and said armature, and winding of stepping relay 6 to battery. Relay 6 also completes a locking circuit to relay 8 from ground over a portion of the above traced circuit to armature 39 and thence through the winding of relay 8 to battery. Relay 6 in addition to completing a locking circuit for itself and for relay 8, completes an energizing circuit for the vertical magnet 15 at armature 38 as follows: From ground by way of working contact of armature 36 and said armature, armature 38 and its working contact, armature 43 and its working contact, and winding of vertical magnet 15 to battery. By the operation of a vertical magnet, the switch shaft and wipers are raised opposite the next or second level, and the vertical test wiper comes into engagement with the vertical test contact 94 opposite the second level. The vertical magnet 15 at its interrupter springs 65, opens the locking circuit for relay 6, whereupon said relay deenergizes. Relay 6, upon deenergizing, opens the circuit for the vertical magnet at armature 38, and at armature 37 opens the locking circuit of the vertical wiper relay 8. The vertical magnet deenergizes and closes its interrupter springs 65. The vertical wiper relay 8, however, is maintained energized from the ground potential on the vertical test contact 94. The vertical magnet by closing its interrupter springs 65 completes an energizing circuit for the stepping relay 6. Stepping relay 6 completes a locking circuit for itself and relay 8 and operates the vertical magnet. The vertical magnet again opens the circuit of the stepping relay and this sequence of operation continues until the vertical test wiper no longer finds a ground potential or until it comes into engagement with a dead test contact, whereupon the relay 6 and the vertical magnet 15 are returned to their normal position.

The wipers of the connector switch are now opposite the third level and as the vertical test wiper 95 finds a dead vertical test contact relay 8 deenergizes and prepares a circuit for the rotary trunk hunting movement at armatures 41 and 43. The subscriber may now dial the remaining or the last digit of the called number or the digit 1. In response to the operation of the calling device by the calling subscriber, the circuit of the line relay is again interrupted.

Assuming that the first seven trunks in the third level are busy, the connector automatically rotates in the same manner as previously described until the test wipers 71 and 72 encounter the test terminals 117 and 118, respectively, of the eighth trunk or the first idle trunk in said level. As the test relay 10 no longer finds a ground potential on the test terminal 118 with which it is now in engagement, said relay deenergizes and prepares a circuit for the switching relay 13 at armature 48, and at armature 47 opens a circuit for the testing relay 6, so said relay will not energize and operate the rotary magnet when this trunk is made busy to other connector switches having access thereto. At armature 50, relay 10 opens a portion of the busy circuit. A short interval after relay 6 deenergizes, the slow acting relay 12 deenergizes and completes a circuit for the switching relay 13 as follows: From grounded release conductor 22, by the way of armature 48 and its resting contact, upper winding of switching relay 13, resting contact of armature 55 and said armature, test wiper 72, test terminal 118, switching chain relay 96 to battery. The switching relay 13 and the chain relay 96 energize in series. The chain relay 96, upon energizing, closes at its contacts 112 and 113 a circuit for energizing the chain relays 97 and 98. It will be noted that the chain relay 96 does not close a chain circuit for the vertical test terminal associated with the third level as none is needed. When the chain relay 96 energizes a circuit may be traced for the relays 97 and 98 as follows: From ground through

the contacts controlled by chain relays of the first seven busy trunks, armature 112 and contact 113, relay 97 to battery, and from contact 113 to the winding of relay 98 to battery. Relay 97 upon energizing, removes ground from the vertical test contact 94 at armature 114 and its resting contact, and at its working contacts prepares another circuit for grounding the vertical test contact 94 when the last two trunks in the second level become busy. Chain relay 98 upon energizing, removes ground from the vertical test contact 78 at armature 115 and its resting contact and at its working contact prepares a new circuit for grounding the vertical test contact 78 when the last two trunks become busy.

Assuming that the first eight trunks in the first three levels are busy, the next connector switch, such as H, to call this group does not take an automatic vertical step because ground has been removed from the vertical test contacts by the operation of the chain relay. The connector rotates as previously described and seizes an idle trunk or the ninth trunk in the first level. The chain relay associated therewith energizes and prepares a point in the circuit for again grounding test contact 78. In the same manner the next connector switch seizes the tenth trunk in the first level. The chain relay 107 energizes and completes the chain circuit for grounding the vertical test contact 78. In the previously described manner the next two switches operated to this group of trunk lines seize the ninth and tenth trunks of the second level and energize the chain relays associated therewith. The chain relays again complete the chain circuit for grounding the vertical test contact 94. Should any more connectors attempt to call the group they would be automatically stepped up to the third level and seize the last two trunks in the third level. The chain relays associated therewith energize and close a circuit for operating "all trunk busy" meter 109. It will be appreciated, however, should any of the busy trunks become idle, the chain relay associated therewith deenergizes and opens the chain circuit to remove ground from the vertical test contact associated therewith or removes ground from the "all trunk busy" meter 109.

A modification is shown in Fig. 2 for modifying the chain relay circuit so that the chain circuit for the first level is opened and ground removed from contact 78 when the first eight trunks of the second level become busy. With this arrangement or by connecting the jumper 120 to contacts 121, the first eight trunks in the first level, the first eight trunks in the second level, the last two trunks in the first level, the first eight trunks in the third level, the last two trunks in the second level, and then the last two trunks in the third level become busy in the order just named, providing, of course, that none of the busy trunks become idle in the meantime.

The number of the second large group assigned to the fourth and fifth levels is 4 and 1. The calling subscriber in order to call this group dials the digit 4 and the connector steps vertically to the fourth level at which time the vertical test wiper 95 engages the vertical test contact 101. If all the trunks on the fourth level were busy, or if only the first eight trunks in the fourth level are busy the switch automatically steps up to the fifth level. The calling subscriber dials the digit 1 and the connector rotates into engagement with the first trunk line in the fifth level in the same manner as previously described. Assuming that the first three trunk lines in the fifth level are busy the connector automatically rotates until it comes into contact with the fourth trunk line which is the first idle trunk in that level. The switching relay operates in series with the chain relay 99. The chain relay 99 closes its contacts thereby closing an energizing circuit for the chain relay 100. Chain relay 100 operates and opens the chain circuit of the fourth level thereby removing ground from the vertical test contact 101. When all the trunks on the fourth level are busy the chain circuit is again completed for grounding the vertical test contact 101 and any other connector switch calling this group is automatically stepped to the fifth level whereupon the connector seizes the last trunk line in the group or the fifth trunk line in the fifth level. When the last trunk line of the fifth level of the group is seized, a circuit is closed through the chain relay contacts for energizing the "all trunk busy" meter 108. The circuit may be traced as follows: From ground through the chain relay contacts associated with the trunk lines, through the winding of relay 108 to battery.

Having described the operation of the switch in connection with the establishing of a connection with the private bank exchange, a brief connection will now be given how the calling subscriber receives the busy signal when all the trunks to the private bank exchange are busy.

When the first digit is transmitted to the connector, the vertical magnet is operated to step the shaft and wipers opposite the first level, as previously explained. With all the trunk lines busy there will be a ground potential on the vertical test contacts 78 and 94 and the vertical magnet will automatically operate as previously explained to step the shaft wipers up to the third level. In response to the calling subscriber dialing the next digit the rotary movement of the switch is started. Assuming that all ten trunk lines in the third level are busy, the wipers are

automatically rotated into engagement with the tenth set of bank contacts of the third level. As will be noticed in Fig. 2, the test terminals of the last or tenth trunk in the third level are not strapped together and the switch will stop with its wipers 71 and 72 in engagement with said terminals as the circuit is no longer completed for the stepping relay 6. Ground, however, on the lower test terminal maintains the test relay 10 energized and said relay is locked up from the grounded release conductor 22 when relay 12 deenergizes. When relay 12 is fully deenergized, the busy tone is transmitted to the calling subscriber through armatures 56 and 50 in the well known manner, whereupon the calling subscriber hangs up and releases the switch as previously described.

The connector switch is also capable of completing connection with private or individual lines, the test terminals of five of such individual lines being shown as the last five trunk lines in the fifth level in Fig. 2. Connections to these lines, however, are directly controlled throughout by the calling subscriber. The desired line is not tested until the wipers have been rotated into engagement with the bank terminals of a desired line, whereupon the desired connection is completed if idle, or if the line is busy, the busy tone is given the calling subscriber in the well known manner.

It can be readily seen that the chain relay circuits, such as disclosed, greatly reduce the number of lost calls because the chain circuit is closed before all idle trunks in the level are taken into use. The closure of the chain circuit before all the trunks in the level are busy takes care of simultaneously hunting switches. For instance, if three connectors are simultaneously hunting over a level at a time when the first seven trunks in the level are busy, the first of the switches will seize the eighth trunk and close the chain circuit, and the other connectors would seize the last two or reserve trunks and complete their connections thereover.

Although the invention has been described as having one or two trunks held in reserve after the closure of the chain circuit it will be appreciated that any desired number of trunks could be held in reserve after the closure of the chain circuits without departing from the spirit of the invention.

Having fully described and ascertained the features of my invention, what is considered new and is desired to have protected by Letters Patent, will be pointed out in the appended claims:

What is claimed is:

1. In a telephone system, a group of lines divided into two sub-groups, and means for making only a portion of the lines in the first sub-group first choice, only a portion of the lines in the second sub-group second choice, the remaining lines in the first sub-group third choice, and the remaining lines in the second sub-group last choice to an automatic switch having access thereto.

2. In a telephone system, a group of lines divided into a plurality of sub-groups, and means for making part of the lines in the first sub-group, part of the lines in the second sub-group, part of the lines in the first sub-group, and part of the lines in the second sub-group, first, second, third, and fourth choices, respectively, in the order named, to an automatic switch having access thereto.

3. In a telephone system, a group of lines divided into two sub-groups, a chain relay for each of said lines, and circuits controlled by said chain relays for making lines in the first sub-group, lines in the second sub-group, lines in the first sub-group and lines in the second sub-group, first, second, third, and fourth choices, respectively, to an automatic switch having access thereto.

4. In a telephone system, a group of lines divided into three sub-groups, a chain circuit for each of said sub-groups, means for closing the chain circuits of the three sub-groups, and means responsive to the closing of the chain circuit of the third sub-group for opening the chain circuits of the first and second sub-groups.

5. In a telephone system, a group of lines divided into three sub-groups, a chain circuit for each of said sub-groups, means for closing the chain circuits of the first and second sub-groups, and means responsive to the closing of the chain circuit of the second sub-group for opening the chain circuit of the first sub-group.

6. In a telephone system, a group of lines divided into three sub-groups, a chain circuit for each of said sub-groups, means for closing the chain circuits of the first and second sub-groups, means responsive to the closing of the chain circuit of the second sub-group for opening the chain circuit of the first sub-group, means for closing the chain circuit of the third sub-group, and means responsive to the closing of the chain circuit of the third sub-group for opening the chain circuit of the second sub-group.

7. In a telephone system, a group of lines divided into three sub-groups, a chain circuit for each of said sub-groups, means for closing the chain circuits of the first and second sub-groups, means responsive to the closing of the chain circuit of the second sub-group for opening the chain circuit of the first sub-group, means for closing the chain circuit of the third sub-group, means responsive to the closing of the chain circuit of the third sub-group for opening the chain circuit of the second sub-group, and means for again closing said chain circuits.

8. In a telephone system, a connector, a switch bank for said connector, a group of

lines divided into sub-groups terminating in said bank, individual test bank terminals for each line, a chain relay associated with each of said terminals in said sub-groups, means for operating the associated chain relay whenever said connector seizes a line, and means operated by said chain relays in the first sub-group when only a portion of said lines are busy for causing said connector to hunt for an idle line in the second sub-group when the connector has been operated to the first sub-group.

9. In a telephone system, a connector, a switch bank for said connector, a group of lines divided into sub-groups terminating in said bank, individual test bank terminals for each line, a chain relay associated with each of said terminals in said sub-groups, means for operating the associated chain relay whenever said connector seizes a line, and means operated by the chain relays in the first and second sub-groups when only part of the lines in the first and second sub-groups are busy for causing said connector to hunt for an idle line in the third sub-group when the connector has been operated to the first sub-group.

10. In a telephone system, a connector, a switch bank for said connector, a group of lines divided into sub-groups terminating in said bank, individual test bank terminals for each line, a chain relay associated with each of said terminals in said sub-groups, means for operating the associated chain relay whenever said connector seizes a line, and means operated by the chain relays in the first, second, and third sub-groups when only a part of the lines in the first, second, and third sub-groups are busy for causing said connector to hunt for an idle line in the first sub-group when the connector has been operated to the first group.

11. In a telephone system, a connector, a switch bank for said connector, a group of lines divided into sub-groups terminating in said bank, individual test bank terminals for each line, a chain relay associated with each of said terminals in said sub-groups, means for operating the associated chain relay whenever said connector seizes a line, and means operated by the chain relays in the first, second, and third sub-groups when all of the trunks in the first sub-group and only a part of the lines in the second and third sub-groups are busy for causing the connector to hunt for an idle line in the second sub-group when the connector is operated to the first group.

12. In a telephone system, a group of lines divided into sub-groups, an automatic switch having access to said lines, and means for causing said switch to automatically move from the first of said sub-groups to the second of said sub-groups responsive to the busying of only a portion of the lines in said first sub-group.

13. In a telephone system, a group of lines divided into sub-groups, means for making any of said lines busy, and means for completing a busy circuit for the first sub-group responsive to the busying of only a portion of the lines in such sub-group.

14. In a telephone system, a group of lines divided into sub-groups, means for making any of said lines busy, means for completing a busy circuit for the first sub-group when only a portion of the lines in such sub-group are busy, and means for opening said circuit.

15. In a telephone system, a group of lines divided into sub-groups, means for making any of said lines busy, means for completing a busy circuit for the first sub-group when only a portion of the lines in such sub-group are busy, means for opening said circuit, and means for again closing said circuit.

In witness whereof, I hereunto subscribe my name this 14th day of August, A. D. 1926.

LEONARD L. RUGGLES.